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*Exempt from Filing Fees Under
Government Code § 6103*

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14 SUPERIOR COURT OF THE STATE OF CALIFORNIA
15 COUNTY OF SACRAMENTO

16 **COUNTY OF SACRAMENTO, a**
17 **California county,**
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19 Petitioner and Plaintiff,
20
21 **v.**
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23 **CALIFORNIA DEPARTMENT OF**
24 **WATER RESOURCES, a California**
25 **State Agency,**
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27 Respondent and Defendant.
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DOES 1 through 50,

Real Parties in Interest.

Case No. 24WM000014

(Related to 24WM000006; 24WM000008;
24WM000009; 24WM000010; 24WM000011;
24WM000012; 24WM000017; 24WM000062;
24WM000076)

**COMPENDIUM OF EVIDENCE IN
SUPPORT OF CAL. DEPT. OF WATER
RESOURCES’ EX PARTE APPLICATION
FOR ORDER TO MODIFY OR STAY THE
PRELIMINARY INJUNCTION – VOLUME
III OF IV**

(CEQA case: California Environmental
Quality Act, Pub. Resources Code, § 21000 et
seq.)
Dept: 36
Judge: Hon. Stephen Acquisto
Action Filed: January 22, 2024

Respondent California Department of Water Resources (DWR) hereby submits the following evidence in support of the DWR’s ex parte application for order to modify or stay the preliminary injunction (Ex Parte Application). For ease of reference, DWR’s Ex Parte Application contains citations to both the declarations themselves (and any exhibits, where relevant), and to the Bates numbered pages referenced in this Compendium of Evidence in Support of DWR’s Ex Parte Application (COE). This is DWR’s second Compendium of Evidence, and the Bates numbered pages continue from DWR’s first Compendium of Evidence in Support of DWR’s Opposition to All Petitioners’ Motions for Preliminary Injunction.

Volume	Declaration	Exhibit	Exhibit Description	Bates Nos.
I	Decl. of Graham Bradner			291-305
I		A	2024 Cost Estimate, titled “Total Project Cost Summary Memorandum”	306-371
I		B	Finch, M. 1985. Earthquake Damage in the Sacramento–San Joaquin Delta, Sacramento and San Joaquin Counties. February. California Geology 38(2):39–44	372-380
I		C	Tsai, Y. 2018. Characterizing Seismic Performance of Levees on Peaty Organic Soils from Case Histories and Simulations. PhD dissertation. University of California, Los Angeles. Los Angeles, CA	381-715
II		D	U.S. Geological Survey. 2016. Earthquake Outlook for the San Francisco Bay Region 2014–2043. Fact Sheet 2016-3020. Version 1. August	716-722
II		E	California Department of Water Resources, October 2018, Supplement C – Water Project Export Disruptions for Multiple-Island Breach Scenarios using the Delta Emergency Response Tool	723-804
II		F	California Department of Water Resources, February 2009, Delta Risk Management Strategy, Phase 1, Executive Summary	805-837
II		G	Sunding, D. and Browne, O. 2024. Benefit-Cost Analysis of the Delta Conveyance Project. Berkeley Research Group	838-913

Volume	Declaration	Exhibit	Exhibit Description	Bates Nos.
III		H	California Department of Water Resources, December 2023, Delta Conveyance Project Final Environmental Impact Report, Chapters 6, 7, 10, 25, 26 and 30	914-1260
III	Decl. of Carolyn Buckman			1261-1267
III		A	Map of 2024-2026 Proposed Geotechnical Activities that are subject to temporary entry permits voluntarily entered by landowners to date or are located on DWR-owned property	1268-1269
III		B	Map of 2024-2026 Proposed Geotechnical Activities that will require court-ordered entry, assuming additional landowners do not enter temporary entry permits	1270-1271
III		C	Delta Conveyance Project - Modernizing California's Water Infrastructure - 2024 Fast Facts	1272-1274
III		D	Facts About the Economic Value of the Delta Conveyance Project	1275-1283
III		E	Sunding, D. and Browne, O. 2024. Benefit-Cost Analysis of the Delta Conveyance Project. Berkeley Research Group	1284-1359
IV	Decl. of Andrew Finney			1360-1364
IV		A	Map of 2024-2026 Proposed Geotechnical Activities that are subject to temporary entry permits voluntarily entered by landowners to date or are located on DWR-owned property	1365-1366
IV		B	Map of 2024-2026 Proposed Geotechnical Activities that will require court-ordered entry, assuming additional landowners do not enter temporary entry permits	1367-1368
IV	Decl. of Jeff Henderson			1369-1371
IV		A	Delta Stewardship Council's "Delta Plan's regulatory policies in PDF format"	1372-1382

Volume	Declaration	Exhibit	Exhibit Description	Bates Nos.
IV		B	“Draft Determination Regarding Appeals of the Certification of Consistency by the California Department of Water Resources for California WaterFix” (November 8, 2018)	1383-1539
IV	Decl. of Katherine Marquez			1540-1557
IV		A	Delta Stewardship Council’s “Administrative Procedures Governing Appeals, Statutory Provisions Requiring Other Consistency Reviews, and Other Forms of Review or Evaluation by the Council”	1558-1581
IV		B	Delta Stewardship Council’s December 16, 2022, comment letter on the Delta Conveyance Project Draft Environmental Impact Report	1582-1620
IV		C	2024-2026 Exploratory Planning and Design Field Investigations - Environmental Compliance, Clearance, and Monitoring Plan	1621-1704
IV		D	Tribal Cultural Resources Management Plan: Phase I (updated July 2024)	1705-1722
IV	Decl. of Demetri Polyzos			1723-1736
IV		A	Facts About the Economic Value of the Delta Conveyance Project	1737-1745
IV		B	Delta Conveyance Project - Modernizing California’s Water Infrastructure - 2024 Fast Facts	1746-1748
IV	Decl. of Craig Wallace			1749-1755
IV		A	Facts About the Economic Value of the Delta Conveyance Project	1756-1764
IV		B	Delta Conveyance Project - Modernizing California’s Water Infrastructure - 2024 Fast Facts	1765-1767

1 Dated: July 24, 2024

Respectfully submitted,

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**EXHIBIT H
TO BRADNER
DECLARATION**

Delta Conveyance Project

Final Environmental Impact Report



December 2023

Chapter 6

Water Supply

This chapter describes potential changes to State Water Project (SWP) and Central Valley Project (CVP) water supply that could result from the Delta Conveyance Project (project). Changes to water supply, by themselves, are not considered an impact under CEQA and are not evaluated as impacts in this chapter. Potential changes to SWP and CVP water supply are described in this introductory chapter to provide a basis for understanding the impact assessments associated with other resource chapters in this document.

Many of the changes or impacts evaluated in this document are related to the potential changes to water supply described in this chapter. Chapter 5, *Surface Water*, is an introductory chapter to describe changes in surface waters of the Sacramento River and San Joaquin River Basins, including the Delta, that could be directly or indirectly affected by SWP and CVP operations. Chapter 7, *Flood Protection*, describes flood management such as regulated flow and storage, and flood protection facilities such as levees in the study area. Chapter 8, *Groundwater*, describes groundwater characteristics in the Sacramento and San Joaquin River Basins. Chapter 9, *Water Quality*, describes surface water quality in the Sacramento and San Joaquin River Basins. Chapter 12, *Fish and Aquatic Resources*, and Chapter 13, *Terrestrial Biological Resources*, discuss riparian corridor biological resources in the study area that are dependent on water supply and surface water flows. Chapter 29, *Environmental Justice*, describes the potential for disproportionately high and adverse effects on minority or low-income populations and draws upon the estimated water deliveries reported in this chapter to support portions of the impact assessment. Chapter 31, *Growth Inducement*, describes potential effects on urban areas caused by changes in SWP and CVP water supply deliveries.

Water supplies and approaches to water supply management vary significantly throughout California depending on supply sources and on various urban, agricultural, and environmental water needs. The study area for the SWP and CVP water supply analysis in this chapter includes the Delta region, areas upstream of the Delta (if modeling indicates a potential change as a result of the project alternatives), and the SWP and CVP south-of-Delta export service areas (i.e., areas that receive water from the Delta watershed that is delivered by the Harvey O. Banks Pumping Plant [Banks Pumping Plant] and C. W. “Bill” Jones Pumping Plant [Jones Pumping Plant]) and SWP’s north-of-Delta export service areas (e.g., areas in Napa and Solano Counties delivered through the North Bay Aqueduct). The SWP and CVP are operated in a coordinated manner. Joint points of diversion allow the use of one project’s diversion facility by the other under certain conditions. In part, both the SWP and CVP water delivery systems rely on runoff and reservoir releases in areas upstream of the Delta to deliver contracted water via the Sacramento and San Joaquin Rivers to Delta export pumps in the south Delta.

The Delta watershed includes the tributary rivers that flow directly into the Delta from the east and the Sacramento River and San Joaquin River Basins. In general, the Delta watershed is represented by the drainage of the Central Valley except for the Tulare Lake area. Areas outside of the Delta that receive water from the Delta watershed include Tulare Lake Basin, Solano County, Napa County, San Francisco Bay Area (Bay Area), Central Coast, and Southern California. Figure 1-2 in Chapter 1, *Introduction*, shows the major SWP and CVP water supply infrastructure. Figure 1-3 shows the SWP and CVP service areas.

6.0 Summary Comparison of Alternatives

Table 6-0 provides a summary comparison of modeled changes to SWP and CVP south of delta water supply by alternative. Some potential water supply changes are not included in the modeling, including the potential benefit associated with having a backup water supply to help prepare for earthquake risk.

Changes to water supply, by themselves, are not considered an impact under CEQA and are not evaluated as impacts in this chapter. Potential changes to SWP and CVP water supply are described in this introductory chapter to provide a basis for understanding the impact assessments associated with other resource chapters in this document. The project alternatives do not include any actions that would modify water deliveries to non-SWP and non-CVP water rights holders, including in-Delta water rights holders. Therefore, only changes to California Department of Water Resources (DWR), Bureau of Reclamation (Reclamation), and SWP water users and CVP water service contractors are included. No specific impact assessment results are presented in this chapter because the effects of these changes are not considered environmental impacts under CEQA.

1 **Table 6-0. Water Supply for Existing Conditions and the Project Alternatives (thousand acre-feet)**

Chapter 6 – Water Supply	Existing Conditions	Project Alternative								
		1	2a	2b	2c	3	4a	4b	4c	5
Total Annual SWP Deliveries Long-Term Average ^{a, d} (SWP Contract Year; January–December)	2,429	2,968	2,959	2,838	2,923	2,968	2,959	2,838	2,923	2,972
Total Annual SWP Deliveries, Average of Dry and Critical Water Years ^{b, d} (SWP Contract Year; January–December)	1,317	1,634	1,605	1,541	1,589	1,634	1,605	1,541	1,589	1,633
Total Annual South-of-Delta ^c CVP Deliveries, Long-Term Average ^a (CVP Contract Year; March–February)	1,587	1,634	1,678	1,610	1,629	1,634	1,678	1,610	1,629	1,633
Total Annual CVP South-of-Delta Deliveries, Average of Dry and Critical Water Years ^b (CVP Contract Year; March–February)	945	963	996	963	970	963	996	963	970	963

2 ^a Long-term average is the average annual for the period October 1921–September 2015 simulated in CalSim 3.

3 ^b Dry and critical is the average annual for the State Water Resources Control Board Water Right D-1641 40-30-30 dry and critical years for the period October 1921–September 2015 simulated in CalSim 3.

4 ^c Values do not include deliveries to exchange contractors.

5 ^d Values do not include deliveries to senior water right holders in the Feather River Service Area under various settlement agreements.

6.1 Overview of California Water Resources

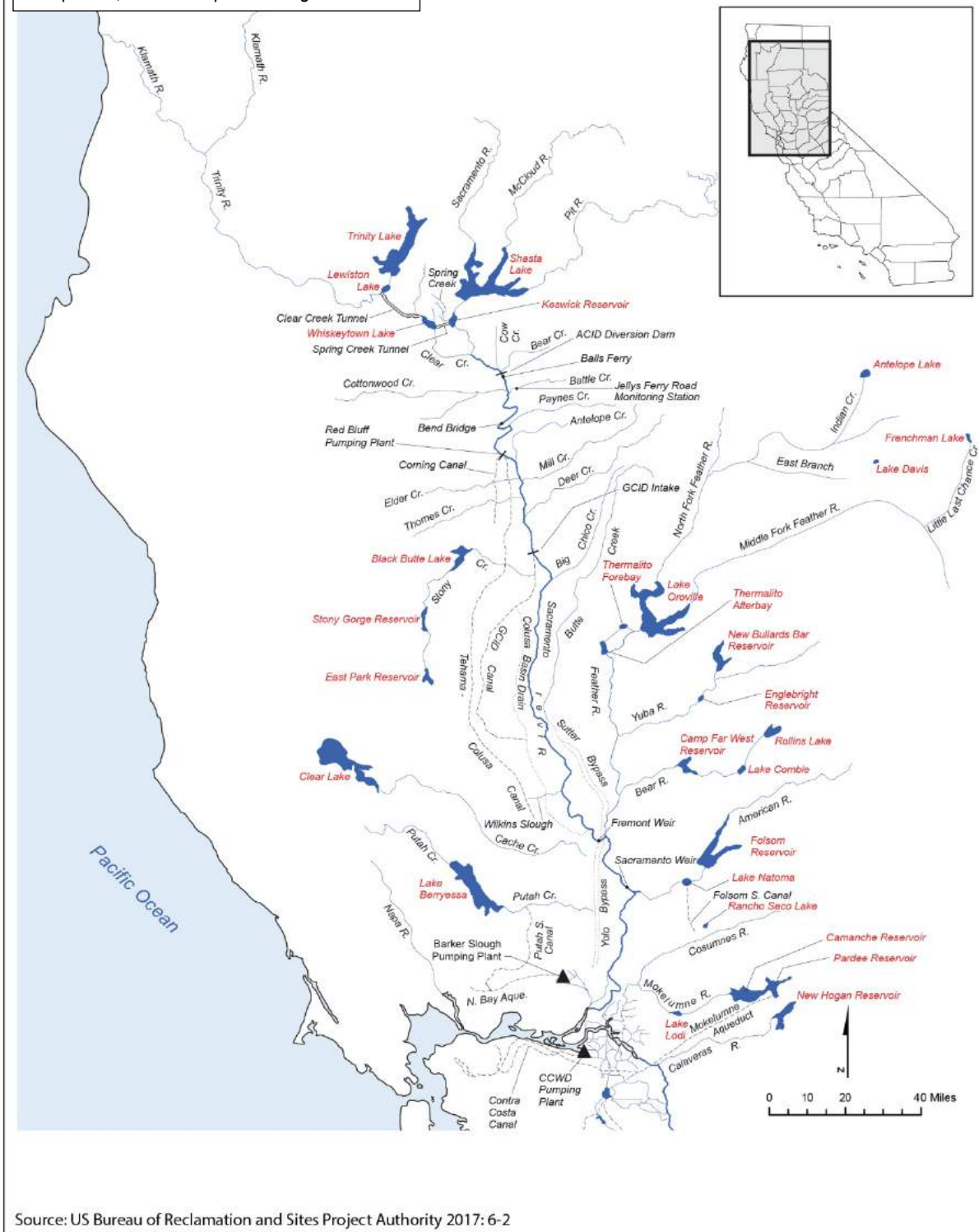
As described in Chapter 5, *Surface Water*, and Chapter 8, *Groundwater*, California's water resources vary dramatically geographically across the state because of extreme differences in precipitation conditions. Precipitation is a considerable source of California's water supply; however, it varies greatly from year to year, by season, and by where it falls geographically in the state. In winter and spring, precipitation and snowmelt are captured in surface water reservoirs to provide flood protection and water supply.

To cope with the state's hydrologic variability, state, federal, and local agencies have constructed a vast interconnected system of surface reservoirs, aqueducts, and water diversion facilities. This system helps California to store and convey water supplies from areas that have water available to areas that have water needs. In most regions of the state, these imported water supplies supplement local and regional water sources.

6.1.1 Developed Water Supplies

California has a long history of constructing large water infrastructure projects. The SWP, originally proposed in 1930, is a collection of canals, pipelines, reservoirs, and hydroelectric power facilities that delivers water to 27 million Californians, 750,000 acres of farmland, and businesses throughout the state. In addition to the SWP, other large water infrastructure projects include Hetch Hetchy Reservoir and Aqueduct, which supply water to the San Francisco Bay Area; Pardee Reservoir and the Mokelumne Aqueduct, which supply water to the East Bay in the San Francisco Bay Area; the federal CVP (including the Friant-Kern Canal), which supplies water to the Central Valley and Bay Area; the Colorado Aqueduct, which supplies water to Southern California; and the Los Angeles Aqueduct, comprising the Owens Valley Aqueduct and Second Los Angeles Aqueduct, which supplies water to the city of Los Angeles, as shown on Figures 6-1a, 6-1b, and 6-1c.

A text description of this figure is provided in Chapter 39, *Text Descriptions of Figures*



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Figure 6-1a. Developed Water Supply Projects in Northern California

A text description of this figure is provided in Chapter 39, *Text Descriptions of Figures*

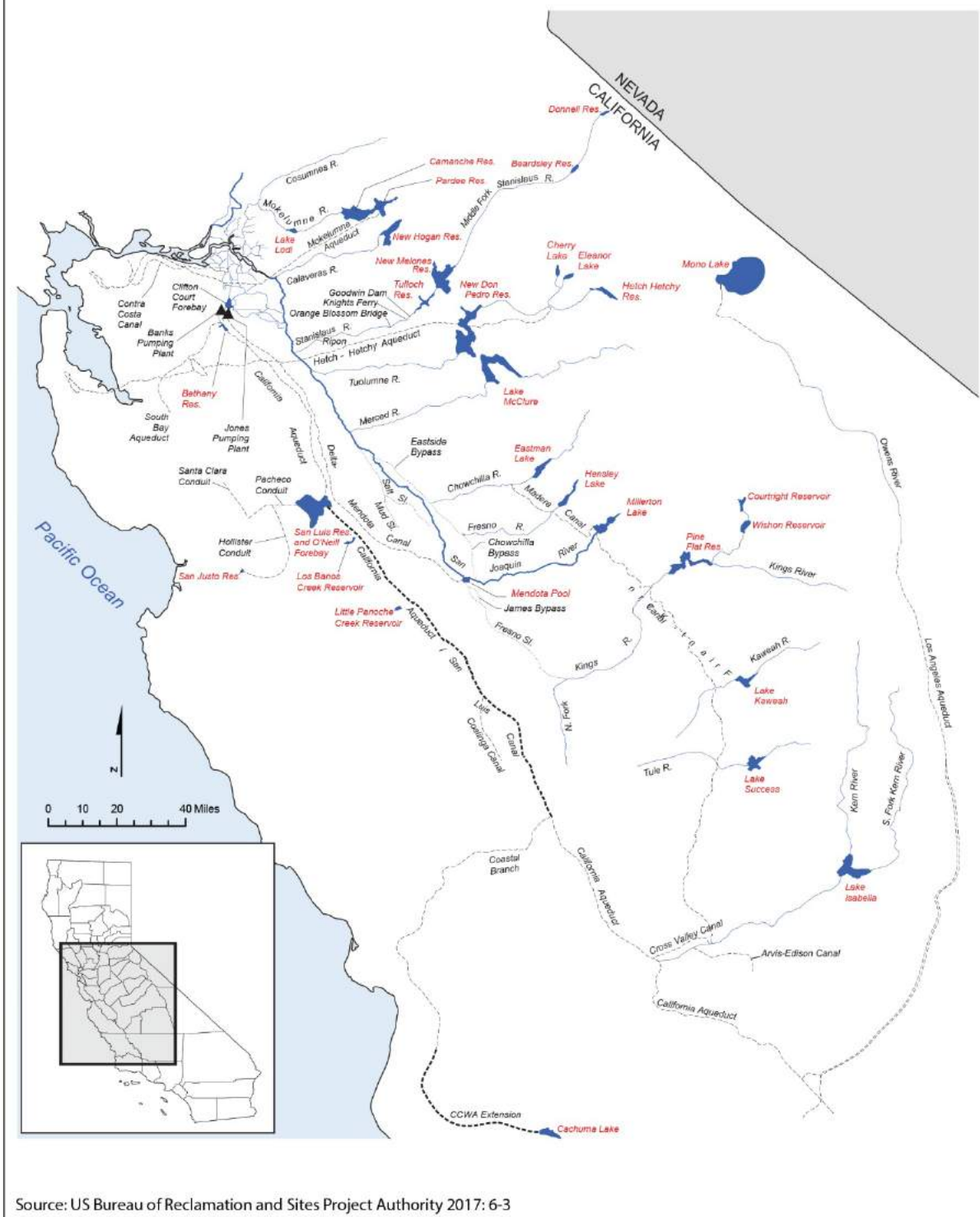


Figure 6-1b. Developed Water Supply Projects in San Francisco Bay Area, San Joaquin Valley, and Tulare Lake

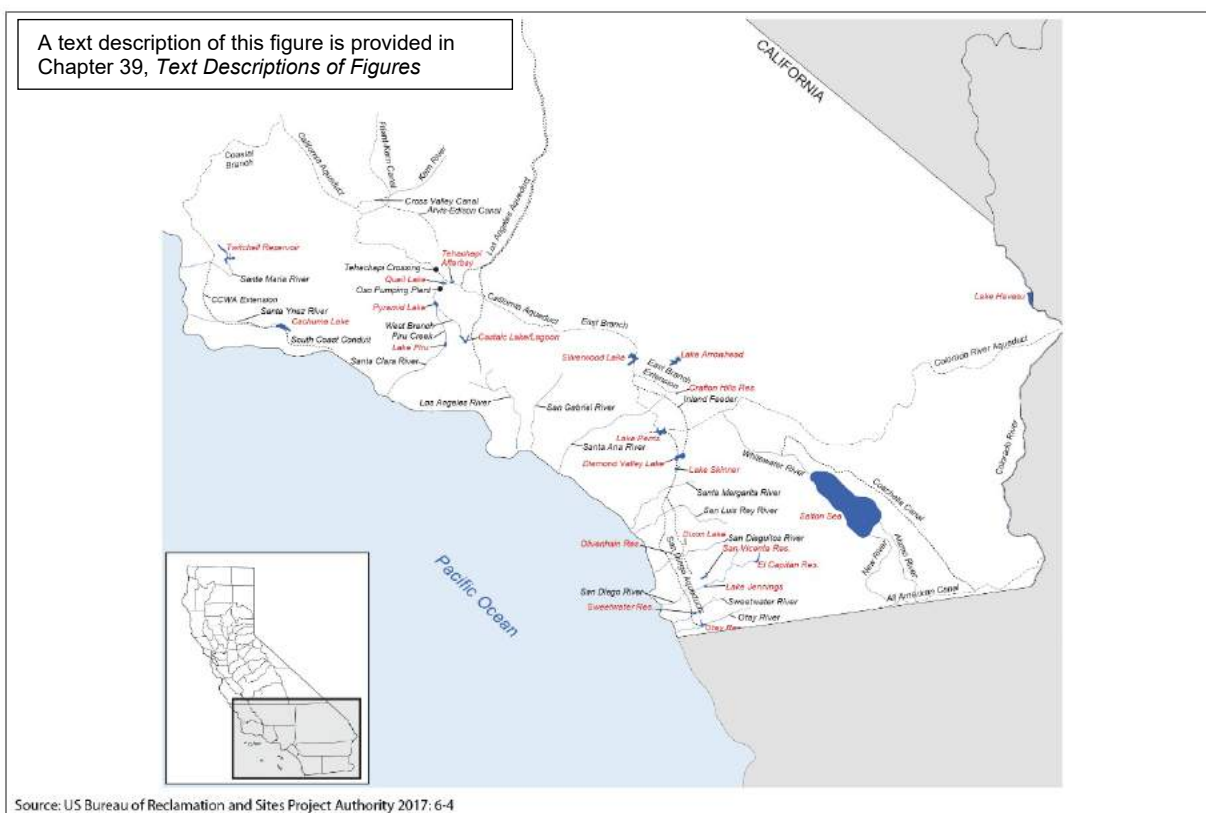


Figure 6-1c. Developed Water Supply Projects in Central Coast and Southern California

6.1.2 Surface Water

This section provides a brief overview of California surface water resources related to water supply. Chapter 5 provides a detailed description of surface water resources in the study area.

In California, winter precipitation and spring snowmelt are captured in surface water reservoirs to provide flood protection and water supply. The state's largest surface water "reservoir" is the Sierra Nevada snowpack, which is the primary source of water supply and natural groundwater recharge in California (California Department of Water Resources 2019a:1-14). The timing, quantity, and location of precipitation in California is distributed largely across the northern and mountainous regions of the state and generally occurs during the cool, winter months; however, agricultural and urban water uses are generally concentrated in the southern, coastal, and valley regions of the state and precipitation generally occurs during the warm summer and fall seasons.

To cope with the state's hydrologic variability, state, federal, and local agencies have constructed vast interconnected systems (i.e., the SWP and CVP) of surface reservoirs, aqueducts, and water diversion facilities. These systems help California store and convey water supplies from areas that have sufficient water to areas that are water deficient. In most regions of the state, these imported water supplies supplement local and regional water sources. California depends on these statewide water management systems to provide clean and reliable water supplies, protect lives and property from floods, endure drought, and sustain environmental values including the restoration and enhancement of terrestrial, wetland, and aquatic ecosystems.

6.1.3 Groundwater

Groundwater is water that exists underground in saturated zones beneath the land surface, and exists throughout California. This section provides a brief overview of California groundwater resources related to water supply. Chapter 8 provides a detailed description of groundwater resources in the study area.

The importance of groundwater as a resource varies regionally. For example, the Central Coast Hydrologic Region has the most reliance on groundwater to meet its local uses, with more than 90% of its water use supplied by groundwater in an average year. The Tulare Lake Hydrologic Region meets about 69% of its local uses with groundwater extraction. The rest of the Central Valley meets between 15% and 35% of local uses with groundwater. In Southern California, the use of groundwater varies between 15% and 37% of annual use (South Coast Hydrologic Region) and 40% of annual use (South Lahontan Hydrologic Region) (California Department of Water Resources 2021a:H-16). Within each of these regions, some local areas are 100% reliant on groundwater.

Groundwater resources will not be immune to climate change; in fact, historical patterns of groundwater recharge have changed considerably in recent years. During droughts, California has historically depended more heavily upon groundwater, and because droughts are expected to be exacerbated by climate change, efficient groundwater basin management is necessary to avoid additional overdraft and to take advantage of opportunities to store water underground and eliminate existing and future overdraft.

A new era for California's groundwater began in September 2014 with the passage of the Sustainable Groundwater Management Act (SGMA). SGMA established a path for the sustainable management of groundwater through the formation of locally organized groundwater sustainability agencies and locally developed groundwater sustainability plans. In response to the requirements of Section 12924 of the California Water Code and SGMA, in December 2016 DWR completed an interim update of Bulletin 118, addressing time-sensitive information important to the SGMA Program. The purpose of the interim update was to provide up-to-date information on groundwater basins subject to critical conditions of overdraft, groundwater basin boundaries, and basin prioritization (California Department of Water Resources 2016:11).

In January 2016, DWR released the final list of groundwater basins subject to critical conditions of overdraft. Bulletin 118, Update 1980 defines a groundwater basin subject to critical conditions of overdraft as follows: "[a] basin is subject to critical conditions of overdraft when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts" (California Department of Water Resources 1980:9). Several basins were identified as being in a critical condition of overdraft, most of which are in the Tulare Lake and San Joaquin River Basins.

In March 2021, DWR released the *Draft Groundwater Update 2020*, the first in what will be a series of 5-year updates required by SGMA. The 2020 update identifies 515 defined alluvial groundwater systems (basins) throughout the state (California Department of Water Resources 2021a:H-11). The majority of California's land area (about 60%) is outside of defined groundwater basins or subbasins, known as non-basin areas; yet groundwater extraction in these areas accounted for only about 5.7% of statewide groundwater production in 2014 (California Department of Water Resources 2021a:2-12). These basins, subbasins, and non-basins have various degrees of supply reliability, considering yield, storage capacity, and water quality.

6.1.4 Alternative Water Sources

Alternative sources of water, such as recycled water, desalinated water, and stormwater, are becoming more commonplace as part of California's water supply. Alternative water sources improve water supply reliability and the state's ability to withstand drought conditions.

California Water Code Section 13050 defines *recycled water* as "water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur and is therefore considered a valuable resource." Recycled water is currently used for groundwater recharge; indirect potable reuse; repelling seawater intrusion; landscape irrigation; and industrial, agricultural, and environmental uses. The State Water Resources Control Board (State Water Board) is developing policy and regulations for direct potable reuse. The most recent survey of municipal water recycling, conducted jointly by DWR and the State Water Board, found that California used 714,000 acre-feet of municipal recycled water during 2015. This was an increase of 45,000 acre-feet since the previous survey in 2009 (California Department of Water Resources 2021b).

Water desalination is the removal of salts and dissolved solids from saline water (brackish water [including groundwater] or seawater), also known as desalting or desalinization. Desalination is receiving increased attention as a means for addressing the water supply challenges of California. In 2002, the California Legislature approved Assembly Bill 2717, which asked DWR to convene the California Water Desalination Task Force to look into potential opportunities and impediments for using seawater and brackish water desalination, and to examine what role, if any, the state should play in furthering the use of desalination technology. A primary finding of the task force is that economically and environmentally acceptable desalination should be considered as part of a balanced water portfolio to help meet California's existing and future water supply and environmental needs. Existing desalination facilities provide about 81,000 acre-feet annually to municipal water supplies. Seven seawater desalination plants are in various stages of planning and operation, with outputs ranging from about 2 acre-feet per year to over 50,000 acre-feet per year, and have the potential to contribute over 130,000 acre-feet annually. Several large-scale brackish groundwater desalination projects have been implemented in Alameda County, Ontario, Orange County, Perris, and Carson. Some facilities produce up to 14 million gallons a day of fresh water from brackish groundwater (CalDesal 2022).

Stormwater can be captured and stored in a variety of ways, including green roofs, infiltration basins, detention basins, and bioretention rain gardens. Captured stormwater can be stored in underground tanks and reservoirs for use on-site or can be used to support groundwater recharge. Historically, stormwater was managed through flood control conveyance facilities to move urban stormwater to receiving waters as quickly as possible and prevent the collection of floodwaters on roads and in urban centers. Local and regional agencies, such as Fresno Metropolitan Flood Control District and Los Angeles County have implemented stormwater capture runoff projects to support groundwater recharge, improve water quality conditions, and attenuate flood flows. The capture and use of urban runoff, including gray water, as part of the water supply portfolio is an emerging consideration; however, barriers such as infrastructure needs, market pricing, and regulations still need to be overcome. The State Water Board has partnered with other state and local agencies to develop strategies to overcome barriers and increase stormwater capture and use to augment surface water supplies, recharge groundwater, and support ecosystems.

6.2 Overview of California Water Demand

Limitations on available surface water, groundwater, and the potential impacts of climate change pose significant challenges to meeting the state's water demands. Population growth is a major factor influencing current and future water uses. California's population is expected to increase from approximately 40.1 million in 2020 to approximately 41.2 million by the year 2025 and 44.8 million by 2050 (California Department of Finance 2021). A larger population requires more water, all other things being equal. However, significant progress in water conservation and water use efficiency has been made and has resulted in reduced per capita use and an overall slowing of the increase in water demand notwithstanding population growth. For example, major water reuse programs such as the Los Angeles County Sanitation District's Water Reuse Program and the City of San Diego's Recycled Water Program, as well as the Silicon Valley Advanced Water Purification Center in San Jose, reduce the demand for potable water that often depends on imported water from the SWP and other sources.

California is one of the most productive agricultural regions in the world. Agriculture is an important element of California's economy, with 77,100 farms and ranches receiving a total of \$50.13 billion for their output in 2017, according to the California Department of Food and Agriculture (California Department of Food and Agriculture 2018:2). In an average year, California irrigates approximately 9.6 million acres of land with roughly 34 million acre-feet (MAF) of water (California Department of Water Resources 2021c).

Another important use of water is for environmental purposes. This includes water use for meeting flow and water quality standards established for various regions and waterbodies, including instream flow standards and regional plans such as the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary and associated State Water Board Water Right Decision 1641 (D-1641). Other applicable laws and regulations with specific water flow and quality requirements also contributed to the environmental water demand. These include the 2019 Biological Opinion (BiOp) issued by the U.S. Fish and Wildlife Service (USFWS) (U.S. Fish and Wildlife Service 2019) and another 2019 BiOp by the National Marine Fisheries Service (NMFS) (National Marine Fisheries Service 2019) for the coordinated long-term operations of the SWP and CVP, the Incidental Take Permit (ITP) by the California Department of Fish and Wildlife (CDFW) on long-term operations of the SWP (California Department of Fish and Wildlife 2020), and the Central Valley Project Improvement Act (CVPIA), which have all directly and indirectly resulted in the dedication of water to fish, wildlife, and habitat restoration. This dedication is accomplished by releasing water from upstream reservoirs for in-river and Delta outflow requirements and by reducing exports from the south Delta pumping plants during specific times, among other actions (California Department of Water Resources 2018).

The state's water resources are variable, and agricultural, urban, and environmental water uses all vary accordingly. In wetter water years with high levels of precipitation, agricultural and urban landscape (outdoor) water demands are lower because higher precipitation, especially in the early spring season, helps meet the needs of these water uses. As a result, applied water demands for urban and irrigated agriculture are usually highest during average to below-average water years.

Table 6-1 shows the precipitation and statewide water use in California from 2011 (a wet year) to 2015 (a critically dry year) compiled by DWR. Californians meet water demands primarily by using local surface water and groundwater supplies, as well as imported water through extensive regional and statewide networks of water storage and conveyance facilities (e.g., the SWP), and through

continued improvement of water use efficiency. Additional emerging water supplies include recycled water and desalination in major urban and coastal areas, respectively, as previously mentioned.

Table 6-1. California Water—Precipitation and Applied Statewide Water Use, 2011–2015

Water Year	2011	2012	2013	2014	2015
Precipitation (millions of acre-feet)	248.1	138.9	142.0	102.6	143.3
Applied Water Use ^a (millions of acre-feet)					
Urban	7.7	8.3	8.3	8.1	7.0
Irrigated Agriculture	31.7	35.0	35.7	35.0	32.4
Environmental Water ^b	53.2	33.9	29.8	21.7	24.7

Source: California Department of Water Resources 2019b:3.

^a *Applied water* refers to water delivered to a user, either indoors or outdoors, and typically occurs in an agricultural or urban setting.

^b *Environmental water* refers to water allocated to: managed wetlands, minimum required Delta outflow, instream flow requirements, and wild and scenic rivers.

6.2.1 SWP and CVP Facilities and Operations

The Delta Conveyance Project is proposed as an SWP facility; however, the SWP operation is linked to that of the CVP through the Coordinated Operation Agreement (Section 6.2.1.3, *SWP/CVP Coordinated Operations, Coordinated Operation Agreement*) that was first established in 1986 and amended in 2018 (Bureau of Reclamation and California Department of Water Resources 1986, 2018). Thus, pertinent descriptions of CVP operation are also included in the discussions of Section 6.2.1.2, *CVP Facilities*, and Section 6.2.1.3.

DWR and Reclamation operate the SWP and the CVP, respectively, to divert, store, and convey water consistent with applicable laws and regulations, and contractual obligations for agricultural, urban, and environmental beneficial uses in the Sacramento River Basin, the Delta, and south of the Delta.¹ The SWP and CVP both include major reservoirs upstream of the Delta and transport water via natural watercourses and canal systems to areas south and west of the Delta. The CVP also includes facilities and operations on the Stanislaus and San Joaquin Rivers.

Operations of the SWP and CVP are highly regulated. The SWP and CVP must meet operational requirements in D-1641 to help meet Delta water quality objectives, as well as requirements in federal BiOps and state ITPs that are intended to protect certain fish and wildlife species. The state also regulates the SWP directly through the State Water Board under California's Porter-Cologne Water Quality Control Act and California's implementation of the federal Clean Water Act. DWR and Reclamation closely coordinate the SWP and CVP operations, respectively, to meet these conditions; however, these regulations can have significant effect on the amount of water the projects can deliver. For the federal, state, and local/regional laws, regulations, and programs that affect water supply operations, see Chapter 1, *Introduction*.

¹ The SWP and CVP will continue to be operated in accordance with D-1641 until a new water rights decision is adopted by the State Water Board.

6.2.1.1 SWP Facilities

The SWP is a multipurpose project with major facilities, including Lake Oroville and Dam, North Bay Aqueduct, Banks Pumping Plant, San Luis Reservoir, South Bay Aqueduct, and California Aqueduct. In addition to its water supply purpose, the SWP also provides functions for flood management, recreational, and environmental purposes. DWR holds contracts with 29 public water agencies for up to a maximum amount of 4.17 MAF in the Feather River Area, North Bay Area, South Bay Area, San Joaquin Valley, Central Coast, and Southern California for water supplies from the SWP. Water stored in the Oroville facilities provides water supply to the Feather River Service Area (FRSA) (i.e., Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District) and is diverted through the Delta, along with available water in the Delta, for delivery to north-of-Delta contractors in Solano and Napa Counties and south-of-Delta SWP long-term water contractors (SWP water contractors) in the Bay Area, San Joaquin Valley, Central Coast, and Southern California. In addition to the 29 contractors, DWR also provides water to senior water right holders in the FRSA and the Delta based on its water right settlement agreements for construction and operation of the SWP. In the past decade, the SWP delivered on average 2.9 MAF of contracted water supplies annually (California Department of Water Resources 2021d:xxxvii). The following subsections provide additional descriptions of SWP facilities and operation.

Oroville Field Division

Lake Oroville has a storage capacity of approximately 3.5 MAF, and is fed by the North, Middle, and South forks of the Feather River. Average annual unimpaired runoff into the lake is about 4.5 MAF. Oroville Dam and related facilities comprise a multipurpose project. The reservoir stores winter and spring runoff, which is later released from storage into the Feather River to meet SWP demands and the project needs. It also provides on-peak and regular hydropower generation with the use of the Thermalito Afterbay and according to water release needs to meet all purposes. Lake Oroville also provides up to 750 thousand acre-feet (TAF) of flood control storage and significant recreation opportunities. It also provides freshwater releases for salinity control in the Delta and for fish and wildlife protection in the Feather River and downstream areas. The location of the Oroville facilities is shown in Figure 6-1a.

Approximately 4 miles downstream of Oroville Dam and Edward Hyatt Powerplant is the Thermalito Diversion Dam. Thermalito Diversion Dam consists of a 625-foot-long, concrete gravity section with a regulated ogee spillway that releases water to the Low Flow Channel of the Feather River. On the right abutment is the Thermalito Power Canal regulating headwork structure. The purpose of the diversion dam is to create a tailwater pool (called Thermalito Diversion Pool) for Edward Hyatt Powerplant and divert water into the 2-mile-long Thermalito Power Canal that conveys water in either direction. The Thermalito Diversion Pool acts as a forebay when Edward Hyatt Powerplant is pumping water back into Lake Oroville when needed. However, the feature was not used in recent years due to water temperature concerns. On the left abutment is the Thermalito Diversion Dam Powerplant with a capacity of 600 cubic feet per second (cfs), which releases water to the low-flow section of the Feather River.

Local agricultural districts, referred to as Settlement Contractors, divert water directly from the afterbay. These diversion points are in lieu of the traditional river diversion exercised by the local districts whose water rights are senior to the SWP.

1 Current operations of the Oroville facilities are governed, in part, by water temperature
2 requirements at two locations: the Feather River Fish Hatchery and in the Low Flow Channel at
3 Robinson Riffle. The existing Feather River flow requirements below Oroville Dam are based on an
4 August 1983 Agreement between the DWR and CDFW (then California Department of Fish and
5 Game [CDFG]). The 1983 Agreement established criteria and objectives for flow and temperatures in
6 the Low Flow Channel, Feather River Fish Hatchery, and the High Flow Channel.

7 Until the Federal Energy Regulatory Commission (FERC) issues the new license for the Oroville
8 facilities, including all hydropower facilities in the complex, DWR will comply with the terms and
9 conditions of the existing FERC license. The pending license does not include specifications outside
10 of the complex, and thus it is assumed that downstream of Thermalito Afterbay Outlet, the flows
11 under a new FERC license are not likely to be different than under the existing license.

12 Delta Field Division

13 SWP facilities in the southern Delta include Clifton Court Forebay, John E. Skinner Delta Fish
14 Protective Facility (Skinner Fish Facility), and the Banks Pumping Plant. SWP operates these
15 facilities under a variety of permits and agreements, including the Coordinated Operation
16 Agreement, which is further described in Section 6.2.1.3.

17 Clifton Court Forebay is a reservoir with a capacity of 31,000 acre-feet at the southwestern edge of
18 the Delta, about 10 miles northwest of Tracy. Clifton Court Forebay provides storage for off-peak
19 pumping, moderates the effect of the pumps on the fluctuation of flow and stage in adjacent Delta
20 channels, and collects sediment before it enters the California Aqueduct. Diversions from Old River
21 into Clifton Court Forebay are regulated by five radial gates.

22 The Skinner Fish Facility is west of Clifton Court Forebay, 2 miles upstream of the Banks Pumping
23 Plant. The Skinner Fish Facility screens fish away from the pumps that lift water into the California
24 Aqueduct. Large fish and debris are prevented from entering the facility by a 388-foot-long trash
25 boom. Smaller fish are diverted from the intake channel into bypasses by a series of metal louvers,
26 while the main flow of water continues through the louvers toward the pumps. These fish pass
27 through a secondary system of screens and pipes into seven holding tanks, where a subsample is
28 counted and recorded. The salvaged fish are then returned to the Delta in oxygenated tank trucks.
29 Very small fish typically remain in the main flow of water and are transported to the pumps and
30 exported from the Delta.

31 The Banks Pumping Plant is in the south Delta, about 8 miles northwest of Tracy; it marks the
32 beginning of the California Aqueduct. The plant discharges into five pipelines that convey water into
33 a roughly 1-mile-long canal, which in turn conveys water to the Bethany Reservoir. By means of 11
34 pumps, including 2 rated at 375 cfs capacity, 5 at 1,130 cfs capacity, and 4 at 1,067 cfs capacity, the
35 plant provides the initial lift of water 244 feet into the California Aqueduct. The nominal capacity of
36 the Banks Pumping Plant is 10,300 cfs. The maximum daily pumping rate at the Banks Pumping
37 Plant is controlled by a combination of D-1641, adaptive management, and permits issued by the
38 U.S. Army Corps of Engineers (USACE) that regulate the rate of diversion of water into Clifton Court
39 Forebay for pumping at the Banks Pumping Plant. The diversion rate is normally restricted to 6,680
40 cfs as a 3-day average inflow and 6,993 cfs as a 1-day average inflow to Clifton Court Forebay in
41 accordance with the existing USACE Section 10 permit issued pursuant to the Rivers and Harbors
42 Act (State Water Resources Control Board 2017:2-69).

1 The Banks Pumping Plant lifts water into the California Aqueduct, which then flows to Bethany
2 Reservoir. From Bethany Reservoir, the South Bay Pumping Plant lifts water into the South Bay
3 Aqueduct to supply portions of Alameda and Santa Clara Counties. South Bay Aqueduct facilities
4 include Lake Del Valle and Patterson Reservoir. Also from Bethany Reservoir, the 444-mile-long
5 California Aqueduct conveys water to the primarily cultivated lands of the San Joaquin Valley and
6 the mainly urban regions of Southern California and the Central Coast.

7 The Barker Slough Pumping Plant diverts water from Barker Slough into the North Bay Aqueduct for
8 delivery in Napa and Solano Counties. Maximum pumping capacity is 175 cfs (pipeline capacity).
9 During the past few years, daily pumping rates have ranged between 0 cfs and 140 cfs. The current
10 maximum pumping rate is 140 cfs because an additional pump is required to be installed to reach
11 175 cfs. In addition, growth of biofilm in a portion of the pipeline is also limiting the North Bay
12 Aqueduct's ability to reach its full capacity.

13 The North Bay Aqueduct intake is approximately 10 miles from the mainstem Sacramento River at
14 the end of Barker Slough. Per CDFW fish screening criteria, each of the 10 North Bay Aqueduct pump
15 bays is individually screened with a positive barrier fish screen consisting of a series of flat, stainless
16 steel, wedge-wire panels with a slot width of 3/32 inch. This configuration is designed to exclude
17 fish approximately 1 inch or larger from being entrained.

18 San Luis Field Division

19 The California Aqueduct transports water to O'Neill Forebay. Water in the forebay can be released to
20 the San Luis Canal or pumped into San Luis Reservoir by the William R. Gianelli Pumping-Generating
21 Plant (Gianelli Pumping-Generating Plant); these facilities are jointly used with Reclamation for CVP
22 operations. DWR generally pumps water through the Gianelli Pumping-Generating Plant into San
23 Luis Reservoir during late fall through early spring for temporary storage until water is released to
24 meet late-spring and summer peak demands of SWP water contractors.

25 The San Luis Reservoir is an offstream storage facility along the California Aqueduct downstream of
26 the Jones and Banks Pumping Plants. The CVP and SWP share San Luis Reservoir storage roughly
27 50/50 (SWP has 1,062 TAF of storage, and CVP has 966 TAF of storage). San Luis Reservoir is used
28 to meet deliveries to the CVP and SWP contractors during periods when Delta pumping is
29 insufficient to meet demands.

30 The San Luis Reservoir operates as a regulator accepting any water pumped from the Jones and
31 Banks Pumping Plants that exceeds contractor demands, then releasing that water back to the
32 aqueduct system when the pumping at the Jones and Banks Pumping Plants is insufficient to meet
33 demands. The reservoir allows the SWP to meet peak-season demands that are seldom balanced by
34 Jones and Banks pumping.

35 As the San Luis Reservoir is drawn down to meet contractor demands, it usually reaches its low
36 point in late August or early September. From September through early October, demand for
37 deliveries declines until it is less than the rate of diversions from the Delta at the Jones and Banks
38 Pumping Plants.

39 SWP water pumped directly from the Delta and water eventually released from San Luis Reservoir
40 continues to flow south in the San Luis Canal, a portion of the California Aqueduct jointly used by the
41 SWP and CVP. The joint use ends near Kettleman City, and the SWP portion of the California
42 Aqueduct continues.

San Joaquin Field Division

The San Joaquin Field Division, in Bakersfield, serves Kern, Kings, San Luis Obispo, and Santa Barbara Counties. The field division is responsible for the operation and maintenance of 123 miles of the California Aqueduct, as well as the Coastal Branch Aqueduct. Four pumping plants known as the Valley String move water over the Tehachapi Mountains and into Southern California. The Buena Vista Pumping Plant, the first in the Valley String, is on the California Aqueduct about 24 miles southwest of Bakersfield in Kern County. The plant operates in a series of sequential lifts in southern San Joaquin Valley to convey California Aqueduct water to and across the Tehachapi Mountains. The Buena Vista Pumping Plant provides the first lift from an elevation of 295.4 to 500.6 feet. The John R. Teerink Wheeler Ridge (Teerink) Pumping Plant is on the California Aqueduct about 27 miles downstream from the Buena Vista Pumping Plant. The Teerink Pumping Plant provides the second lift from an elevation of 492 to 724.5 feet and furnishes water for a turnout in the reach of the aqueduct that leads to the Ira J. Chrisman Wind Gap (Chrisman) Pumping Plant. An in-line plant, the Chrisman Pumping Plant is situated on the California Aqueduct about 1.6 miles downstream from the Teerink Pumping Plant. It lifts SWP water 518 feet for its journey to the A. D. Edmonston Pumping Plant, which is the final plant in the Valley String and the largest of the 21 SWP pumping plants. The Edmonston Pumping Plant's two main discharge lines stair-step 8,400 feet up the mountainside to a 62-foot-high, 50-foot-diameter surge tank.

The field division also maintains and operates the Coastal Branch Aqueduct, which extends 14.8 miles, and includes nearly 100 miles of buried pipelines and five pumping plants. In the San Joaquin Valley near Kettleman City, Phase I of the Coastal Branch Aqueduct includes the Las Perillas Pumping Plant and the Badger Hill Pumping Plant and serves agricultural areas west of the California Aqueduct. The Las Perillas Pumping Plant, about 1 mile from the California Aqueduct, provides the first lift for delivery of SWP water from the aqueduct through the first 15 miles of the Coastal Branch Aqueduct. The Badger Hill Pumping Plant is 3 miles downstream from the Las Perillas Pumping Plant and provides the second lift for delivery through the first 15 miles of the aqueduct.

The Coastal Branch's Phase II extended the conveyance facility to serve municipal and industrial (M&I) water users in San Luis Obispo and Santa Barbara Counties. Phase II consists of three pumping plants that lift water 1,500 feet and convey it through buried 57-inch-diameter pipelines to the summit of Polonio Pass in the Temblor Mountain Range: the Devil's Den Pumping Plant, Bluestone Pumping Plant, and Polonio Pass Pumping Plant.

Southern Field Division

The remaining water conveyed by the California Aqueduct is delivered to Southern California, home to about one-half of California's total population. Before this water can be delivered, the water must first cross the Tehachapi Mountains. Pumps at the Edmonston Pumping Plant, situated at the foot of the mountains, raise the water 1,926 feet—the highest single lift of any pumping plant in the world. From there, the water enters about 8 miles of tunnels and siphons as it flows into Antelope Valley, where the California Aqueduct divides into two branches: the East Branch and the West Branch.

The East Branch carries water through the Tehachapi East Afterbay, Alamo Powerplant, Pearblossom Pumping Plant, and Mojave Siphon Powerplant into Silverwood Lake in the San Bernardino Mountains, which stores 73,000 acre-feet of water. From Silverwood Lake, water flows through the San Bernardino Tunnel into Devil Canyon Powerplant. Water continues down the East

Branch to Lake Perris, the terminus of the East Branch. Lake Perris lies just east of Riverside, has a capacity of 131,500 acre-feet, and serves as a regulatory and emergency water supply facility for the East Branch.

Phase I of the East Branch Extension of the California Aqueduct provides conveyance facilities to deliver SWP water to San Geronimo Pass Water Agency and to the eastern portion of the San Bernardino Valley Municipal Water District, which delivers water to areas such as Yucaipa, Calimesa, Beaumont, Banning, and other communities. The East Branch Extension is composed of a combination of existing San Bernardino Valley Municipal Water District facilities and newly constructed SWP facilities. While the new pipelines were designed for the ultimate conveyance capacity, the installed Phase I pumping capacity was less than one-half the ultimate capacity—enough to meet the immediate foreseeable demand for SWP water. Phase II brought the extension to its ultimate storage and conveyance capacity with the new Citrus Reservoir and Pump Station, enlargement of the Crafton Hills Dam, and additional pipelines (California Department of Water Resources 2018).

At the bifurcation of the California Aqueduct in Antelope Valley, the West Branch carries water through the Oso Pumping Plant, Quail Lake, Lower Quail Canal, and William E. Warne Powerplant into Pyramid Lake in Los Angeles County. From there, water flows through the Angeles Tunnel, Castaic Powerplant, Elderberry Forebay, and Castaic Lake, the terminus of the West Branch. Castaic Lake is north of Santa Clarita, has a capacity of 324,000 acre-feet, and is a regulatory and emergency water supply facility for the West Branch. Castaic Powerplant is owned and operated by the Los Angeles Department of Water and Power.

6.2.1.2 CVP Facilities

Reclamation is the largest wholesale water supplier in the United States, and the nation's second largest producer of hydroelectric power. Its facilities also provide substantial flood management, recreation, and fish and wildlife benefits. Reclamation operates the CVP. Reclamation coordinates operation of CVP in the Delta with the SWP in accordance with the water rights permits issued by the State Water Board and the Coordinated Operation Agreement (Section 6.2.1.3).

The CVP consists of 20 dams and reservoirs that together can store nearly 12 MAF of water. Reclamation holds over 270 contracts and agreements for water supplies that depend upon CVP operations. Through operation of the CVP, Reclamation delivers water in 29 of California's 58 counties in the following approximate amounts: 5 MAF of water for farms, 600 TAF of water for M&I uses (i.e., enough water to supply about 2.5 million people for a year), and an average of 355 TAF of Level 2 CVP water supply for wildlife refuges (plus additional Level 2 and Incremental Level 4 supplies delivered from various sources). Reclamation operates the CVP under water rights granted by the State of California, including those intended to protect agricultural and fish and wildlife beneficial uses in the Delta. The following subsections provide a description of the major CVP facilities by operating division.

Trinity River Division

The Trinity River Division includes Trinity Lake, Lewiston Reservoir, the area along the Trinity River from Trinity Lake to the confluence with the Klamath River, and the lower Klamath River from the confluence with the Trinity River.

Trinity Lake is a CVP reservoir on the Trinity River with a capacity of 2.4 MAF. Trinity Lake storage varies according to upstream hydrology, downstream water demands, and instream flow requirements. Reclamation maintains at least 600 TAF in Trinity Reservoir, except during the years when Shasta Lake is at low levels (i.e., about 10% to 15% of years).

Lewiston Reservoir is a CVP facility on the Trinity River and is 7 miles downstream of Trinity Dam. Lewiston Reservoir is used as a regulating reservoir for downstream releases to the Trinity River and to Whiskeytown Lake. The Lewiston Reservoir water storage volume is more consistent throughout the year because this reservoir is used to regulate flow releases to the powerplant and other downstream uses and not to provide long-term water storage. The mean annual inflow to Trinity Lake is 1.26 MAF per year (water years 2001–2017). From water years 1965–1980, an average of 80% of inflow was diverted to the Sacramento River Basin. An average of 61% of inflow was diverted for water years 1981–2000. Under the Trinity River Record of Decision (U.S. Fish and Wildlife Service et al. 2000), an average of 51% of inflows has since been diverted (water years 2001–2017). Water is diverted from the lower outlets in Trinity Lake to Lewiston Reservoir to provide cold water to the Trinity River.

Trinity River exports are first conveyed through Carr Powerplant, which flows directly into Whiskeytown Lake. The average seasonal timing of Trinity River exports varies in an effort to conserve coldwater pools and meet temperature objectives on the upper Sacramento and Trinity Rivers and manage economics of power production. Periodically, increased water releases are made from Trinity Dam consistent with Reclamation Safety of Dams criteria intended to prevent dam overtopping. Although flood control is not an authorized purpose of the Trinity River Division, flood control benefits are provided through normal operations.

Diversion of Trinity water to the Sacramento Basin provides supplemental water supply and hydroelectric power generation for the CVP and assists in water temperature management in the upper Sacramento River.

Shasta/Trinity River Division

The CVP's Shasta Division includes facilities that conserve water in the Sacramento River for (1) flood control, (2) navigation maintenance, (3) agricultural water supplies, (4) M&I water supplies, (5) hydroelectric power generation, (6) conservation of fish in the Sacramento River, and (7) protection of the Delta from intrusion of saline ocean water. The Shasta Division includes Shasta Dam, Shasta Lake, and Shasta Powerplant; Keswick Dam, Keswick Reservoir, and Keswick Powerplant; and the Shasta Temperature Control Device.

Shasta Lake has a maximum storage capacity of 4.552 MAF. Shasta Dam is on the Sacramento River just below the confluence of the Sacramento, McCloud, and Pit Rivers. The dam regulates the flow from a drainage area of approximately 6,649 square miles. Water in Shasta Lake is released through or around the Shasta Powerplant to the Sacramento River, where it is further regulated downstream by Keswick Dam.

Historical water storage volumes for Shasta Lake range from 1.1 MAF to over 4.5 MAF, depending on upstream hydrology, downstream water demands, and instream flow and water temperature requirements.

Keswick Reservoir has a capacity of approximately 23,800 acre-feet and serves as an afterbay for releases from Shasta Dam and for discharges from the Spring Creek Powerplant. All releases from

Keswick Reservoir are made to the Sacramento River at Keswick Dam. The dam has a fish-trapping facility that operates in conjunction with the Coleman National Fish Hatchery on Battle Creek.

Reclamation operates the Shasta, Sacramento River, and Trinity River divisions of the CVP to meet (to the extent possible) the provisions of State Water Board Water Right Order 90-05 (Order 90-05). An April 5, 1960, memorandum of understanding between Reclamation and CDFW (then CDFG) originally established flow objectives in the Sacramento River for the protection and preservation of fish and wildlife resources. The agreement provided for minimum releases into the natural channel of the Sacramento River at Keswick Dam for normal and critical years. Since October 1981, Keswick Dam has operated based on a minimum release of 3,250 cfs for normal years from September 1 through the end of February, in accordance with an agreement between Reclamation and CDFW. This release schedule was included in Order 90-05, which maintains a minimum release of 3,250 cfs at Keswick Dam and Red Bluff Diversion Dam from September through the end of February in all water years, except critical years.

The CVP is operated to meet the navigation flow requirement of 5,000 cfs to Wilkins Slough (a gauging station on the Sacramento River), under all but the most critical water supply conditions, to facilitate pumping and use of screened diversions. At flows below 5,000 cfs at Wilkins Slough, diverters have reported increased pump cavitation as well as greater pumping head requirements. Diverters can operate for extended periods at flows as low as 4,000 cfs at Wilkins Slough, but pumping operations become severely affected and some pumps become inoperable at flows lower than this. Flows may drop as low as 3,500 cfs for short periods while changes are made in Keswick releases to reach target levels at Wilkins Slough, but using the 3,500 cfs rate as a target level for an extended period would have major impacts on diverters.

American River Division

Reclamation's Folsom Reservoir, the largest reservoir in the American River watershed, has a capacity of 967 TAF. The mean annual inflow to Folsom Lake is about 2.7 MAF per year. Folsom Dam, on the American River approximately 30 miles upstream from the confluence with the Sacramento River, is operated as a major component of the CVP. The American River Division includes facilities that provide conservation of water on the American River for flood management, fish and wildlife protection, recreation, meeting Delta flow and water quality requirements, irrigation and M&I water supplies, and hydroelectric power generation. Initially authorized features of the American River Division included Folsom Dam, Folsom Lake, and Folsom Powerplant; Nimbus Dam and Nimbus Powerplant; and Lake Natoma.

Nimbus Dam creates Lake Natoma, a forebay built to re-regulate flows of the American River and to direct water into the CVP Folsom South Canal. Releases from Nimbus Dam to the American River pass through the Nimbus Powerplant when releases are less than 5,000 cfs or through the spillway gates for higher flows. The American River flows 23 miles between Nimbus Dam and the confluence with the Sacramento River. Annual maximum water storage volumes for Folsom Lake for water years 2001–2021 vary between about 136 TAF and over 950 TAF, and for Lake Natoma between 6,800 acre-feet and over 8,600 acre-feet for the same period (California Department of Water Resources 2021e, 2021f).

Delta and West San Joaquin Divisions

The CVP's Delta Division includes the Delta Cross Channel, the Contra Costa Canal and Pumping Plants, Contra Loma Dam, Martinez Dam, the Jones Pumping Plant (formerly called Tracy Pumping

Plant), the Tracy Fish Collection Facility, and the Delta-Mendota Canal. The Delta Cross Channel is a gated diversion channel in the Sacramento River near Walnut Grove and Snodgrass Slough. The Contra Costa Water District (CCWD) diversion facilities use CVP water resources and water rights to serve district customers directly and to convey portions of the water into CCWD's Los Vaqueros Project. The Jones Pumping Plant diverts water from the Delta to the head of the Delta-Mendota Canal.

Flows into the Delta Cross Channel from the Sacramento River are controlled by two 60-foot by 30-foot radial gates. When the gates are open, water flows from the Sacramento River through the Delta Cross Channel to channels of the lower Mokelumne and San Joaquin Rivers toward the interior Delta. The Delta Cross Channel operation improves water quality in the interior Delta by improving circulation patterns of good quality water from the Sacramento River toward Delta diversion facilities. Between October 1 and May 20, the gates are operated to reduce juvenile salmonid entrainment risk.

The CVP uses the Sacramento River, San Joaquin River, and Delta channels to transport water to the export pumping plant in the south Delta: the Jones Pumping Plant, about 5 miles north of Tracy, which has six available pumps. The Jones Pumping Plant has a physical capacity of approximately 5,200 cfs. Because of limited capacity in the Delta-Mendota Canal, the plant is operated at a rate of approximately 4,600 cfs or below, unless Reclamation accesses the Delta-Mendota Canal/California Aqueduct Intertie to operate at the full physical capacity.

The Delta-Mendota Canal is operated and maintained by the San Luis and Delta-Mendota Water Authority under contract with Reclamation. The Delta-Mendota Canal begins at the Jones Pumping Plant and runs 117 miles south along the western edge of the San Joaquin Valley. Water may be pumped from the canal into O'Neill Forebay, and then pumped into San Luis Reservoir by the Gianelli Pumping-Generating Plant. The Delta-Mendota Canal ends at Mendota Pool, on the San Joaquin River near the town of Mendota. The Delta-Mendota Canal has an initial capacity of 4,600 cfs that decreases to about 3,200 cfs at its terminus.

Water demands for the Delta-Mendota Canal of the Delta Division and San Luis Unit of the West San Joaquin Division are primarily of three separate types: San Joaquin River Exchange Contractors, CVP water service contractors, and wildlife refuge contractors. A considerably different contractual relationship exists between Reclamation and contractors within each of these three groups. San Joaquin River Exchange Contractors agreed not to exercise their senior rights to water in the San Joaquin River for a CVP water supply from the Delta. Reclamation thus provided the San Joaquin River Exchange Contractors CVP water supply of 840 TAF per year, with a maximum reduction under the Shasta critical year criteria to an annual water supply of 650 TAF. CVP water service contractors that receive their CVP water supply from the Delta are subject to the availability of CVP water supplies that can be developed, and reductions in contractual supply can occur. Wildlife refuge contractors receive CVP water supplies for specific managed lands for wildlife purposes, and the CVP contract water supply can be reduced under Shasta critical year criteria by up to 25%.

To achieve the best operation of the CVP, it is necessary to combine the contractual demands of these three types of contractors to achieve an overall pattern of requests for water. In most years sufficient supplies are not available to meet all water contractor demands because of statutory, regulatory, and water rights requirements. In some dry or critical years, water deliveries are limited because there is insufficient storage in northern CVP reservoirs to meet all statutory, regulatory, and water rights requirements including water temperatures, and to make additional water deliveries

1 via the Jones Pumping Plant. The scheduling of water demands, together with the scheduling of the
2 releases of water supplies from the northern CVP reservoirs and CVP San Luis Reservoir to meet
3 those demands, is a CVP operational objective that is intertwined with the Trinity, Sacramento, and
4 American River operations.

5 **Stanislaus River Region**

6 The Stanislaus River originates in the western slopes of the Sierra Nevada and drains a watershed of
7 approximately 900 square miles. The average unimpaired runoff in the basin is approximately 1.2
8 MAF per year; the median historical unimpaired runoff is 1.1 MAF per year. Snowmelt contributes
9 the largest portion of the flows in the Stanislaus River, with the highest runoff occurring in the
10 months of April, May, and June. The flow in the lower Stanislaus River is primarily controlled by
11 New Melones Reservoir, which has a storage capacity of about 2.4 MAF. New Melones Reservoir is
12 approximately 60 miles upstream from the confluence of the Stanislaus River and the San Joaquin
13 River and is operated by Reclamation.

14 New Melones Reservoir is operated primarily for purposes of water supply, flood management,
15 power generation, fishery enhancement, and water quality improvement in the lower San Joaquin
16 River. The reservoir and river also provide recreation benefits. Flood management operations are
17 conducted in conformance with USACE's operational guidelines.

18 The operating criteria for New Melones Reservoir are affected by (1) water rights, (2) instream fish
19 and wildlife flow requirements, (3) applicable D-1641 water quality and flow requirements,
20 (4) dissolved oxygen requirements on the Stanislaus River, (5) CVP contracts, and (6) flood
21 management considerations. Water released from New Melones Dam and Powerplant is re-
22 regulated at Tulloch Reservoir and is either diverted at Goodwin Dam primarily for irrigation
23 purposes or released from Goodwin Dam to the lower Stanislaus River.

24 D-1641 sets flow requirements on the San Joaquin River at Vernalis from February to June. These
25 flows are commonly known as the Vernalis Bay-Delta flow requirements. Since D-1641 has been in
26 place, the Vernalis Bay-Delta flow requirements have, at times, been an additional demand on the
27 New Melones water supply beyond that provided for in the Interim Plan of Operation, which is the
28 current operating plan for New Melones Reservoir.

29 **San Felipe Division**

30 The San Felipe Division provides a supplemental water supply in the Santa Clara Valley in Santa
31 Clara County and the north portion of San Benito County. In addition to meeting demands in the San
32 Joaquin Valley, the San Luis Reservoir is operated to supply water to the CVP San Felipe Division in
33 San Benito and Santa Clara Counties. The San Felipe Division delivers both irrigation and M&I water
34 supplies. Water is delivered within the service areas not only by direct diversion from distribution
35 systems, but also through instream and offstream groundwater recharge operations being carried
36 out by local interests. A primary purpose of the San Felipe Division in Santa Clara County is to
37 provide supplemental water to help prevent land surface subsidence in the Santa Clara Valley
38 caused by groundwater pumping. Santa Clara Valley Water District is the nonfederal operating
39 entity for all the San Felipe Division facilities except for the Hollister Conduit and San Justo
40 Reservoir.

Friant Division

Friant Dam is on the San Joaquin River, 25 miles northeast of Fresno where the San Joaquin River exits the Sierra Nevada foothills and enters the valley. The drainage basin is 1,676 square miles with an average annual runoff of 1.77 MAF.

The dam provides flood management on the San Joaquin River, provides downstream releases to meet senior water rights requirements above Mendota Pool, and provides conservation storage as well as diversion into Madera and Friant-Kern Canals. Water is delivered to a million acres of cultivated land in Fresno, Kern, Madera, and Tulare Counties in the San Joaquin Valley via the Friant-Kern Canal south into Tulare Lake Basin and via the Madera Canal north to Madera Irrigation District and Chowchilla Water District. A minimum of 5 cfs is required to pass the last water right holding about 40 miles downstream near Gravelly Ford. The reservoir, Millerton Lake, has a total capacity of 520,528 acre-feet.

6.2.1.3 SWP/CVP Coordinated Operations

DWR and Reclamation coordinate operations of water delivery facilities in the Central Valley. The water rights for the SWP and CVP are conditioned by the State Water Board to protect the beneficial uses of water in the Sacramento Valley. The SWP and CVP coordinate and operate to meet the jointly assigned water right requirements in the Delta.

Coordinated Operation Agreement

The Agreement between the United States of America and the State of California for Coordinated Operation of the Central Valley Project and the State Water Project (known as the Coordinated Operation Agreement, or COA), signed in 1986 and subsequently amended in 2018, sets forth procedures for coordination of operations, identifies formulas for sharing joint responsibilities for meeting Delta standards and other legal uses of water, identifies how unstored flow will be shared, sets up a framework for exchange of water and services between the projects, and provides for periodic review of the agreement.

Reclamation and DWR operate their respective facilities in accordance with the COA. Implementation of the COA principles has continuously evolved since 1986 as changes have occurred to SWP and CVP facilities, to operating criteria, and to the overall physical and regulatory environment. For example, since 1986, when the COA was originally executed, updated water quality and flow standards adopted by the State Water Board, CVPIA, and Endangered Species Act (ESA) responsibilities have affected both SWP and CVP operations. The 1986 COA incorporated State Water Board Water Right Decision 1485 provisions regarding Delta salinity, outflow, and export restrictions. It also envisioned and provided a methodology to incorporate future regulatory changes, like Delta salinity requirements, but did not explicitly address sharing of export restrictions.

In 2018, Reclamation and DWR modified four key elements of the COA to explicitly address changes since the COA was signed: (1) in-basin uses including updated regulatory requirements since 1986, (2) export restrictions, (3) CVP use of the Banks Pumping Plant up to 195,000 acre-feet per year, and (4) periodic review.

Suisun Marsh Preservation Agreement

Since the early 1970s, the California Legislature, State Water Board, Reclamation, CDFW, Suisun Resource Conservation District, DWR, and other agencies have worked to preserve beneficial uses in Suisun Marsh. Early on, salinity standards were set by the State Water Board to protect alkali bulrush production, a primary waterfowl plant food. The most recent standard under D-1641 acknowledges that multiple beneficial uses deserve protection.

A contractual agreement between DWR, Reclamation, CDFW, and Suisun Resource Conservation District contains provisions for DWR and Reclamation to mitigate the effects on Suisun Marsh channel water salinity from the SWP and CVP operations and other upstream diversions. The Suisun Marsh Preservation Agreement requires DWR and Reclamation to meet salinity standards, sets a timeline for implementing the Plan of Protection, and delineates monitoring and mitigation requirements. In addition to the contractual agreement, State Water Board Water Right Decision 1485 adopted salinity standards in 1978, which have been carried forward to D-1641.

There are two primary physical mechanisms for meeting salinity standards set forth in D-1641: (1) the implementation and operation of physical facilities in the Marsh, and (2) management of Delta outflow (i.e., facility operations are driven largely by salinity levels upstream of Montezuma Slough and salinity levels are highly sensitive to Delta outflow). Physical facilities (described below) have been operating since the early 1980s and have proven to be a highly reliable method for meeting standards.

Suisun Marsh Salinity Control Gates

The Suisun Marsh Salinity Control Gates (SMSCG) are located on Montezuma Slough about 2 miles (3.22 kilometers) downstream from the confluence of the Sacramento and San Joaquin Rivers, near Collinsville. The objective of SMSCG operation is to decrease the salinity of the water in Montezuma Slough. The gates control salinity by restricting the flow of higher salinity water from Grizzly Bay into Montezuma Slough during incoming tides and retaining lower-salinity Sacramento River water from the previous ebb tide. Operation of the gates in this fashion lowers salinity in Suisun Marsh channels and results in a net movement of water from east to west through Suisun Marsh.

The SMSCG are operated during the salinity control season, which is October to May. Operational frequency is affected by salinity at D-1641 compliance stations, hydrologic conditions, weather, Delta outflow, tide, fishery considerations, and other factors. The boat lock portion of the gate is held partially open during SMSCG operation to allow an opportunity for continuous salmon passage. The boat lock gates may be closed temporarily, however, to stabilize flows to facilitate safe passage of watercraft through the facility.

Roaring River Distribution System

The Roaring River Distribution System was constructed as part of the Initial Facilities in the Plan of Protection for the Suisun Marsh. The system was constructed to provide lower-salinity water to 5,000 acres of private and 3,000 acres of CDFW-managed wetlands on Simmons, Hammond, Van Sickle, Wheeler, and Grizzly Islands.

Water is diverted through a bank of eight 60-inch-diameter culverts equipped with fish screens into the Roaring River intake pond on high tides to raise the water surface elevation in the distribution system above the adjacent managed wetlands. Managed wetlands north and south of the system receive water, as needed, through publicly and privately owned turnouts on the system.

Morrow Island Distribution System

The Morrow Island Distribution System was constructed in the southwestern Suisun Marsh as part of the Initial Facilities in the Plan of Protection for the Suisun Marsh. The contractual requirement for Reclamation and DWR is to provide water to the ownerships so that lands may be managed according to approved local management plans. The system was constructed primarily to channel drainage water from the adjacent managed wetlands for discharge into Suisun Slough and Grizzly Bay. This approach increases circulation and reduces salinity in Goodyear Slough.

The distribution system is used year-round, but most intensively from September through June. When managed wetlands are filling and circulating, water is tidally diverted from Goodyear Slough just south of Pierce Harbor through three 48-inch culverts.

South Delta Temporary Barriers Project

The South Delta Temporary Barriers Project was initiated by DWR in 1991. The project consists of four rock barriers across south Delta channels. The Temporary Barriers Project has been shown to improve water levels and water circulation in the south Delta and improves migration conditions for San Joaquin River salmon (California Department of Water Resources 2022). These rock barriers are designed to act as flow control structures, trapping tidal waters behind them after a high tide.

The Temporary Barriers Project will continue to be planned and permitted. Computer model simulations; real-time monitoring; and coordination with local, state, federal agencies, and interested parties will help determine if the temporary rock barriers operations need to be modified.

San Luis Joint-Use Complex

Water in the main stem of the California Aqueduct flows south by gravity into the San Luis Joint-Use Complex, which was designed and constructed by the federal government and is operated and maintained by DWR. This section of the California Aqueduct serves both the SWP and the CVP. San Luis Reservoir, the nation's largest offstream reservoir, is impounded by Sisk Dam and lies at the base of the foothills on the west side of the San Joaquin Valley in Merced County, about 2 miles west of O'Neill Forebay. The reservoir provides offstream storage for excess winter and spring flows diverted from the Delta. It is sized to provide seasonal carryover storage. The reservoir can hold about 2.03 MAF, of which 1.06 MAF (approximately 52%) is DWR's share, and 965 TAF (approximately 48%) is Reclamation's share. Construction began in 1963 and was completed in 1967. Filled in 1969, the reservoir also provides a variety of recreational activities as well as fish and wildlife benefits.

In addition to the Sisk Dam, San Luis Reservoir, and O'Neill Dam and Forebay, the San Luis Complex consists of the following.

- O'Neill Pumping-Generating Plant (federal facility).
- William R. Gianelli Pumping-Generating Plant (joint federal-state facilities).
- San Luis Canal (joint federal-state facilities).
- Dos Amigos Pumping Plant (joint federal-state facilities).
- Coalinga Canal (federal facility).

- 1 • Pleasant Valley Pumping Plant (federal facility).
- 2 • Los Banos and Little Panoche Detention Dams and Reservoirs (joint federal–state facilities).

3 The O'Neill Pumping-Generating Plant pumps water from the Delta-Mendota Canal to O'Neill
4 Forebay, where it mixes with water from the California Aqueduct. From O'Neill Forebay, the water
5 can either be pumped up into San Luis Reservoir via the Gianelli Pumping-Generating Plant or leave
6 via the San Luis Canal. The Dos Amigos Pumping Plant is on the San Luis Canal and 18 miles
7 southeast of Sisk Dam. It lifts water 113 feet from the aqueduct as it flows south from O'Neill
8 Forebay.

9 Water is redirected into San Luis Reservoir during the fall, winter, and spring months when the two
10 pumping plants usually can divert more water from the Delta than is needed for scheduled demands.
11 Because the amount of water that can be diverted from the Delta is limited by available water
12 supply, regulatory constraints, and the capacities of the two pumping plants, the fill and drawdown
13 cycle of San Luis Reservoir is an extremely important element of project operations.

14 In April and May, export pumping from the Delta is limited during the D-1641 San Joaquin River
15 pulse period standards as well as by the 2019 BiOps and 2020 ITP. During this same time, SWP/CVP
16 irrigation demands are increasing. Consequently, by April and May, the San Luis Reservoir has
17 begun the annual drawdown cycle. In some exceptionally wet conditions, when excess water
18 supplies from the San Joaquin River or Tulare Lake Basin occur in the spring, the San Luis Reservoir
19 may not begin its drawdown cycle until late in the spring.

20 In July and August, the Jones Pumping Plant diversion is at the maximum capability, and some
21 CVP water may be exported using excess Banks Pumping Plant capacity as part of a Joint Point of
22 Diversion (JPOD) operation. Irrigation demands are greatest during this period, and San Luis
23 Reservoir continues to decrease in storage capacity until it starts to be refilled with local inflow and
24 Delta diversion, and the cycle begins anew.

25 The operation of the San Luis Unit requires coordination between the SWP and CVP because some of
26 its facilities are entirely owned by the State of California and others are joint-use state and federal
27 facilities. San Luis Unit annual water supply is contingent on coordination with SWP and CVP needs
28 and capabilities. When the SWP excess export capacity is used to support additional pumping for the
29 CVP under the JPOD allowance, it may be of little consequence to SWP operations but extremely
30 critical to CVP operations. The availability of excess SWP export capacity for the CVP is contingent,
31 in part, on the ability of the SWP to meet its SWP water contractors' water supply commitments.
32 Generally, the CVP will utilize excess SWP export capacity; however, there are times when the SWP
33 may need to utilize excess CVP export capacity. Additionally, close coordination by SWP and CVP is
34 required during this type of operation to ensure that water pumped into O'Neill Forebay does not
35 exceed the CVP's capability to pump into San Luis Reservoir or into the San Luis Canal at the Dos
36 Amigos Pumping Plant. Although secondary to water management concerns, power scheduling at
37 the joint facilities also requires close coordination. Because of time-of-use power cost differences,
38 both entities will likely want to schedule pumping and generation simultaneously. When facility
39 capabilities of the two projects are limited, equitable solutions are achieved between the operators
40 of the SWP and the CVP.

41 With the existing facility configuration, the operation of the San Luis Reservoir could affect the water
42 quality and reliability of water deliveries to the San Felipe Division if San Luis Reservoir is drawn
43 down too low. Reclamation addresses this condition through coordination with the San Felipe

Division contractors and may solicit cooperation from DWR, as long as changes in SWP operations to assist with providing additional water in San Luis Reservoir (beyond what is needed for SWP deliveries and the SWP share of San Luis Reservoir minimum storage) does not affect SWP allocations or deliveries. If the CVP is not able to maintain sufficient storage in San Luis Reservoir, there could be potential impacts on resources in Santa Clara and San Benito Counties. During summer months, algae blooms of up to 35 feet thick often develop in the reservoir. When reservoir storage levels drop below 300,000 acre-feet, algae blooms may enter the Pacheco Pumping Plant Lower Intake and affect drinking water treatment plant deliveries within Santa Clara County. Deliveries to Santa Clara and San Benito may be severely or completely interrupted when storage levels are drawn down such that there is insufficient hydraulic head to effectively operate the Pacheco Pumping Plant. Deliveries to other SWP and CVP contractors are made through the Gianelli Intake, which is about 40 feet lower than the Lower Pacheco Intake and is generally unaffected by the water quality and supply interruption issues that affect the San Felipe Division.

6.2.1.4 SWP and CVP Water Supplies and Deliveries

SWP Water Contracts

In the 1960s, DWR began entering into long-term water supply contracts (i.e., SWP water contracts) with 32 water districts or agencies to provide water from the SWP. Over the years, a few of these water agencies have been restructured, and today DWR has contracts with 29 public entities. These 29 SWP water contractors supply water to urban and agricultural water users in Northern California, the Bay Area, the San Joaquin Valley, the Central Coast, and Southern California. Of the contracted water supply, approximately three-quarters goes to M&I users, and one-quarter goes to agricultural users. Through these SWP water contracts, the SWP provides water to over 27 million people in California and 750,000 acres of farmland throughout the state (State Water Contractors 2021). The foundation of allocating water to each contractor is based on their respective “Table A” amount, which is the maximum amount of water that is allocated and delivered to them by the SWP on an annual basis. Under statewide contracts, DWR allocates Table A water as an annual supply made available for scheduled delivery throughout the year. Table A totals approximately 4.2 MAF, with more than 3 MAF for San Joaquin Valley and Southern California water users. Table A does not represent a guaranteed water supply but rather a maximum allocated amount. Although an SWP water contractor may request up to its full Table A amount of water each year, in practice the available water is allocated in proportion to Table A and is frequently less, sometimes much less, than the full Table A amount. The contracts have been amended numerous times. Most recently, DWR and the SWP water contractors negotiated a contract extension amendment, and a water management amendment. Both are described below. Additionally, DWR and the SWP contractors have negotiated a proposed amendment to the SWP water supply contracts to allocate the costs of a new Delta Conveyance facility, including the costs identified in Water Code Section 85089. See Chapter 1 for a description of the approval process.

On December 11, 2018, DWR approved the SWP Water Supply Contract Extension Project extending the term of each of the SWP water contracts to December 31, 2085, and amending certain financial and other provisions of the contracts. In early 2021, under the water management amendments, DWR implemented additional water management practices that allow SWP water contractors greater flexibility to move and store their allocated SWP supplies through transfers and exchanges among themselves. This allows contractors to better manage their water supplies and better utilize regional water supplies when necessary.

DWR uses a forecasting water supply allocation process that is updated monthly, incorporates known conditions in the Central Valley watershed to date, and forecasts future hydrologic conditions to estimate SWP Table A water supplies that can be delivered to SWP water contractors as the water year progresses.

The initial Table A allocation for SWP water contract deliveries is made by December 1 of each year with a conservative assumption of future precipitation to avoid over-allocating water before the hydrologic conditions are well defined for the year. As the water year unfolds, hydrology and water supply delivery estimates are updated using measured and known information and conservative forecasts of future hydrology.

Another water supply consideration is the contractual ability of SWP contractors to “carry over” allocated (but undelivered) Table A supplies from the previous year to the next if space is available in the San Luis Reservoir. The carryover storage is often used to supplement an individual contractor’s current year Table A allocations if conditions are dry. Carryover supplies left in San Luis Reservoir by SWP contractors can result in higher storage levels in San Luis Reservoir. As SWP pumping fills San Luis Reservoir, the contractors are notified to take, or lose, their carryover supplies. Carryover water not taken, after notice is given to remove it, then becomes water available for reallocation to all contractors in a given year.

Article 21 of the SWP water supply contracts provides an interruptible water supply made available only when certain conditions exist: (1) the SWP share of the San Luis Reservoir is physically full or is projected to be physically full; (2) other SWP reservoirs south of the Delta are at their storage targets, or the conveyance capacity to fill these reservoirs is maximized; (3) the Delta is in excess conditions; (4) current year Table A allocation, which may be far less than the 4,173 TAF maximum, is being fully met; and (5) the Banks Pumping Plant has export capacity beyond that which is needed to meet current year Table A allocation and other SWP operational demands.

Article 21 (beyond the current year Table A allocation) water, which is delivered early in the calendar year, may be reclassified as Table A water later in the year depending on final allocations, hydrology, and SWP water contractor requests. Reclassification does not affect the amount of water carried over in San Luis Reservoir, nor does it alter pumping volumes or schedules. Availability of SWP water supplies is also related to Article 56 of the SWP water contracts. Article 56 provides for storage by SWP water contractors of SWP and non-SWP water in SWP and non-SWP reservoirs and groundwater banks outside of their service areas, and programs to allow transfers and exchanges of SWP water between SWP water contractors.

CVP Water Contracts

As the divisions of the CVP became operational, Reclamation entered into long-term contracts with water districts, irrigation districts, and others for delivery of CVP water. Approximately 250 contracts provide for varying amounts of water. Most of these original contracts were for a term of 40 years. The nature of the contracts varies, as the CVP is operated to meet its obligations to deliver water to senior water right holders who diverted water prior to construction of the CVP, wildlife refuge areas identified in the CVPIA, and water service contractors. Some of the contracts, including the Sacramento River Settlement contracts, the San Joaquin Exchange Contracts, and certain refuge contracts, have defined minimum deliveries.

Reclamation renewed many of its settlement contracts and water service contracts in 2005 consistent with the requirements of the CVPIA following issuance of the 2004 NMFS and 2005

1 USFWS BiOps regarding the long-term operations of the SWP and CVP. For the contracts not
2 reviewed, Reclamation executed interim water service contracts. Reclamation delivers water to the
3 CVP contractors in accordance with contracts between Reclamation and the CVP contractors.

4 Reclamation allocates CVP water on an annual basis in accordance with contracts. Reclamation
5 bases north-of-Delta allocations primarily on available water supply within the system north of the
6 Delta along with expected controlling regulations throughout the year. For south-of-Delta
7 allocations, Reclamation relies on upstream water supply, previously stored water south of the Delta
8 (in San Luis Reservoir), and conveyance capability through the Delta. Flows on the San Joaquin River
9 often limit conveyance, as these flows are a driver of the flow direction within the Delta and, through
10 their influence on the Old and Middle River net reverse flow, can affect entrainment levels at the
11 state and federal pumps.

12 The water allocation process for the CVP begins in the fall when Reclamation makes preliminary
13 assessments of the next year's water supply possibilities, incorporating fall storage conditions
14 combined with a range of forecasted hydrologic conditions. Reclamation refines these preliminary
15 assessments as the water year progresses.

16 As the water year unfolds, Central Valley hydrology and water supply delivery estimates are
17 updated using measured and known information and conservative forecasts of future hydrology.

18 **Delta Water Exports**

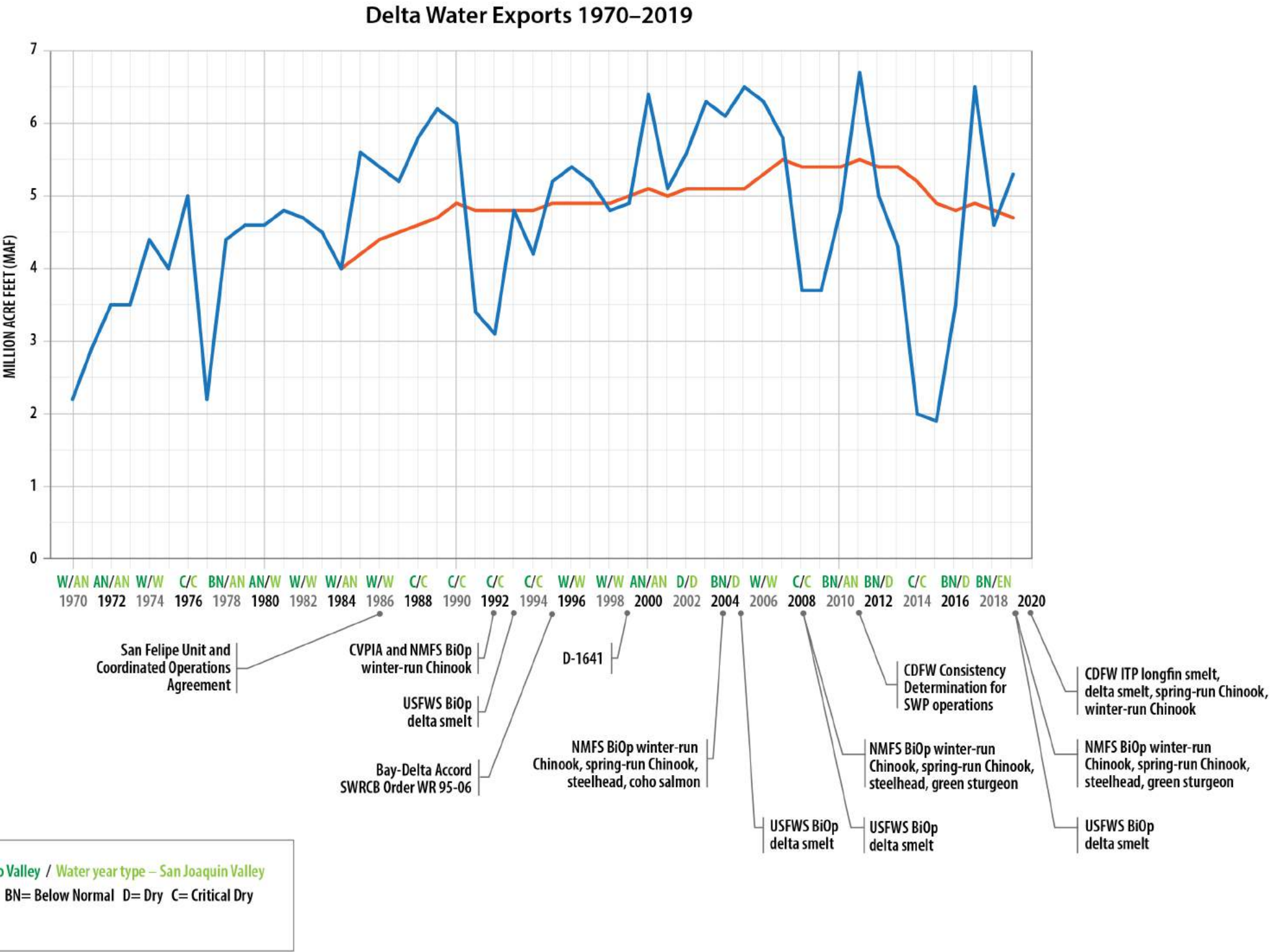
19 Delta exports and water deliveries to SWP and CVP contractors are subject to hydrologic, demand,
20 and regulatory conditions that have changed significantly since the CVP provided initial water
21 deliveries starting in the 1940s (Chapter 1, Section 1.2, *Background*). As described previously,
22 California water demand has continued to increase as a consequence of population growth,
23 expanded agricultural acreage in production, and the dedication of water supplies for environmental
24 needs. The regulatory environment changed as new laws were enacted by Congress or the California
25 State Legislature, and new regulatory requirements were imposed to reflect changed water
26 management policy and practices to respond to major drought events and climate change. In-Delta
27 water use has remained relatively constant over the past 100 years and averages about 4% (0.9
28 MAF) of inflows into the Delta (Delta Stewardship Council 2018:83). In recent decades, SWP and
29 CVP Delta exports exhibit a relative plateau to decrease, in average, with increased variability and
30 reduced reliability. Figure 6-2 shows the trend in annual Delta exports for the period 1970 through
31 2019 with a timeline of the major changes that have affected water supplies and demands, such as
32 the construction of the San Felipe Unit, implementation of the CVPIA, the USFWS and NMFS BiOps,
33 and the CDFW ITP. It is expected that the trend in exports will continue to decrease due to
34 increasing regulatory and environmental needs, and changes in hydrologic conditions under climate
35 change.

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A text description of this figure is provided in Chapter 39, *Text Descriptions of Figures*



1
2 **Figure 6-2. Delta Water Exports 1970–2019**

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6.2.1.5 Regional and Local Diversions from the Delta

There are over 2,200 diversions in the Delta area that are estimated to divert up to 5,000 cfs during peak summer months (California Department of Water Resources 2009:D-15). Most of the in-Delta diversions are related to agricultural operations. However, several communities divert surface water from the Delta, including the City of Antioch, City of Stockton, East Bay Municipal Utility District (EBMUD), Sacramento County, and CCWD. Numerous industries along the Contra Costa County shoreline from Martinez to Antioch, including powerplants and refineries, and industries in San Joaquin County near Stockton also divert surface water.

Surface water in the Delta also is influenced by consumptive use of groundwater by agricultural crops and by seepage from the surface water into the interior of the islands and tracts. A substantial portion of the water diverted from the Delta or that seeps into the islands and tracts is returned to the Delta surface water by agricultural and drainage flows and seepage that is pumped from the islands and tracts into the Delta.

Agencies and water districts that divert and use water from the Delta for M&I uses and agricultural irrigation are described below.

Freeport Regional Water Authority

The Freeport Regional Water Project (FRWP), completed in 2011, diverts up to a maximum of about 286 cfs from the Sacramento River near Freeport for Sacramento County and EBMUD. EBMUD diverts water pursuant to its amended contract with Reclamation. Sacramento County diverts using its water rights and its CVP contract supply. Reclamation delivers CVP water pursuant to its respective water supply contracts with the Sacramento County Water Agency (SCWA) and EBMUD through the FRWP to areas in central Sacramento County. SCWA is responsible for providing water supplies and facilities to areas in central Sacramento County, including the Laguna, Vineyard, Elk Grove, and Mather Field communities through a capital funding zone known as Zone 40.

North Delta Water Agency

The North Delta Water Agency (NDWA), which includes about 300,000 acres within the north Delta, was created in 1973 by an act of the California Legislature. NDWA's primary purpose is to assure and protect the water supply and water quality for landowners within agency boundaries. NDWA entered into a contract with DWR in 1981 to assure a dependable water supply of suitable quality. The contract requires DWR to ensure a certain quality of water and, under certain conditions, to financially compensate if the water quality conditions cannot be met. The contract also provides that DWR will furnish such water as may be required within NDWA to the extent not otherwise available under the individual water rights of the water users. The contract provides that water within the boundaries of NDWA will be of suitable quality through year-round criteria monitored at seven locations.

Central Delta Water Agency

The Central Delta Water Agency (CDWA) was formed to assist landowners to protect and assure a dependable supply of water of suitable quality sufficient to meet existing and future needs. The agency encompasses approximately 120,000 acres in San Joaquin County, all of which is within the Delta. The lands within the CDWA are primarily agricultural but also contain recreational and

significant wildlife habitat areas. These lands are dependent on water supply from in-channel Delta diversions for irrigation and other beneficial uses. The in-channel water supply is currently dependent on the flow and quality of both the Sacramento and San Joaquin River systems.

Contra Costa Water District Diversion Facilities

CCWD diverts water from the Delta for irrigation and M&I uses under its CVP contract and under its own water right permits and license, issued by the State Water Board. The CCWD water system includes the Mallard Slough, Rock Slough, Old River, and Middle River (on Victoria Canal) intakes; the Contra Costa Canal and shortcut pipeline; and the Los Vaqueros Reservoir. The Rock Slough Intake facilities, the Contra Costa Canal, and the shortcut pipeline are owned by Reclamation but operated and maintained by CCWD under contract with Reclamation. Mallard Slough Intake, Old River Intake, Middle River Intake, and Los Vaqueros Reservoir are owned and operated by CCWD and are not part of the CVP.

City of Stockton

The City of Stockton began operation of a 30-million-gallon-per-day intake facility in 2012, as part of the Delta Water Supply Project (Phase 1) to divert water along the San Joaquin River at Empire Tract (City of Stockton 2021).

South Delta Water Agency

The principal purpose of the South Delta Water Agency is to protect the water supply of the lands within its boundaries against salinity intrusion and to assure a dependable supply of water of suitable quality to meet present and future needs. The area within the agency boundary (Middle Roberts, Upper Roberts, Union, Fabian Tract, and Stark Tract Islands) encompasses about 148,000 acres and is primarily agricultural with some municipal use. The primary source of water is in-channel water supply in the southern Delta from San Joaquin and Sacramento River flows that are diverted for irrigation and other beneficial uses via several small pumps and siphons.

City of Antioch

The City of Antioch has a water right to divert from the San Joaquin River and is a customer of the CCWD. Whenever the river salinity is at an acceptable level (i.e., chloride concentration less than 250 milligrams per liter), the appropriative water right is used (and water is diverted from the San Joaquin River near Antioch Bridge). Whenever the river salinity level is unacceptable, or when demand exceeds the existing pumping capacity, the City purchases substitute or additional water supplies directly from the CCWD. Currently, the City is implementing a brackish water desalination facility that will allow the use of their Delta water right year-round, even when river salinity is at unacceptable levels.

6.2.1.6 Water Transfers

California water law and the CVPIA promote water transfers as an important water resource management tool to address water shortages, provided that certain protections to source areas, users, and affected environmental resources are incorporated into the water transfer. Parties seeking water transfers generally acquire water from willing sellers who have surplus reservoir storage water, sellers who can pump groundwater instead of using surface water, or sellers who will

1 fallow crops or substitute a crop that uses less water to reduce normal consumptive use of surface
2 diversions.

3 Water transfers involving the SWP and CVP (facilities and contractors) occur when a water agency
4 or a water right holder willingly undertakes actions to make project or non-project water available
5 for transfer. These transfers may require export from the Delta through SWP and/or CVP facilities.
6 In some cases, water transfers may be for in-Delta environmental uses.

7 There is a potential for other voluntary water market transactions that could be conveyed to the
8 Delta for export or environmental purposes. These could include exchanges of non-project water,
9 coordinated or integrated operations of projects other than the SWP or CVP, or sales of water rights
10 that could be used to supplement project water supplies or for increasing instream flows. These
11 other types of transactions would most likely come from some of the same sources and have similar
12 constraints and in-Delta impacts.

13 The analysis in Appendix 3H, *Non-Project Water Transfer Analysis for Delta Conveyance*, concludes
14 that there is more than sufficient available export capacity for water transfers in all water year types
15 with the current facilities. Maximum historical water transfers in each water year type were less
16 than the permitted annual volumes. In below normal years, when there is greater demand for water
17 transfers, historical data shows there was still sufficient available export capacity even after water
18 transfers were exported.

19 Therefore, though the project may add additional export capacity, it is unlikely to increase the
20 amount of water transfers, because the current capacity is not even fully utilized. For this reason,
21 potential direct or indirect impacts of water transfers is not further discussed in this chapter, as the
22 project appears very unlikely to increase transfer activity.

23 6.3 Water Supply Changes

24 This section describes the changes, as well as the methods used to determine such changes,
25 associated with water supply that would result from project construction, operation, and
26 maintenance.

27 Many of the waterways evaluated in this resource chapter are important to California Native
28 American Tribes (Tribes). Rivers have cultural value to Tribes for fishing, gathering, drinking, and
29 bathing, and water is used for cleansing as part of ceremony. Rivers have spiritual meaning to
30 Tribes, as the rivers relate to creation stories, afterlife, ancestors, and how ancestors move around in
31 the environment. In recognition of the Tribal values of this resource, water and waterways are also
32 evaluated in Chapter 32, *Tribal Cultural Resources*, and, as such, these resources informed the
33 Chapter 32 Tribal cultural resources analysis.

34 6.3.1 Methods for Analysis

35 6.3.1.1 Process and Methods of Review for Water Supply

36 Consistent with previous modeling analyses conducted by DWR and Reclamation for the SWP and
37 CVP, including the 2019 *Reinitiation of Consultation on the Coordinated Long-Term Operation of the*
38 *Central Valley Project and State Water Project Final Biological Assessment* (Bureau of Reclamation
39 2019) and the 2020 *Incidental Take Permit for the Long-Term Operation of the State Water Project in*

the *Sacramento–San Joaquin Delta 2081-2019-066-00* (California Department of Fish and Wildlife 2020), the modeling results presented in this section assumed that the SWP and CVP were solely responsible for providing any needed water for implementing the project alternatives. The project alternatives do not include any actions that would modify water deliveries to non-SWP and non-CVP water rights holders, including in-Delta water rights holders. Therefore, only changes to DWR, Reclamation, and SWP water users and CVP water service contractors are included in this chapter.

Basis for Quantification of SWP and CVP Exports and Deliveries

The analysis of changes in Delta exports and SWP/CVP water deliveries compares simulated water supply conditions (based upon CalSim 3 results) of the project alternatives to existing conditions, reflecting differences in SWP/CVP surface water supply availability resulting from SWP/CVP operations.

For each project alternative, changes in reservoir storage, annual deliveries, and Delta outflow are presented to provide a basis for understanding changes in SWP and CVP exports and deliveries. However, no specific impact assessment results are presented in this chapter because the effects of these changes are not considered environmental impacts under CEQA. Changes in Delta outflow and SWP/CVP upstream reservoir storage are relevant to water quality (Chapter 9, *Water Quality*), conditions for fisheries (Chapter 12, *Fish and Aquatic Resources*), recreation (Chapter 16, *Recreation*), public services and utilities (Chapter 21, *Public Services and Utilities*), and hydroelectric generation (Chapter 22, *Energy*). Specific impacts analysis and mitigation measures are provided in those chapters.

6.3.1.2 Evaluation of Operations

The water supply analysis was conducted using the CalSim 3 model. A full description of the modeling tools and outputs is included in Appendix 5A, *Modeling Technical Appendix*.

CalSim 3 is a reservoir-river basin planning model developed by DWR and Reclamation to simulate the operation of the SWP and CVP over a range of different hydrologic conditions. CalSim 3 allows for specification and achievement of a series of user-specified priorities and goals. It is the best available planning model for the SWP and CVP system operations. Earlier versions of CalSim, in particular CalSim II, have been used in previous system-wide evaluations of SWP and CVP operations. Inputs to CalSim 3 include water diversion requirements (demands), stream accretions and depletions, reservoir inflows, irrigation efficiencies, and parameters to calculate return flows, nonrecoverable losses, and groundwater hydrology. Sacramento and San Joaquin Valley and tributary rim basin hydrologic inputs are based on an adjusted historical sequence of monthly stream flows over a 94-year period (1922–2015), in order to represent a sequence of flows at a given level of development. Adjustments to historic hydrologic sequences are imposed based on current land use and meteorological and hydrologic conditions to develop an existing (2020) level of hydrology. Projected future land use, meteorological, and hydrologic conditions expected in 2040 are used to develop a future (2040) level of development. The resulting hydrology represents the simulated water supply available from Central Valley streams to the SWP and CVP at the given level of development for use in CalSim 3 simulations. For this document, the 2020 level hydrology was used for the existing conditions simulation and all project alternatives. The No Project Alternative uses the 2040 level hydrology in the CalSim 3 simulations.

CalSim 3 produces outputs for river flows and diversions, reservoir storage, Delta flows and exports, Delta inflow and outflow, deliveries to project and non-project users, and controls on project

1 operations. Water rights deliveries to non-SWP and non-CVP water rights holders do not change in
2 the CalSim 3 simulations of the project alternatives. As previously mentioned, CalSim 3 and its
3 predecessor, CalSim II, have been adopted by DWR and Reclamation for the purpose of SWP/CVP
4 system operations analysis in the context of long-term planning. Despite being recognized as the
5 best available tool for this purpose and as the standard tool for project evaluation to support the
6 environmental review process, CalSim 3 is subject to certain limitations. These include the use of
7 assumptions for approximating the operations of various facilities and regulatory requirements,
8 approximations of real-time daily or even hourly operational considerations in order to incorporate
9 them into a monthly model, and additional uncertainty inherited from input data and the model
10 development process (Appendix 5A, Section B, *Hydrology and Systems Operations Modeling*, for more
11 detail). Therefore, inferences using CalSim 3 results from any single scenario may be appropriate for
12 general, long-term trend assessment, but may not be adequate to support detailed reviews on an
13 individual timestep basis or for selected periods. The following provides some examples for
14 illustrative purposes.

15 Under extreme hydrologic and operational conditions where there is not enough water supply to
16 meet all requirements, the SWP and CVP operators use a complicated decision process to decide on
17 how to operate the projects to best meet the overall balance of requirements. This process is unique
18 depending on the specific circumstances and operational requirements in place at the time. During
19 these periods in a simulation, CalSim 3 utilizes a series of operating rules to reach a solution to allow
20 the continuation of the simulation. These operating rules are a simplified version of the very
21 complex decision processes that SWP and CVP operators would use in actual extreme conditions.
22 Therefore, model results and potential changes under these extreme conditions should be
23 recognized as an approximation of the actual operations that would occur under those conditions.

24 As an example, CalSim 3 results show very infrequent simulated occurrences of extremely low
25 storage conditions at SWP and CVP reservoirs during critical drought periods when storage is at
26 “dead pool” levels (below the elevation of the lowest river outlet). Simulated occurrences of
27 reservoir storage conditions at dead pool levels may occur coincidentally with simulated potential
28 impacts. These conditions can occur both with and without the project alternatives, though not
29 necessarily in the same timestep. Dead pool conditions are never more frequent under the project
30 alternatives and are often less frequent when compared to simulation results without the project
31 alternatives. When reservoir storage is at dead pool levels, there may be instances in the simulation
32 results in which flow conditions fall short of minimum flow criteria, salinity conditions may exceed
33 salinity standards, diversion conditions fall short of allocated diversion amounts, and operating
34 agreements are not met. During real-life operations, operators would use allowable real-time
35 adjustments in operation to satisfy regulatory, legal, and contractual requirements given the current
36 conditions and hydrologic constraints to the maximum extent possible. In some cases, certain
37 voluntary extraordinary water conservation and changes in regulatory requirements for water
38 rights or for flow and water quality requirements could be imposed to accommodate extreme
39 conditions, such as during the drought emergency of 2012–2016. These potential, specific real-time
40 actions are not simulated in CalSim 3 during these periods because these actions were implemented
41 to address the specific circumstances under the emergency declaration and associated emergency
42 regulations. These specific actions or level of implementation cannot be predicted a priori, nor could
43 they be reasonably incorporated as regular operations. Therefore, the results of CalSim 3 reflect the
44 assumption that these interventions are not imposed.

45 Recognizing the model limitations discussed here and in Appendix 5A, the applications of CalSim 3
46 (and its predecessors) are considered appropriate only when modeling results are used in a

1 statistical comparative analysis, that is, with two scenarios that differ only in terms of operational
2 and other assumptions that are needed to understand the effects of the project being analyzed.
3 Under a comparative analysis, the potential influences of model limitations can be reduced. This
4 application mode is compatible with the needs of the environmental review process and, thus, is
5 used in the analysis presented in this chapter as described below.

6 Modeling results are presented with project alternatives paired based on their corresponding
7 facility capacity and operation for better contrasting the differences. For example, CalSim 3 results
8 for Alternative 1 (6,000 cfs) and Alternative 3 (6,000 cfs) are paired together, Alternative 2a (7,500
9 cfs) and Alternative 4a (7,500 cfs) are paired together, etc. CalSim 3 is a mass-balance model and,
10 thus, its results are not influenced by conveyance alignment. However, despite having the same
11 north Delta intake capacity and operation as Alternatives 1 and 3, Alternative 5 (i.e., Bethany
12 Reservoir alternative) is presented separately from the other alternatives because export capacity
13 assumptions are slightly different than in Alternatives 1 and 3. All project alternatives include
14 assumptions about Banks Pumping Plant outages, which can reduce exports below physical or
15 permit capacity. For project alternatives other than Alternative 5, this outage-based limit on exports
16 is applied to the total pumping at the Banks Pumping Plant; for Alternative 5, this outage-based limit
17 is only applied to the south-of-Delta exports at the Banks Pumping Plant. This is due to diversions
18 from the proposed north Delta intakes under Alternative 5 going directly to Bethany Reservoir
19 through facilities that are different from those associated with the other project alternatives (i.e.,
20 Southern Complex) and the Banks Pumping Plant. This distinction allows for slightly higher exports
21 under Alternative 5 when compared to Alternatives 1 and 3, which can cause minor differences in
22 the results of the surface water analyses between the two alignments.

23 Even with comparative analysis, model uncertainty and its influence on the model results that are
24 presented cannot be completely avoided. Therefore, in addition to showing the effects of the project
25 being analyzed, observed differences between two scenarios can sometimes include the effects of
26 model uncertainty. While no exact quantification of model uncertainty is available, DWR believes
27 that CalSim 3 results are subject to approximately a 5% uncertainty. These considerations and
28 appropriate use of CalSim 3 and its modeling results are discussed in more detail in the Appendix
29 5A, Section B.

30 **SWP and CVP Exports and Deliveries**

31 SWP and CVP water supply availability is evaluated in this chapter as SWP/CVP exports into the
32 export service areas and SWP/CVP deliveries throughout the system. Water deliveries downstream
33 of San Luis Reservoir are not necessarily the same volume as Delta exports because portions of the
34 exported water are stored in San Luis Reservoir and portions are lost during conveyance.

35 The model results for CVP Settlement, Refuge, and Exchange Contractors and SWP FRSA Contractors
36 are complex. Deliveries to CVP Settlement, Refuge, and Exchange Contractors and SWP FRSA
37 Contractors are only shown for average, dry, and critical water year types; dry and critical water
38 year types are the only years in which allocations for these contractors may be less than 100%.
39 Deliveries to these contractors may be reduced very infrequently in these years because of
40 reservoirs reaching dead pool storage. In the modeling, some CVP water contractors receive their
41 full contract amounts in water years that are classified as Shasta non-critical (based on the
42 hydrologic Shasta Index). In Shasta critical water years (there are 12 occurrences in the 94 years
43 simulated under current climate conditions), these contractors receive 75% of their full contract
44 amounts. The model meets these deliveries unless that is not possible because storages are at dead

pool. Hence, deliveries reported for these contractors will include 12 normally reduced-allocation years and may include very infrequent additional reductions (either in Shasta critical years or other years) because of the simulated dead pool storage conditions.

Similarly, in the modeling, FRSA water contractors receive their full contract amounts in water years that are classified as Feather River non-critical (based on the hydrologic Feather River Index). In Feather River critical water years (there are six occurrences in the 94 years simulated under current climate conditions) these contractors receive 50% of their full contract amounts per year, except if that would result in more than two 50% allocations in a 7-year period. This latter condition applies once under current climate conditions, so there is one Feather River critical water year which has a 100% allocation. The model meets these deliveries unless that is not possible because storages are at dead pool. Hence, deliveries reported for these contractors will include 5 normally reduced-allocation years and may include very infrequent additional reductions (either in Feather River critical years or other years) because of the simulated dead pool storage conditions.

When reporting changes in CVP Settlement, Refuge, and Exchange Contractors and SWP FRSA Contractors, average deliveries are provided for the combination of the D-1641 40-30-30 dry and critical years for the period of October 1921–September 2015. The computation of these year types with CalSim 3 hydrology can differ from the historical water year types used in the earlier CalSim II model, in particular in a few years previously designated as dry years that are designated as below normal years in CalSim 3. The methods for generating the forecast-based water year types used in CalSim 3 are described in Appendix 5A. Use of Sacramento Valley 40-30-30 year types as defined in D-1641 in the existing conditions model run provides a consistent set of years that covers all the Shasta critical and Feather River critical years under both current and future climate conditions; as well as providing a consistent reporting of results in dry and critical years for all SWP and CVP water contractors (as shown in Appendix 5A).

Despite these detailed model inputs and assumptions, the model may still very infrequently show dead pool conditions in very dry years that appear to prevent Reclamation and DWR from meeting their contractual obligations to their corresponding contractors. Such model results are considered anomalies that reflect the inability of the model to make real-time policy decisions under extreme circumstances, as the actual (human) operators must do. Thus, any reductions simulated due to reservoir storage conditions being at dead pool for these types of deliveries should only be considered as indicators of stressed water supply conditions under that project alternative and should not be understood to reflect literally what would occur in the future. In actual future operations, as has always been the case in the past, the project operators would work in real time to satisfy legal and contractual obligations given the current conditions and hydrologic constraints with or without the project.

6.3.2 Comparison of Project Alternatives with Existing Conditions

Changes in average annual water supplies based on model simulation results for the No Project Alternative (2040 hydrology) compared against existing conditions are shown in Table 6-2. The frequency of available Article 21 south-of-Delta water supplies over the 94-year simulation period for existing conditions and the No Project Alternative are shown in Table 6-3. Table 6-4 shows a summary of Delta outflow and exports for the No Project Alternative compared against existing conditions.

Changes in average annual water supplies based on model simulation results for the project alternatives under 2020 conditions compared against existing conditions are shown in Table 6-5. The frequency of available Article 21 south-of-Delta water supplies over the 94-year simulation period for existing conditions and the project alternatives is shown in Table 6-6. Table 6-7 shows a summary of Delta outflow and exports for the project alternatives compared against existing conditions. Modeled results do not estimate a water supply benefit associated with having an alternate water supply source as a backup for potential future supply interruptions caused by seismic events. Detailed results for monthly and annual changes are presented in Appendix 6A, *Water Supply 2040 Analysis*.

Table 6-2. Water Supply Summary, Changes to Water Supply by the No Project Alternative (2040 Hydrology), Geographic Area, and User, Shown in Thousand Acre-Feet and Resulting Percentages, as Compared to Existing Conditions (2020 Hydrology)

Parameter/Location	EC (TAF)	No Project (TAF)	No Project (%)
End of September Storage (Long-Term Average)			
Trinity Lake	1,438	1,321	-8%
Shasta Lake	2,827	2,715	-4%
Lake Oroville	1,964	1,673	-15%
Folsom Lake	546	484	-11%
San Luis Reservoir	619	558	-10%
CVP San Luis Reservoir	193	174	-10%
SWP San Luis Reservoir	426	385	-10%
Annual SWP Deliveries Long-Term Average^a (SWP Contract Year; January–December)			
Total SWP Contractors Deliveries	3,509	3,273	-7%
SWP FRSA	1,081	1,056	-2%
SWP Table A	2,110	1,926	-9%
SWP A56	226	184	-19%
SWP A21	93	107	15%
Annual SWP Deliveries, Average of Dry and Critical Water Years^b (SWP Contract Year; January–December)			
Total SWP Contractors Deliveries	2,375	2,135	-10%
SWP FRSA	1,059	1,019	-4%
SWP Table A	1,145	979	-14%
SWP A56	166	129	-23%
SWP A21	6	9	51%
Annual CVP Deliveries, Long-Term Average^a (CVP Contract Year; March–February)			
Total CVP Deliveries	4,483	3,883	-13%
Total CVP Deliveries North-of-Delta	575	528	-8%
CVP North-of-Delta Agriculture	309	230	-26%
CVP North-of-Delta M&I	140	171	22%

Parameter/Location	EC (TAF)	No Project (TAF)	No Project (%)
CVP North-of-Delta Refuge Level 2	125	127	2%
Total CVP Deliveries South of the Delta	1,587	966	-39%
CVP South-of-Delta Agriculture	1,168	577	-51%
CVP South-of-Delta M&I	141	109	-23%
CVP South-of-Delta Refuge Level 2	278	280	1%
CVP Settlement Contractors	1,503	1,564	4%
CVP Exchange Contractors	818	825	1%
Annual CVP Deliveries, Average of Dry and Critical Water Years^b (CVP Contract Year; March–February)			
Total CVP Deliveries	3,620	3,145	-13%
Total CVP Deliveries North of the Delta	411	361	-12%
CVP North-of-Delta Agriculture	131	66	-50%
CVP North-of-Delta M&I ^c	156	168	8%
CVP North-of-Delta Refuge Level 2	124	127	3%
Total CVP Deliveries South of the Delta	945	422	-55%
CVP South-of-Delta Agriculture	571	71	-88%
CVP South-of-Delta M&I	112	81	-28%
CVP South-of-Delta Refuge Level 2	261	270	3%
CVP Settlement Contractors	1,492	1,567	5%
CVP Exchange Contractors	772	795	3%

Alt = alternative; CVP = Central Valley Project; EC = existing conditions; FRSA = Feather River Service Area; M&I = municipal and industrial; SWP = State Water Project; TAF = thousand acre-feet.

^a Long-term average is the average annual for the period October 1921–September 2015 simulated in CalSim 3.

^b Dry and critical is the average annual for the State Water Resources Control Board Water Right D-1641 40-30-30 dry and critical years for the period October 1921–September 2015 simulated in CalSim 3.

^c The CVP North-of-Delta M&I includes a number of individual diversions including East Bay Municipal Utility District (EBMUD) diversion at Freeport. The diversion is made in drought years when EBMUD's total system storage is forecast to be less than 500,000 acre-feet. This extra diversion during only dry/critical years and zero in other years causes the dry/critical average, which includes those diversions, to be higher than the long-term average, with zero diversion in the wetter years.

Table 6-3. Frequency of Years of Available Article 21 Deliveries South-of-Delta for the No Project Alternative (2040 Hydrology) as Compared to Existing Conditions (2020 Hydrology) over the Simulation Period

Article 21 Deliveries South-of-Delta	EC	No Project
Total Years of available Article 21 supplies	61	50
Long-Term Average ^a (SWP Contract Year; January–December)		
Percent of Years of available Article 21 supplies	65%	53%

EC = existing conditions; SWP = State Water Project.

^a Long-term average is the average annual for the period October 1921–September 2015 simulated in CalSim 3.

Table 6-4. Summary of Annual Delta Outflow and Exports October–September under the No Project Alternative (2040 Hydrology) as Compared to Existing Conditions (2020 Hydrology)

Parameter/Location	EC (TAF)	No Project (TAF)	No Project (%)
Outflow	15,216	16,751	10%
Total Delta Export	4,939	4,133	-16%
SWP Delta Export Total ^a	2,401	2,186	-9%
SWP Delta Export at North Delta Diversion Intakes	0	0	N/A
SWP Delta Exports at South Delta Intakes	2,401	2,186	-9%
CVP Delta Export Total	2,538	1,947	-23%
CVP Delta Export at North Delta Diversion Intakes	0	0	N/A
CVP Delta Exports at South Delta Intakes	2,538	1,947	-23%

CVP = Central Valley Project; EC = existing conditions; N/A = not applicable; SWP = State Water Project; TAF = thousand acre-feet.

^a Values do not include transfer water delivered as part of the lower Yuba River Accord.

Table 6-5. Water Supply Summary, Changes to Water Supply by the Project Alternatives, Geographic Area, and User, Shown in Thousand Acre-Feet and Resulting Percentages, as Compared to Existing Conditions (2020 Hydrology)

Parameter/Location	EC (TAF)	Alts 2b, 4b (TAF)	Alts 2b, 4b (%)	Alts 2c, 4c (TAF)	Alts 2c, 4c (%)	Alts 1, 3 (TAF)	Alts 1, 3 (%)	Alts 2a, 4a (TAF)	Alts 2a, 4a (%)	Alt 5 (TAF)	Alt 5 (%)
End of September Storage (Long-Term Average)											
Trinity Lake	1,438	1,443	0%	1,445	0%	1,443	0%	1,441	0%	1,443	0%
Shasta Lake	2,827	2,846	1%	2,844	1%	2,838	0%	2,841	1%	2,837	0%
Lake Oroville	1,964	1,979	1%	1,980	1%	1,981	1%	1,982	1%	1,983	1%
Folsom Lake	546	552	1%	552	1%	552	1%	551	1%	551	1%
San Luis Reservoir	619	695	12%	696	12%	699	13%	699	13%	700	13%
CVP San Luis Reservoir	193	192	0%	191	-1%	194	0%	194	0%	193	0%
SWP San Luis Reservoir	426	502	18%	504	18%	506	19%	505	18%	506	19%
Annual SWP Deliveries Long-Term Average ^a (SWP Contract Year; January–December)											
Total SWP Contractors Deliveries	3,509	3,918	12%	4,001	14%	4,046	15%	4,037	15%	4,050	15%
SWP FRSA	1,081	1,079	0%	1,079	0%	1,078	0%	1,078	0%	1,079	0%
SWP Table A	2,110	2,338	11%	2,372	12%	2,391	13%	2,380	13%	2,392	13%
SWP A56	226	260	15%	258	14%	252	11%	252	11%	252	11%
SWP A21	93	240	159%	293	216%	325	250%	327	252%	328	254%
Annual SWP Deliveries, Average of Dry and Critical Water Years ^b (SWP Contract Year; January–December)											
Total SWP Contractors Deliveries	2,375	2,594	9%	2,640	11%	2,686	13%	2,656	12%	2,686	13%
SWP FRSA	1,059	1,053	0%	1,052	-1%	1,052	-1%	1,051	-1%	1,053	-1%
SWP Table A	1,145	1,313	15%	1,364	19%	1,413	23%	1,381	21%	1,412	23%
SWP A56	166	222	34%	219	32%	215	29%	217	30%	215	29%
SWP A21	6	6	-6%	6	-8%	6	3%	7	21%	6	3%
Annual CVP Deliveries, Long-Term Average ^a (CVP Contract Year; March–February)											
Total CVP Deliveries	4,483	4,507	1%	4,525	1%	4,531	1%	4,578	2%	4,530	1%
Total CVP Deliveries North-of-Delta	575	577	0%	576	0%	576	0%	579	1%	576	0%
CVP North-of-Delta Agriculture	309	311	1%	310	0%	311	0%	313	1%	310	0%
CVP North-of-Delta M&I	140	141	0%	140	0%	140	0%	141	0%	140	0%
CVP North-of-Delta Refuge Level 2	125	125	0%	125	0%	125	0%	125	0%	125	0%

Parameter/Location	EC (TAF)	Alts 2b, 4b (TAF)	Alts 2b, 4b (%)	Alts 2c, 4c (TAF)	Alts 2c, 4c (%)	Alts 1, 3 (TAF)	Alts 1, 3 (%)	Alts 2a, 4a (TAF)	Alts 2a, 4a (%)	Alt 5 (TAF)	Alt 5 (%)
Total CVP Deliveries South of the Delta	1,587	1,610	2%	1,629	3%	1,634	3%	1,678	6%	1,633	3%
CVP South-of-Delta Agriculture	1,168	1,191	2%	1,209	3%	1,213	4%	1,256	8%	1,213	4%
CVP South-of-Delta M&I	141	141	0%	142	1%	143	1%	145	3%	143	1%
CVP South-of-Delta Refuge Level 2	278	278	0%	278	0%	278	0%	278	0%	278	0%
CVP Settlement Contractors	1,503	1,502	0%	1,502	0%	1,503	0%	1,503	0%	1,503	0%
CVP Exchange Contractors	818	818	0%	818	0%	818	0%	818	0%	818	0%
Annual CVP Deliveries, Average of Dry and Critical Water Years^b (CVP Contract Year; March–February)											
Total CVP Deliveries	3,620	3,145	-13%	3,646	1%	3,650	1%	3,641	1%	3,678	2%
Total CVP Deliveries North of the Delta	411	420	2%	417	1%	415	1%	419	2%	415	1%
CVP North-of-Delta Agriculture	131	138	6%	136	4%	134	2%	138	6%	134	2%
CVP North-of-Delta M&I ^c	156	157	1%	157	1%	156	1%	157	1%	156	0%
CVP North-of-Delta Refuge Level 2	124	124	0%	124	0%	124	0%	124	0%	124	0%
Total CVP Deliveries South of the Delta	945	963	2%	970	3%	963	2%	996	5%	963	2%
CVP South-of-Delta Agriculture	571	589	3%	595	4%	589	3%	621	9%	588	3%
CVP South-of-Delta M&I	112	113	1%	113	1%	113	1%	115	2%	113	1%
CVP South-of-Delta Refuge Level 2	261	261	0%	261	0%	261	0%	261	0%	261	0%
CVP Settlement Contractors	1,492	1,491	0%	1,491	0%	1,491	0%	1,491	0%	1,491	0%
CVP Exchange Contractors	772	772	0%	772	0%	772	0%	772	0%	772	0%

Alt(s) = alternative(s); CVP = Central Valley Project; EC = existing conditions; FRSA = Feather River Service Area; M&I = municipal and industrial; SWP = State Water Project;
TAF = thousand acre-feet.

^a Long-term average is the average annual for the period October 1921–September 2015 simulated in CalSim 3.

^b Dry and critical is the average annual for the State Water Resources Control Board Water Right D-1641 40-30-30 dry and critical years for the period October 1921–September 2015 simulated in CalSim 3.

^c The CVP North-of-Delta M&I includes a number of individual diversions including East Bay Municipal Utility District (EBMUD) diversion at Freeport. The diversion is made in drought years when EBMUD's total system storage is forecast to be less than 500,000 acre-feet. This extra diversion during only dry/critical years and zero in other years causes the dry/critical average, which includes those diversion, to be higher than the long-term average, with zero diversion in the wetter years.

Table 6-6. Frequency of Years of Available Article 21 Deliveries South-of-Delta over the Simulation Period

Article 21 Deliveries South-of-Delta	EC	Alts 2b, 4b	Alts 2c, 4c	Alts 1, 3	Alts 2a, 4a	Alt 5
Total Years of available Article 21 supplies	61	67	66	71	73	74
Long-Term Average ^a (SWP Contract Year; January–December)						
Percent of Years of available Article 21 supplies	65%	71%	70%	76%	78%	79%

Alt(s) = alternative(s); EC = existing conditions.

^a Long-term average is the average annual for the period October 1921–September 2015 simulated in CalSim 3.**Table 6-7. Summary of Annual Delta Outflow and Exports October–September under the Project Alternatives as Compared to Existing Conditions (2020 Hydrology)**

Parameter/Location	EC (TAF)	Alts 2b, 4b (TAF)	Alts 2b, 4b (%)	Alts 2c, 4c (TAF)	Alts 2c, 4c (%)	Alts 1, 3 (TAF)	Alts 1, 3 (%)	Alts 2a, 4a (TAF)	Alts 2a, 4a (%)	Alt 5 (TAF)	Alt 5 (%)
Outflow	15,216	14,777	-3%	14,681	-4%	14,631	-4%	14,604	-4%	14,626	-4%
Total Delta Export	4,939	5,377	9%	5,478	11%	5,528	12%	5,563	13%	5,532	12%
SWP Delta Export Total ^a	2,401	2,811	17%	2,895	21%	2,940	22%	2,931	22%	2,944	23%
SWP Delta Export at North Delta Diversion Intakes	0	558	N/A	675	N/A	740	N/A	673	N/A	746	N/A
SWP Delta Exports at South Delta Intakes	2,401	2,252	-6%	2,220	-8%	2,200	-8%	2,258	-6%	2,198	-8%
CVP Delta Export Total	2,538	2,566	1%	2,583	2%	2,588	2%	2,631	4%	2,588	2%
CVP Delta Export at North Delta Diversion Intakes	0	0	N/A	0	N/A	0	N/A	100	N/A	0	N/A
CVP Delta Exports at South Delta Intakes	2,538	2,566	1%	2,583	2%	2,588	2%	2,532	0%	2,588	2%

Alt(s) = alternative(s); CVP = Central Valley Project; EC = existing conditions; N/A = not applicable; SWP = State Water Project; TAF = thousand acre-feet.

^a Values do not include transfer water delivered as part of the lower Yuba River Accord.

6.3.2.1 No Project Alternative

The No Project Alternative represents the circumstances under which the project (or project alternative) does not proceed and considers predictable actions, such as projects, plans, and programs that would be predicted to occur in the foreseeable future if the Delta Conveyance Project was not constructed and operated, which are identified in Appendix 3C, *Defining Existing Conditions, No Project Alternative, and Cumulative Impact Conditions*, Section 3C.3.2, *No Project Alternative Conditions*, including Table 3C-2. Under the No Project Alternative, no construction or modification to SWP or CVP facilities or operations would occur. Under the No Project Alternative, DWR would continue to operate the SWP to divert, store, and convey SWP water consistent with applicable laws and contractual obligations. Because of the interrelated operation of the SWP and CVP, the No Project Alternative would also assume the current operation of the CVP would continue. The No Project Alternative also discusses how other predictable actions by water suppliers that receive SWP supplies, described in Appendix 3C, Section 3C.3.2.5, *No Project Alternative Assumptions for Water Agency Actions*, could affect the environment.

Future Water Supply Conditions

Under the No Project Alternative, DWR operation of the SWP and Reclamation operation of the CVP are assumed to remain subject to the current take prohibition for listed species and other ESA requirements required by the 2019 USFWS and NMFS BiOps (U.S. Fish and Wildlife Service 2019; National Marine Fisheries Service 2019) and the 2020 ITP (for SWP only) (California Department of Fish and Wildlife 2020). The No Project Alternative is intended to identify predictable or foreseeable conditions under a long-term scenario in which the Delta Conveyance Project is not approved or implemented. Such foreseeable actions include a continuing uncertainty of SWP/CVP south Delta exports, increasing vulnerability in the south Delta to long-term degradation in water quality due to sea level rise that could be expected to occur, and continuing vulnerability resulting from a major seismic or levee failure event that could cause salinity intrusion that would temporarily halt export operations (Appendix 3C).

Climate Change and Sea Level Rise

Climate change is projected to change precipitation and runoff patterns in the future. While the specifics of future conditions are uncertain, most future projections indicate that climate change is likely to result in earlier spring runoff and increased severity of extreme dry and wet conditions. Under the No Project Alternative, the SWP and CVP would be limited in their ability to capture flashy winter storm events, which would decrease SWP and CVP water supply reliability into the future. Tables 6-2, 6-3, and 6-4 present modeling results that simulate changes in water supply conditions into the future under the No Project Alternative; the key drivers for these changes are the climate change and sea level rise assumptions incorporated into the modeling effort. Key water supply changes expected to occur under the No Project Alternative include the following.

- Total SWP deliveries: Average annual SWP deliveries would decrease under the No Project Alternative for the long-term average, dry water years, and critical water years (Table 6-2). Long-term average annual deliveries and dry and critical water year deliveries would decrease 7% and 10%, respectively.
- SWP Table A deliveries: Average annual SWP Table A deliveries are expected to decrease under the long-term average, dry water years, and critical years for the No Project Alternative (Table

6-2). Long-term average annual and dry and critical water year Table A deliveries would decrease 9% and 14%, respectively.

- SWP Article 56 and Article 21 deliveries: Average annual SWP Article 56 deliveries would decrease under the long-term average, dry water years, and critical water years compared to deliveries under existing conditions (Table 6-2). For both the long-term average and for dry and critical years, Article 56 deliveries would decrease 19% and 23%, respectively. Article 21 deliveries would increase on both the long-term average and during dry and critical years by 15% and 51%, respectively. While the increase in Article 21 delivery amounts may appear a substantive percentage, it is a smaller absolute increase (in dry and critical years, the Article 21 supply increases from 6 to 9 TAF). Additionally, as shown in Table 6-3 under the No Project Alternative, Article 21 deliveries would decrease in frequency but would increase in quantity when available because of the flashy storms that are projected to occur in the future.
- SWP Feather River Service Area: Annual deliveries to the SWP FRSA under the long-term average and dry and critical water years are expected to decrease when compared to existing conditions (Table 6-2). On a long-term average, deliveries are expected to decrease 2%, and during dry and critical water years, deliveries are expected to decrease 4%.
- CVP Deliveries: The long-term average annual total CVP deliveries for the No Project Alternative are expected to decrease 13%. During dry and critical years, decreases to total CVP deliveries of 13% are expected (Table 6-2). Modeling results indicated that the greatest decreases would occur for south-of-Delta agriculture, with decreases of 51% projected on the long-term average and 88% in dry and critical water years.

Generally, SWP and CVP deliveries would continue to decrease into the future beyond the 2040 horizon because of climate change and sea level rise. Trends in climate change and sea level rise are expected to continue, which would result in more extreme precipitation conditions coupled with higher sea level rise. These changes would likely continue to decrease SWP and CVP deliveries past the 2040 conditions modeled.

Earthquake Risk

As discussed in Chapter 1, Section 1.2.3.3, *Delta Levee Risks*, earthquakes pose a risk to Delta levees. When levees fail, water rushes into the lower-than-sea-level islands, pulling salt water from San Francisco Bay into the Delta. Depending on the location and timing of the levee failure, it may increase salinity in the area of the Banks and Jones Pumping Plants such that Delta diversions may need to halt for months (or even years). While the No Project Alternative does include continued efforts to improve Delta levees, some risk of failure would continue into the future. Prolonged periods of reduced or no pumping would result in the need to ration water supplies or release water from reservoirs south of the Delta due to intrusion of higher salinity seawater in the Delta. Delta inflows and outflows would be managed to provide flushing and restoration of water quality, which could result in exceedances of “normal” Delta outflow based on increased tidal flows into and out of the unrepaired levees and flooded islands. Management shifts could reduce the amount of water allocated for pumping by the SWP and CVP.

Additionally, because water supplies in the Delta are subject to regulatory and judicial requirements such as the ESA, reductions in consumptive withdrawals to protect species and associated habitat(s) in the Delta area could limit the ability to pump water for the SWP and CVP, especially under reduced water supply conditions related to a major earthquake event and levee failures.

Other Predictable Actions

The No Project Alternative also considers projects, plans, and programs that would be predicted to occur in the foreseeable future if the Delta Conveyance Project was not constructed and operated. A list and description of actions included as part of the No Project Alternative are provided in Appendix 3C, Section 3C.3.2.5. As described in Chapter 4, *Framework for the Environmental Analysis*, and Appendix 3C, the No Project Alternative includes the possible actions of California water suppliers other than DWR under a long-term scenario in which the Delta Conveyance Project is not approved or implemented and therefore SWP water supply reliability is not improved.² In this scenario, SWP water supply reliability would be expected to continue to degrade, and water agencies that receive SWP supplies would need to take additional actions to address local shortages that likely go beyond those actions identified in long-term planning documents. These actions could include pursuing additional water conservation programs, water recycling projects, groundwater recovery projects, desalination of seawater or brackish groundwater, surface water storage, groundwater management, or water transfers and exchanges.³

Public water agencies participating in the Delta Conveyance Project have been grouped into four geographic regions. The water agencies within each geographic region would foreseeably pursue a similar suite of water supply projects under the No Project Alternative (Appendix 3C, Section 3C.3.2.5). Table 6-8 shows the options available for each region and the potential to address water supply shortfalls in the No Project Alternative. Table 6-8 also includes the estimated range of forgone water supplies that the project would have provided if constructed and operated. The estimated range reflects a low and high range of water provided by the project alternative and is based on the SWP delivery information summarized in Table 6-7 above. Additional information on the geographic grouping of SWP contractors participating in the Delta Conveyance Project is provided in Appendix 3C, Section 3C.3.2.5.

Table 6-8. Other Predictable Actions in the No Project Alternative

Region	Estimated Range of Forgone Water Supplies if the Delta Conveyance Project Is Not Constructed (from Existing Conditions in 2020 to No Project Alternative in 2040)	Available Alternate Supply Types	Net Effects on Water Supply
Northern Coastal	20,500 AF – 27,200	Increased/accelerated desalination, water recycling, groundwater management (recovery, brackish water desalination), water use efficiency improvements	Alternate water supplies would foreseeably compensate for the supply decrease associated with climate change and sea level rise, but an extended outage associated with earthquake risk would pose challenges.

² CVP contractors would also likely consider other actions to address water supply shortages, but they are not discussed as part of the No Action/No Project because the project only includes improving water supply reliability for SWP contractors.

³ It is acknowledged that water agencies are already exploring these types of actions as outlined in their water management plans. However, the No Project Alternative focuses on the added level of these actions that would be needed in order to replace any water reliability that would be gained through the Delta Conveyance Project.

Region	Estimated Range of Forgone Water Supplies if the Delta Conveyance Project Is Not Constructed (from Existing Conditions in 2020 to No Project Alternative in 2040)	Available Alternate Supply Types	Net Effects on Water Supply
Northern Inland	10,200 AF – 13,600 AF	Water recycling, groundwater recovery (brackish water desalination), water use efficiency improvements	While alternate water supply options in this region are limited, the decrease in supply would be smaller than in other regions. Alternate water supplies would foreseeably compensate for the supply decrease associated with climate change and sea level rise, but an extended outage associated with earthquake risk would pose challenges.
Southern Coastal	126,800 – 168,300 AF	Increased/accelerated desalination, water recycling, groundwater recovery (brackish water desalination), groundwater management, water use efficiency improvements	Alternate water supplies would foreseeably compensate for the supply decrease associated with climate change and sea level rise, but an extended outage associated with earthquake risk would pose challenges.
Southern Inland	251,500 AF – 333,900 AF	Water recycling, groundwater recovery (brackish water desalination), water use efficiency improvements	This region (including Kern County and inland areas south of the Tehachapi Mountains) has geographic and physical limitations on alternate water supplies. Parts of the Metropolitan Water District within this region would have access to water from a portfolio of supplies that span multiple regions and supply sources. For other entities, limited groundwater and desalination options would result in few options to address supply shortages from the SWP. Supply shortages associated with climate change, sea level rise, and earthquake risk would persist in the No Project Alternative.

AF = acre-feet; SWP = State Water Project.

The low range of water supplied reflects Alternatives 2b and 4b and the high range reflects Alternative 5.

Without the Delta Conveyance Project, public water agencies would be faced with declining water supply reliability from the SWP, which would have a compounding effect on existing production from groundwater and recycling that is dependent on SWP water quality. The Northern Coastal, Northern Inland, and Southern Coastal regions have the potential to address the supply shortfalls

through alternate supplies, but those alternate supplies may be insufficient if there is an extended outage at the Delta diversion facilities in the case of an earthquake and levee failure. The Southern Inland region would have a substantial shortfall from the SWP and has limited options for alternate supplies. In addition, this area is going to have other supply limitations imposed by the SGMA (discussed in more detail in Chapter 8, *Groundwater*). SGMA may limit groundwater pumping in some areas to promote sustainable groundwater management, which would increase pressure on surface water supplies. Under the No Project Alternative, declining surface water supply reliability, paired with decreasing groundwater, may result in water supplies that are not able to meet demand in some areas.

6.3.2.2 Project Alternatives

Total SWP Deliveries

Average annual SWP deliveries would increase from existing conditions under all project alternatives for the long-term average, dry water years, and critical water years (Table 6-5). Modeled long-term average annual increases would be 12% for Alternatives 2b and 4b; 14% for Alternatives 2c and 4c; and 15% for Alternatives 1, 2a, 3, 4a, and 5. Increases to SWP deliveries are also expected during dry and critical water years, with models indicating a range between 9% for Alternatives 2b and 4b; 11% for Alternatives 2c and 4c; 12% for Alternatives 2a and 4a; and 13% for Alternatives 1, 3, and 5. The project alternatives would also provide a water supply reliability benefit associated with earthquake risk that is not captured in the modeling. In the event that a seismic event causes a levee failure, saltwater intrusion into the Delta could reduce or temporarily stop diversions in the south Delta. The project alternatives would have an additional diversion in a different location, which would improve reliability in the case of these events.

SWP Feather River Service Area

No changes to annual deliveries to the SWP FRSA under the long-term average is expected when compared to existing conditions (Table 6-5). During dry and critical water years, deliveries are expected to remain similar to existing conditions and for Alternatives 1, 2b, 3, 4b, and 5.

SWP Table A Deliveries

Average annual SWP Table A deliveries are expected to increase under the long-term average, dry water years, and critical years for all project alternatives (Table 6-5). On a long-term average, Table A deliveries are expected to be 11% for Alternatives 2b and 4b; 12% for Alternatives 2c and 4c; and 13% for Alternatives 1, 3, 2a, 4a, and 5. During dry and critical years, increases of Table A deliveries are expected to be 15% for Alternatives 2b and 4b; 19% for Alternatives 2c and 4c; 21% for Alternatives 2a and 4a; and 23% for Alternatives 1, 3, and 5.

SWP Article 56 and Article 21 Deliveries

Average annual SWP Article 56 deliveries would increase under the long-term average and dry and critical water years compared to deliveries under existing conditions (Table 6-5). On a long-term average Article 56 deliveries would increase between 11% for Alternatives 1, 2a, 3, 4a, and 5; 14% for Alternatives 2c and 4c; and 15% for Alternatives 2b and 4b over existing conditions. During dry and critical years, Article 56 deliveries would increase 29% for Alternatives 1, 3, and 5; 30% for Alternatives 2a and 4a; 32% for Alternatives 2c and 4c; and 34% for Alternatives 2b and 4b.

1 Average annual SWP Article 21 deliveries would also increase under the long-term average and,
2 depending on the project alternative, would decrease or increase under dry and critical water years
3 compared to deliveries under existing conditions (Table 6-5). On a long-term average Article 21
4 deliveries would increase 159% for Alternatives 2b and 4b; 216% for Alternatives 2c and 4c; 250%
5 for Alternatives 1 and 3; 252% for Alternatives 2a and 4a; and 254% for Alternative 5 over existing
6 conditions. During dry and critical years, Article 21 deliveries would decrease 6% under
7 Alternatives 2b and 4b and 8% under Alternatives 2c and 4c; however, they would remain
8 essentially the same for Alternatives 1, 3, and 5; and increase 21% under Alternative 2a and 4a.

9 Article 21 deliveries typically include a small amount for north-of-Delta SWP water contractors that
10 could occur every year, and occasional but more significant deliveries for south-of-Delta contractors.
11 The project alternatives are not likely to affect the frequency of north-of-Delta Article 21 deliveries
12 but could influence, and likely increase, those for south-of-Delta deliveries. Table 6-6 shows the
13 changes in frequency of south-of-Delta Article 21 deliveries. As shown, the frequency of available
14 Article 21 water would increase over existing conditions for all project alternatives. Under existing
15 conditions, about 61 years of the 94-year simulation period (about 65%) has some amount of
16 available Article 21 supplies. Available Article 21 supplies would increase to about 67 years (71%)
17 of the simulation period under Alternatives 2b and 4b, and to 74 years (about 79%) of the
18 simulation period under Alternative 5.

19 CVP Deliveries

20 The long-term average annual total CVP deliveries for all of the project alternatives are expected to
21 remain essentially the same (Table 6-5). Alternatives 2a and 4a would result in the highest increase
22 for south-of-Delta agriculture deliveries, with an average annual increase of 8%.

23 During dry and critical years, most project alternatives would result in increases in deliveries (Table
24 6-5). Alternatives 2a and 4a would result in the greatest increase: 9% for south-of-Delta agriculture
25 deliveries. Similar to SWP deliveries, Alternatives 2a and 4a could provide a benefit of increased
26 resilience to seismic events in the Delta.

27 CVP Settlement and Exchange Contractors do not show any change in average annual deliveries and
28 under dry and critical dry water years as those deliveries are under water rights that are unaffected
29 by the operations of the north Delta intakes.

This chapter describes the environmental setting and study area for flood protection; analyzes impacts that could result from construction, operation, and maintenance of the Delta Conveyance Project (project); and provides mitigation measures to reduce the effects of potentially significant impacts. This chapter also analyzes the impacts that could result from compensatory mitigation required for the project, describes any additional mitigation necessary to reduce those impacts, and analyzes the impacts that could result from other mitigation measures associated with other resource chapters in this Final Environmental Impact Report (EIR). The flood protection resources considered are flood management systems (including State Water Project [SWP] and Central Valley Project [CVP] flood control reservoirs and downstream channels), drainage patterns and runoff flows, and flood flows in the study area.

7.0 Summary Comparison of Alternatives

Table 7-0 provides a summary comparison of impacts on flood protection by project alternative. The table presents the CEQA findings after all mitigation is applied. If applicable, the table also presents quantitative results after all mitigation is applied.

Consistent with the evaluation of potential impacts on other resources, the qualitative and quantitative analyses discussed in this section assess the significance of project impacts in relation to existing conditions. All project alternatives are for water supply purposes and, with the exception of modifications to levees at intake locations, include no changes in flood management infrastructure in the Sacramento River Basin and in the Delta, including the reservoirs of the SWP and CVP, and associated flood operation rules and management, which contribute to the flood protection afforded by the Sacramento River Flood Control Project (SRFCP). Therefore, the impacts from project alternatives were evaluated for flood protection of nearby urban and nonurban areas along the reach of the Sacramento River from the American River confluence to Sutter Slough, where the drainage of floodwater may be affected by the construction and operation of the intakes. Potential impacts from project facilities impeding or redirecting localized flood flow were also evaluated. All of these impacts are contained in the Delta, which constitutes the study area. The analysis of flood-related impacts included a quantitative and qualitative approach, depending on the location where these impacts may occur. These two categories of analysis require different settings to accommodate the different regulatory frameworks associated with applicable flood management practices. This section provides a summary of these two categories of impact assessments, including the reasons for selecting the associated existing conditions and No Project Alternative and the resulting flood control impacts.

The assessment of potential flood control impacts on the passage of floodwater in the Sacramento River was conducted to be consistent with the *2022 Central Valley Flood Protection Plan (CVFPP) Update* (2022 CVFPP Update) (California Department of Water Resources 2022a), based on consultation with the Central Valley Flood Protection Board (CVFPB). Consistency with the 2022 CVFPP Update is important because the channel and levees of this section of the Sacramento River are part of the State Plan of Flood Control (SPFC), as defined in California Water Code (Wat. Code)

1 Section 9110(f). The 2022 CVFPP Update, which is the long-term plan for areas protected by the
2 SPFC, has a 50-year planning horizon from 2022 for analysis purposes and for developing
3 assessment strategy. Therefore, the analysis for potential flood control impacts on the area
4 protected by the SPFC was conducted using a similar approach and planning horizon. To maintain
5 consistency with the regulatory and planning purposes, flood control impact analyses along the
6 Sacramento River protected by the SPFC used the years 2022 and 2072 as reference years for
7 existing conditions and the No Project Alternative, respectively. This change from the approach used
8 in other resource assessments (existing conditions at 2020 and No Project at 2040) is considered
9 necessary for the flood control impact assessment to be consistent with the SPFC.

10 The proposed north Delta intake structures require placement along the bank of the Sacramento
11 River, with a portion of the structure projecting into the flowing water. This could effectively
12 constrict the conveyance capacity of the river along the respective length of each intake, resulting in
13 a rise in water surface elevation (WSE) upstream of the intakes. The corresponding WSE increase is
14 dependent on the combination of intakes used to achieve project needs, the facility configuration,
15 and the phase of construction for each intake.

16 Hydraulic analyses examined the effect of the project on WSEs in the Sacramento River between the
17 American River confluence and Sutter Slough. The effects of the intakes on the WSE are expected to
18 occur only within this reach of the Sacramento River. This reach of the river, which includes urban
19 levees extending south from the American River confluence to around the location of the Freeport
20 Regional Water Authority intake, protects Sacramento urban areas; these areas are subject to Urban
21 Level of Flood Protection (i.e., 200-year level of flood protection). The rest of the levees further
22 downstream along the Sacramento River are considered rural levees or nonurban levees that are
23 not subject to the Urban Level of Flood Protection. Therefore, for completeness of the assessment
24 for each project alternative, it was necessary to evaluate the impacts on WSEs of the Sacramento
25 River for 100- and 200-year flood events under existing conditions (i.e., 2022 conditions) and future
26 conditions (i.e., 2072 conditions) with climate change, including corresponding hydrologic change
27 and sea level rise. The results of the hydraulic analyses indicate that WSE increases in the
28 Sacramento River between the American River confluence and Sutter Slough during the 100-year
29 and 200-year flood events would result in a less-than-significant impact on flood protection during
30 construction and during operations with permanent facilities, except that Alternatives 2a and 4a,
31 where all three intakes are used, would increase Sacramento River WSE upstream of the intakes
32 between 0.11 and 0.12 foot during construction and result in a significant impact. Mitigation
33 Measure FP-1: *Phased Construction of the Proposed North Delta Intakes* would reduce the magnitude
34 of WSE increases during the 100-year and 200-year flood event to a less-than-significant level.

35 The assessment for potential flood protection impacts from the permanent project facilities during
36 operations was also evaluated using flood flows consistent with those used to develop the 1957 U.S.
37 Army Corps of Engineers (USACE) Sacramento River Project Levee design profiles. The 1957 design
38 profile assessment is required by USACE and CVFPB as part of their corresponding permitting
39 process for the project to demonstrate that project operations would not impede the continued
40 functions of the levees and channels as originally designed. The 1957 levee design profiles were not
41 considered as part of the CEQA impact assessment because the CEQA impact thresholds used by the
42 California Department of Water Resources (DWR) in this Final EIR are more stringent than the 1957
43 profiles. The details and results of the analysis using the 1957 levee profiles are provided in
44 Appendix 7B, *Evaluation against U.S. Army Corps of Engineers 1957 Design Profiles*.

1 For the impact assessment on localized flood flow impacts from various project facilities, an
2 approach consistent with the assessment of other resources in this Final EIR was applied. This
3 portion of the flood assessment compared changes in conditions resulting from the project with
4 existing conditions. Existing conditions include existing facilities and ongoing programs that existed
5 as of January 15, 2020 (i.e., the publication date of the Notice of Preparation). The No Project
6 Alternative includes reasonably foreseeable changes in existing conditions (such as sea level rise
7 and climate change) and changes that would be expected to occur in the year 2040 if the project
8 were not approved.

9 The project would include permanent facilities within the 100-year flood hazard area, and therefore,
10 where necessary to protect the water conveyance infrastructure from flooding, facilities would be
11 conservatively designed to withstand a 200-year flood event with projected climate change
12 hydrology for 2100 and extreme sea level rise during operations (Delta Conveyance Design and
13 Construction Authority 2022a:62, 2022b:42). For launch shaft sites at Bouldin and Lower Roberts
14 Islands, the levees would be improved to meet the Delta-specific Public Law (PL) 84-99 standards,
15 where applicable, which is an improvement to existing conditions. As a result, these areas would be
16 out of the projected 100-year flood hazard area due to the levee improvement, alleviating the need
17 to assess potential impacts on local flood flows. This approach was not proposed for the Twin Cities
18 Complex, and therefore a two-dimensional (2-D) hydraulic analysis for the Twin Cities Complex was
19 conducted. The analysis showed limited increases in flood depth and area around the Twin Cities
20 Complex during construction (which includes a ring levee to minimize impacts on the surrounding
21 lands) and operations. The flood effects analysis for the Twin Cities Complex site found that the ring
22 levee (during construction) and stockpile storage areas (during operations) for all project
23 alternatives would increase the 100-year flood depth by a maximum of approximately 0.4 foot and
24 would increase the 100-year floodplain by approximately 15 acres when compared to existing
25 conditions (i.e., 2022 conditions). The ring levee associated with construction at the Twin Cities
26 Complex site exhibited the largest increases to the depth and areal extent of the 100-year flood
27 event. The extent and change of the maximum WSE during a 100-year flood event was considered a
28 less-than-significant impact. All launch, maintenance, and reception shaft sites would enact
29 nonstructural flood risk management measures.

30 The Southern Forebay is not located in the 100-year flood hazard zone and would be designed in
31 accordance with DWR Division of Safety of Dams (DSOD) requirements for jurisdictional dams
32 based on the anticipated maximum embankment height and storage volume. The Southern Forebay
33 includes an overflow emergency spillway that would be used in the unlikely condition that the
34 forebay water level continued to rise above the design maximum elevation. The emergency spillway
35 would discharge flow from the Southern Forebay into Italian Slough, which flows into Old River. To
36 accommodate this, a portion of the existing Italian Slough levee would be removed. New levees
37 would be constructed to channelize and contain the spillway discharge flows between the outboard
38 toe of the spillway and the existing levee along Italian Slough. The discharge into Italian Slough
39 would initially be contained within the slough's existing levees but would, over a short distance,
40 converge with Old River. The connection to Old River and the broader Delta waterways would allow
41 spillway flows to be absorbed during any emergency discharge.

42 The potential hydraulic impact of the Southern Forebay Emergency Spillway on the existing levee
43 system of Italian Slough and Old River was evaluated using a one-dimensional (1-D) hydraulic
44 model. The change in WSEs was compared between the different operational scenarios (i.e., spillway
45 releases of 3,000, 4,500, 6,000, and 7,500 cubic feet per second [cfs]) and the baseline (i.e., no spill
46 event). The 7,500 cfs scenario exhibited the largest increases in WSEs when compared to the

baseline for both the 100-year flood event and the mean higher high-water event (Delta Conveyance Design and Construction Authority 2022c:Att 2-5). For the 100-year flood event, the 7,500 cfs scenario increased WSEs by 0.44 foot when compared to the baseline with the affected area extending 2.47 miles upstream and 1.55 miles downstream of the spillway location. For the mean higher high-water event, the 7,500 cfs scenario increased WSEs by 0.67 foot when compared to the baseline with the affected area extending 2.47 miles upstream and 1.94 miles downstream of the spillway location. Although the spillway was assumed to flow for 12 hours, peak WSEs were achieved in 2 hours or less for the scenarios modeled. In the scenarios modeled, the peak WSE was located upstream of the spillway location due to backwater effects from the additional flow entering Italian Slough from the spillway. None of the scenarios analyzed resulted in overtopping levees of the main Italian Slough channel or Old River due to the releases from the Southern Forebay Emergency Spillway.

Constructions of the facilities under various project alternatives involve excavation, grading, stockpiling, soil compaction, and dewatering that could result in alterations to runoff, drainage patterns, erosion, stream courses, and WSEs during construction of facilities. All project features would be constructed to not increase peak runoff flows into adjacent storm drains, drainage ditches, or rivers and sloughs. All surface water runoff and dewatering flows or additional runoff during construction would be captured, treated, stored, and, if possible, reused on-site. If additional stored water is not needed, the treated runoff flows would be released in a manner that would not increase peak WSEs in adjacent channels. Shallow flooding has historically occurred at the sites of the proposed north Delta intakes due to natural depressions. Therefore, the project alternatives include drainage and pump enhancements to ensure intake facilities would not be subject to flooding during operation. During construction, the local drainage at intake facility sites would be managed to minimize local flooding through installing temporary pumps if necessary to allow continued construction activities. Because drainage and pump enhancements are included in facility design, the potential impacts of localized flooding at the intakes would be minimized. Overall, the project alternatives would have less-than-significant impacts on existing drainage patterns of the facility site or surrounding area.

Table 7-0 summarizes the comparison of impacts on flood protection by project alternatives disclosed in this chapter.

1 **Table 7-0. Comparison of Impacts on Flood Protection by Project Alternative**

Chapter 7 – Flood Protection	Project Alternative								
	1	2a	2b	2c	3	4a	4b	4c	5
Impact FP-1: Cause a Substantial Increase in Water Surface Elevations of the Sacramento River between the American River Confluence and Sutter Slough	LTS	S (LTS with mitigation)	LTS	LTS	LTS	S (LTS with mitigation)	LTS	LTS	LTS
Construction Phase									
River Reaches with Urban Levees – Max WSE Difference Relative to EC (feet) <i>100-Year Flood Event</i>	0.08	0.10	≤0.08	≤0.08	0.08	0.10	≤0.08	≤0.08	0.08
River Reaches with Urban Levees – Max WSE Difference Relative to EC (feet) <i>200-Year Flood Event</i>	0.08	0.10	≤0.08	≤0.08	0.08	0.10	≤0.08	≤0.08	0.08
River Reaches with Nonurban Levees – Max WSE Difference Relative to EC (feet) <i>100-Year Flood Event</i>	0.10	0.11	≤0.10	≤0.10	0.10	0.11	≤0.10	≤0.10	0.10
River Reaches with Nonurban Levees – Max WSE Difference Relative to EC (feet) <i>100-Year Flood Event with Mitigation</i>	N/A	0.09	N/A	N/A	N/A	0.09	N/A	N/A	N/A
River Reaches with Nonurban Levees – Max WSE Difference Relative to EC (feet) <i>200-Year Flood Event</i>	0.10	0.12	≤0.10	≤0.10	0.10	0.12	≤0.10	≤0.10	0.10
River Reaches with Nonurban Levees – Max WSE Difference Relative to EC (feet) <i>200-Year Flood Event with Mitigation</i>	N/A	0.09	N/A	N/A	N/A	0.09	N/A	N/A	N/A
Operations Phase									
River Reaches with Urban Levees – Maximum WSE Difference Relative to EC (feet) <i>100-Year Flood Event</i>	0.04	0.05	≤0.04	≤0.04	0.04	0.05	≤0.04	≤0.04	0.04
River Reaches with Urban Levees – Maximum WSE Difference Relative to EC (feet) <i>200-Year Flood Event</i>	0.04	0.05	≤0.04	≤0.04	0.04	0.05	≤0.04	≤0.04	0.04

Chapter 7 – Flood Protection	Project Alternative								
	1	2a	2b	2c	3	4a	4b	4c	5
River Reaches with Nonurban Levees – Maximum WSE Difference Relative to EC (feet)	0.04	0.05	≤0.04	≤0.04	0.04	0.05	≤0.04	≤0.04	0.04
<i>100-Year Flood Event</i>									
River Reaches with Nonurban Levees – Maximum WSE Difference Relative to EC (feet)	0.04	0.05	≤0.04	≤0.04	0.04	0.05	≤0.04	≤0.04	0.04
<i>200-Year Flood Event</i>									
Impact FP-2: 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 That Would Result in Flooding On- or Off-Site or Impede or Redirect Flood Flows	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS

- 1 Note: Alternatives 2b, 2c, 4b, and 4c (3,000-cfs and 4,500-cfs capacity alternatives) were not modeled since WSE impacts would be similar to, or less than, the
2 corresponding alternatives of the same alignment but larger capacity (i.e., Alternatives 1 and 3 [6,000-cfs capacity alternatives]).
3 cfs = cubic feet per second; EC = existing conditions; N/A = not applicable; WSE = water surface elevation; LTS = less than significant; S = significant.

7.1 Environmental Setting

This section describes flood risks, flood management, and flood management facilities within the study area that could be affected by construction, operation, and maintenance of the project.

Flood protection is related to surface water resources discussed in Chapter 5, *Surface Water*, which describes Sacramento and San Joaquin River Basin hydrology, and the hydrology of the Delta. Chapter 6, *Water Supply*, describes SRFCP and CVP facilities and their operation, including facilities with specific flood-management responsibilities.

7.1.1 Study Area

The study area, defined as the area in which impacts may occur, primarily comprises the statutory Delta (or legal Delta)—as defined by Wat. Code Section 12220—as well as areas southwest and east of the legal Delta to include the facility footprints associated with Bethany Reservoir (for Alternative 5) and the supervisory control and data acquisition (SCADA) fiber route (for all project alternatives) near the proposed north Delta intakes, respectively. The study area includes portions of Sacramento, Yolo, San Joaquin, Contra Costa, and Alameda Counties. The assessments for potential flood control impact from the project alternatives focus on the legal Delta as well as the immediate area east of the Delta for the SCADA Fiber Route because the area around Bethany Reservoir is outside of the floodplain (Figure 7-1).

The Delta covers approximately 1,300 square miles and is a complex network of channels, levees, subsided islands, sloughs, rivers, and tributaries that is located at the confluence of the Sacramento and San Joaquin Rivers (Delta Stewardship Council 2021:1-3). The Sacramento and San Joaquin Rivers are the two biggest contributors to Delta inflows, with additional inflows being provided by tributaries to the east (i.e., Mokelumne, Cosumnes, and Calaveras Rivers). Historically, the natural Delta system was formed by water inflows from upstream tributaries in the Delta watershed and outflows to Suisun Bay and San Francisco Bay. In the late 1800s, local land reclamation efforts in the Delta resulted in the construction of channels and levees that began altering the Delta's surface water flows. Over time, the natural pattern of water flows continued to change as the result of upper watershed diversions and the construction of facilities to divert and export water through the Delta to areas where supplemental water supplies are needed. Chapter 5 includes a more detailed description of the Sacramento and San Joaquin River Basins and their influence on the Delta.

Because the area around Bethany Reservoir is outside of the floodplain, and the impact assessment focuses on the legal Delta, the area around the Bethany Reservoir Discharge Structure is not addressed in this analysis. The Delta includes many federal, state, regional, and local flood management facilities, including levee systems, bypasses, floodways, weirs, and other pertinent facilities. The construction or operations of the project alternatives would not affect these flood management facilities and do not include any changes in flood control operations. Flood control operation and associated rules are under the jurisdiction of USACE. Therefore, the operations of project alternatives would have no impacts on flood protection upstream of the Delta, and the level of flood protection under project alternatives would remain the same. Since the project would not affect the Sacramento River upstream of the Delta or the San Joaquin River Basin outside of the Delta, the study area associated with flood protection focuses on the specific areas in the Delta that may be affected by project facilities—including the intakes, launch/maintenance/reception shafts, and Southern Forebay (although the latter is applicable to Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c

only). The proposed intakes are on the Sacramento River and the flow at intake locations are subject to the operation of upstream flood management facilities including the reservoirs of the SRFCP, SWP, and CVP. However, the effects of project alternatives on flows in the Sacramento River are expected to be minimal upstream of the American River confluence (see later sections for more discussion). Therefore, flood control and management facilities on the Sacramento River upstream of the American River confluence are only discussed briefly to provide context and references for discussing the existing flood management in the Delta. A more detailed description of the surface reservoirs, conveyance systems, and water diversion facilities in the Sacramento and San Joaquin River Basins can be found in Chapter 5.

7.1.2 Areas Subject to Flooding

The Delta, as part of the estuary formed by the Sacramento and San Joaquin Rivers, is an inherently flood-prone area. Fluctuations in Delta WSEs are often entirely driven by high discharge events in upstream areas of the Delta tributaries (i.e., the Sacramento River, San Joaquin River, and eastside tributaries discussed above). Delta WSE variations are heavily influenced by additional factors, including astronomical tides and atmospheric effects (pressure and wind); the effects of these processes decrease with distance into the Delta and along the river channels as riverine inflows become more dominant. Generally, the tidal influence can extend to the Sacramento River near Sacramento, and the San Joaquin River between Mossdale Bridge and Vernalis. Fluvial inflow, salinity control operations, and Delta exports also affect Delta WSEs, although these effects tend to be localized in non-flooding conditions.

The Federal Emergency Management Agency (FEMA) is a primary source of current flood risk information. FEMA uses Flood Insurance Studies to produce Flood Insurance Rate Maps (FIRMs). Probability of flooding is defined by the probability that a flood may occur in any given year. For example, a 100-year flood is a flood that has a 1% chance of occurring in any given year, or more formally, a 1% chance of annual exceedance probability (AEP). FEMA refers to areas that are subject to inundation by the 1% AEP flood as Special Flood Hazard Areas (SFHAs). Figure 7-1 shows floodplains in the Delta that have a 1% AEP (Federal Emergency Management Agency 2020). The Delta spans numerous FIRM panels and contains several FEMA flood zones. FEMA FIRMs indicate that much of the central Delta—essentially all of the nonurban Delta—is within SFHAs and considered to be subject to flooding with 1% AEP. Encroachments within these flood zones are subject to federal, state, and local regulatory requirements. The federal regulatory requirements represent the minimum level of compliance needed, while state and local requirements may be more stringent. FEMA continues to evaluate floodplain delineations as needed based on continued hydrology changes that may affect the AEP frequency calculation and additional evaluation of facility conditions and improvement.

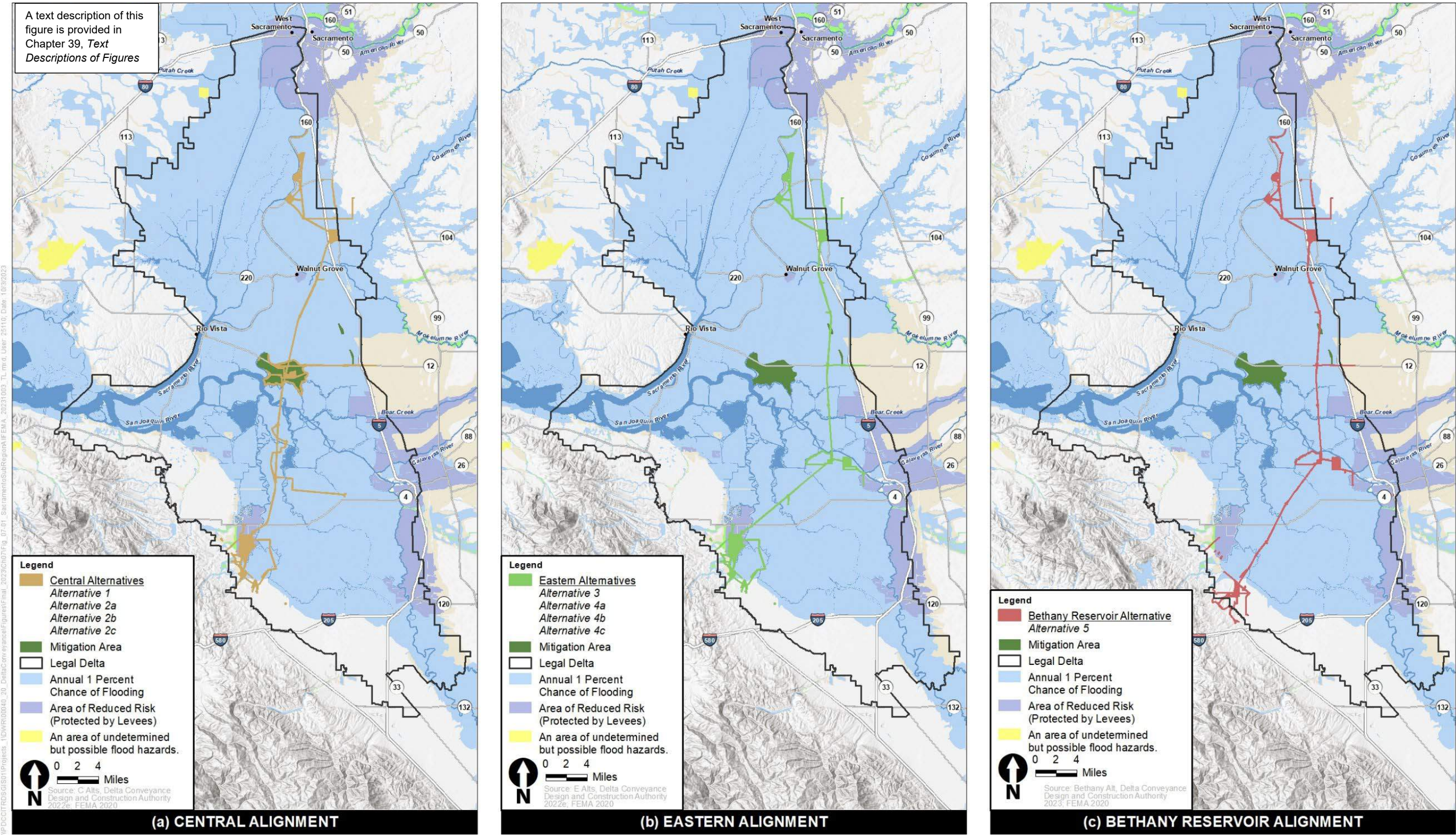


Figure 7-1 FEMA Floodplains for a 1% AEP Flood in the Delta

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For the assessment of potential impacts from project alternatives on local flood flows, the Delta's 100-year floodplain is generally considered the extent of the study area; however, the area subject to flooding is greater than shown in Figure 7-1 during a more significant flood event. Separate considerations are required to address the potential flood management impacts on the greater flood management system that resides in the part of the Delta near the proposed north Delta intakes. Detailed analyses are not needed in areas with reduced flood risks due to levee improvement because those areas are functionally out of the 100-year floodplain based on FEMA's National Flood Insurance Program (NFIP). The location of the project facilities within the floodplain warrants evaluation of potential flood impacts from proposed facility plans. As shown in Figure 7-1, the majority of the facilities proposed for the project alternatives are within the 100-year (i.e., 1% AEP) floodplain in the Delta—Bethany Reservoir Pumping Plant being the most notable project feature that is not. While the SCADA Fiber Route is not within the legal Delta, a significant portion of the facility footprint is within the 100-year floodplain. Figure 7-1 also depicts "Area[s] of Reduced Risk"—a FEMA designation that describes an area with a levee where the risk of being flooded is reduced, but not completely removed. FEMA does not delineate floodplains for floods smaller than the 1% AEP, such as the 2% and 10% AEP (50- and 10-year, respectively) flood events.

Delta flooding could interrupt the conveyance of water through the Delta for the SWP, the CVP, in-Delta users, the Contra Costa Water District, the cities of Antioch and Stockton, and others relying on the Delta for water supplies (Delta Stewardship Council 2020:5). Levee failures could also damage key features of the Delta ecosystem existing on the heavily altered landscape, including managed wetlands in Suisun Marsh and habitats of wintering greater sandhill cranes at Staten Island and nearby tracts. Moreover, levee failure could degrade Delta water quality if waters rush into a heavily subsided Delta island, pulling higher-salinity water (from the western Delta) into the central Delta. Because the elevations of many Delta islands are below sea level, these failures would draw salt water from San Francisco Bay and introduce additional pollutants into Delta water with flood debris, farm chemicals, and others.

Some generalizations can be made about the geographic differences in the nature of the flood threats in the various regions of the Delta, including the following.

- North and south Delta: The flood risks in both the north and south Delta are more related to the storm events in the Sacramento and San Joaquin River Basins, depending on the combination of factors including the intensity and volume of rainfall and if the temperature would be warm enough to trigger early snowmelt, adding additional volume into the channels. These conditions can increase the risk of levee failures due to scour, seepage, and slumping. For these reasons, north and south Delta receive protection from flood control systems established for the Sacramento and San Joaquin River systems. Occasionally, extended periods of snowmelt, extending into June and July, may affect north and south Delta, but the flooding effects are more localized in upstream areas.
- Flood concerns in the north Delta are particularly acute. The combined flood flows of the Morrison Stream Group, Dry Creek, the Cosumnes River, and the Mokelumne River converge and accumulate because the downstream Delta channels lack the capacity to convey the combined flow (which can be exacerbated by high tidal conditions) to the Sacramento and San Joaquin Rivers. River stages rise until levees give way or are overtopped, which occurred in 1986. During that flood event, the levees failed on McCormack-Williamson Tract, Glanville Tract, Dead Horse Island, and Tyler Island sequentially over a period of hours on the afternoon and evening of February 18, 1986, followed by a levee failure on New Hope Tract.

- West Delta: In the west Delta region, high water stages due to tides and total Delta inflow (especially from the Yolo Bypass) and high winds could result in extreme wave wash erosion, displacement of riprap, and waves overtopping the levees. Deep peat and weak foundations combined with island interiors well below sea level could contribute to the structural stresses on west Delta levees.

7.1.3 Factors That Influence Flood Risk in the Study Area

California's Central Valley, including the Delta, is a broad, gently sloping valley formed by the Sacramento and San Joaquin Rivers. The lower-lying lands along these two rivers and the Delta were once floodplains and marshlands that were regularly inundated for long periods during large, seasonal flood events before reclamation (California Department of Water Resources 2012a:1-2). The history of flood management in the Central Valley can be traced back to the mid-1800s. More than 1 million people are now living in the Central Valley floodplain where major flood events in 1983, 1986, 1995, and 1997 created cumulative flood damage estimated in excess of \$3 billion (California Department of Water Resources 2012a:1-1). The Central Valley Flood Control Project management system includes levees along the major rivers and streams of the valley floor and around the islands of the Delta, a major bypass system for the Sacramento River and its tributaries, several bypass segments along the San Joaquin River, and reservoirs on almost all major rivers and streams draining to the Central Valley (California Department of Water Resources 2012a:1-3). These facilities were built and owned by different entities, including federal, state, and local agencies, to reduce flood risk. That is, the facilities were designed for a capacity or specific purpose that would mitigate, but not entirely eliminate, flooding. Therefore, there is always flood risk in areas within the floodplain that are protected by these flood management systems, which seek to reduce potential life loss and property damage. Proper land use management for floodplain and levee-protected areas, and additional mitigation actions such as flood insurance, are all integral parts of flood management.

The study area (i.e., the Delta) is formed by the confluence of the Sacramento and San Joaquin Rivers. Therefore, the flooding conditions in the Delta can be influenced by the flood management system and its operation; however, the flooding conditions in the Delta can also be influenced by eastside tributaries (i.e., the Cosumnes and Mokelumne Rivers), tidal effects, and potential sea level rise.

Flood risk is a combination of the chance of flooding and the consequence of flooding (i.e., life loss and property damages once flooding occurs), and it is not static through time. Flood risks in the study area can be influenced by many factors, including the following.

- Hydrologic conditions, such as the intensity and volume of precipitation and runoff.
- Existing flood management facilities, such as levees and bypasses.
- Levee conditions, standards, and level of compliance.
- Seismic activity.
- Land subsidence and increased hydraulic loading on a levee and its foundation.
- Sunny-day hazards, such as damage due to burrowing animals, penetrations, and vegetation.
- High-water conditions, such as high tides and storm surges.

- Regional planning efforts that address flood management and emergency preparedness, response, and mitigation.

The following sections provide information about the different factors that increase flood risk in the study area.

7.1.3.1 Hydrologic Conditions

California's statewide annual precipitation is highly variable. While annual precipitation ranges between roughly 100 million and 300 million acre-feet, about 200 million acre-feet of rain and snow fall per year on average (California Natural Resources Agency et al. 2020:53). This precipitation is generally greatest in the Sierra Nevada and north coast regions, with precipitation ranging from 36 to 160 inches per year in these areas (California Natural Resources Agency et al. 2020:53).

Conversely, some of the southern regions of the state receive less than 4 inches of precipitation per year. The geographic variation and the variability in precipitation that California receives make it challenging to manage the available runoff that can be captured in storage to meet water needs while also managing flood risk.

Annual precipitation data from California shows significant year-to-year variation. This inter-annual variability makes trend analysis difficult; an analysis of precipitation records since the 1890s shows no statistically significant trend in precipitation throughout California. Although the overall precipitation trend is generally flat over the past 120 years, the precipitation record indicates significant decadal variability giving rise to dry and wet periods. A decadal fluctuation signal has become apparent in Northern California, where winter precipitation varies with a period of 14 to 15 years (California Department of Water Resources 2020:10). This decadal signal has increased in intensity over the twentieth century, resulting in more distinct dry and wet periods. For example, the average water year (i.e., October 1–September 30) precipitation between 1966 and 2015 was 51.8 inches (California Department of Water Resources 2020:10). However, there are extremely dry years—such as 1976–1977 with only 19.0 inches—and extremely wet years—such as 2016–2017 with 94.7 inches—as a result of this decadal variability.

Certain large storm events can lead to high discharge events in upstream areas of the Delta tributaries (i.e., the Sacramento River, San Joaquin River, and eastside tributaries). This large increase in Delta inflows—which increases Delta WSEs—can coincide with substantial flooding in the Delta, as was the case in February 1986. In the 2 weeks prior, heavy rains saturated Northern California watersheds and contributed to high inflows into the north Delta from the Cosumnes River, Dry Creek, and the Morrison Stream Group. The inflows exceeded the conveyance capacity of north Delta channels, resulting in ponding upstream of Franklin Road. A series of levee failures ensued at Glanville Tract, McCormack-Williamson Tract, Dead Horse Island, Tyler Island, and New Hope Tract (Delta Conveyance Design and Construction Authority 2022d:Att 1-1).

7.1.3.2 Existing Flood Management Facilities

Flood management facilities (e.g., reservoirs, bypasses, levees) along the Sacramento and San Joaquin Rivers and their tributaries reduce frequency of flooding in the floodplain along these rivers. Since their construction, these facilities have helped promote public safety and prevent billions of dollars of flood-related damages (California Department of Water Resources 2017a:iii).

Human-made structures and economic activities in a floodplain will be always subject to flood risk. Flood management facilities were built with specific designed capacities and intended functions and

1 were not built to stop all flooding. Once infrastructure is in place, an associated level of flood
2 protection may shift due to changes in hydrology under climate change and other continued
3 development in the watershed, especially in the floodplain.

4 Flood management facilities could be overwhelmed and even fail if hydrologic conditions exceed
5 designed capacities, if certain deficiencies exist, or if a combination of both elements occur. Recent
6 examples of large-scale flood events include the February 1986 flood with damages that occurred
7 mostly in the Sacramento Valley and the Delta, and the December 1996–January 1997 flood, during
8 which there were five deaths and more than \$300 million in damages throughout the Central Valley,
9 including in the Delta (U.S. Army Corps of Engineers 2015:1-11).

10 State Plan of Flood Control

11 The Central Valley's flood management system consists of many reservoirs, levees, and other flood
12 management facilities that were built by various entities over time. In 1953, structures, lands,
13 programs, and modes of operation and maintenance were brought together in a state-federal flood
14 protection system known as the SPFC. The SPFC facilities include approximately 1,600 miles of
15 levee, and approximately 150 reservoirs are constructed on streams draining to the Central Valley. A
16 group of 10 major multipurpose reservoirs play an important role in moderating Central Valley
17 flood inflows (excluding those draining to the Tulare Lake Basin) (California Department of Water
18 Resources 2012a:1-5). One such reservoir is Lake Oroville, which regulates the mainstem of the
19 Feather River as part of the SRFCP and SPFC. Authorized as a multipurpose facility, operation of the
20 Oroville facilities is dependent on hydrology and DWR's objectives. Lake Oroville stores winter and
21 spring runoff for release to the Feather River, as necessary, for SWP and flood control operation
22 purposes. Typically, releases to the Feather River are managed to conserve water while meeting a
23 variety of water delivery requirements, including flow, temperature, fisheries, diversions, and water
24 quality.

25 California's CVFPB is the regulatory body for flood management in the Central Valley. DWR has flood
26 management responsibility for its own facilities (e.g., Lake Oroville) and, as described further later,
27 shares responsibility for operations and maintenance (O&M) for a portion of the flood management
28 system in the Central Valley with the CVFPB.

29 Wat. Code Section 9110(f) defines the SPFC as follows.

30 The state and federal flood control works, lands, programs, plans, policies, conditions, and mode of
31 maintenance and operations of the Sacramento River Flood Control Project described in
32 Section 8350, and of flood control projects in the Sacramento River and San Joaquin River
33 watersheds authorized pursuant to Article 2 (commencing with Section 12648) of Chapter 2 of Part 6
34 of Division 6 for which the board or the department has provided the assurances of nonfederal
35 cooperation to the United States, and those facilities identified in Section 8361.

36 The SPFC facilities are a portion of the larger flood management system in the Central Valley for
37 which the state has special responsibilities. The SRFCP, as part of the SPFC facilities, is one of the
38 primary flood control features on the Sacramento River system, as described in the *State Plan of
39 Flood Control Descriptive Document* (California Department of Water Resources 2010:2-2). The
40 SRFCP area spans from Red Bluff to the northern Delta and includes a complex system of levees,
41 overflow weirs, drainage pumping plants, and flood bypass channels. O&M of these facilities serves a
42 critically important role in managing floods that affect the Delta.

1 The channels of a flood management system convey floodwater for safe discharge based on their
2 design capacities and profiles. The flood bypass channels (i.e., Butte Basin; Tisdale, Sutter, and Yolo
3 bypasses) of the SRFCP are designed to convey flood flows away from the river systems when their
4 capacities are constrained due to high runoff conditions. The Yolo Bypass is a feature of the SRFCP
5 and is located immediately west of the metropolitan area of Sacramento and West Sacramento,
6 extending from the Fremont Weir (upstream of the Delta) to Liberty Island (within the Delta).
7 During high water, the diversion of water to the Yolo Bypass relieves the pressure of high flows from
8 the Sacramento River and alleviates flood risk in the region. This function results in the Yolo Bypass
9 flooding about once every 3 years, mostly between December and February; it is usually cleared for
10 farming operation in the spring, but the period of inundation may be longer if necessary (Delta
11 Stewardship Council 2020:12).

12 CVFPB is the nonfederal sponsor of the SRFCP and shares responsibility with DWR for O&M of these
13 facilities. DWR is responsible for maintaining and operating some portions of the SRFCP, including
14 the Fremont Weir, Sacramento Weir, and flood-carrying capacity of the Yolo Bypass. CVFPB also has
15 agreements with other local maintaining agencies for remaining facilities (California Department of
16 Water Resources 2010:5-5-5-14, 2017b:5-1). Flood control channels that are part of the SPFC (i.e.,
17 SPFC channels) are under the jurisdiction of DWR and the CVFPB. As directed by the Central Valley
18 Flood Protection Act of 2007, DWR prepared the CVFPP as a policy plan to improve flood risk
19 management, reduce the chance of flooding (and damages once flooding occurs), and improve public
20 safety, preparedness, and emergency response for the Central Valley receiving protection from the
21 SPFC. The CVFPP was first adopted by the CVFPB in 2012 and is subject to an update every 5 years.
22 DWR analyzed channel design capacities and profiles as part the *2017 Flood System Status Report*,
23 which was incorporated into the *2017 Central Valley Flood Protection Plan Update* (California
24 Department of Water Resources 2017b, 2017c).

25 The SPFC facilities are a portion of the larger flood management system in the Central Valley. The
26 performance of SPFC facilities relies on non-SPFC federal facilities, including reservoirs—such as
27 Shasta and Folsom Lakes—that provide substantial regulation of flows to levels that downstream
28 SPFC facilities can accommodate as designed. On the Sacramento River, Shasta Lake regulates
29 inflows from the Sacramento, McCloud, and Pit Rivers as well as numerous other tributaries and
30 creeks. While not part of the SPFC, Shasta Lake—as a multipurpose reservoir—serves an important
31 role in managing California’s water supply while also providing flood control storage to help manage
32 flood risk along the Sacramento River (California Department of Water Resources 2010:2-14).
33 Similarly, Folsom Lake, formed by construction of Folsom Dam and managed by the Bureau of
34 Reclamation (Reclamation), is the largest reservoir in the American River Basin and the only
35 reservoir in the basin with designated flood control functions.

36 Other public and private levees, locally operated drainage systems, and other state, federal, and local
37 facilities work in conjunction with the broader SPFC facilities. Major non-SPFC facilities that affect
38 the performance of SPFC facilities (or provide flood risk reduction benefits to areas protected by
39 SPFC levees) include levees that are not part of the federal projects, modifications and alterations to
40 SPFC levees that have not been state-authorized, debris management facilities (e.g., Yuba
41 Goldfields), and most of the reservoirs in the Central Valley (California Department of Water
42 Resources 2017c:1-33).

43 Overall, the riverine system and channels in the Central Valley have been heavily modified and have
44 limited capacity due to early reclamation development in the twentieth century (California
45 Department of Water Resources 2010:5-2).

Flood Management Facilities in the Delta

Land uses in the Delta are primarily rural and are dominated by agriculture and open space, with several dispersed small communities, although larger population centers (i.e., Sacramento, West Sacramento, and Stockton) exist as well. Flood management facilities within the Delta primarily include levees, which often protect lands at or below sea level. Flood management in the Delta is mainly provided via reclamation districts and local flood control agencies. Flood management responsibilities in Delta areas outside areas protected by SPFC facilities are managed by a variety of local agencies, which are supported by the state's Delta Special Flood Projects Program and Delta Levees Maintenance Subventions Program (California Department of Water Resources 2012a:3-24). In addition to flood protection, Delta levees also benefit habitats and ecosystems and offer significant recreational opportunities (Delta Stewardship Council 2020:21).

About 380 miles of the total 1,100 miles of levees in the Delta are SPFC levees (Delta Stewardship Council 2017:1). SPFC levees are subject to federal levee standards and, where applicable, to DWR's *Urban Levee Design Criteria*, which requires a 200-year level of flood protection (California Department of Water Resources 2012b:7-1 to 7-50); they are also under CVFPB jurisdiction. SPFC levees in the northern Delta are part of the SRFCP and partially protect urban centers (i.e., 200-year level of flood protection)—such as Sacramento and West Sacramento—and towns such as Clarksburg, Hood, and Courtland (California Department of Water Resources 2017b:3-3). Figure 7-2 distinguishes between the urban and nonurban levees in the northern Delta; this figure was adapted from Figure G01 in the Sacramento River Flood Flow Hydraulic Modeling—HEC-RAS 2D Technical Memorandum in Attachment A of the *Volume 1, Delta Conveyance Final Draft Engineering Project Report, Central and Eastern Option* (C-E EPR) (Delta Conveyance Design and Construction Authority 2022e:21). In the southern Delta, the Lower San Joaquin River Flood Control Project is also part of SPFC facilities and includes levees that protect, or partially protect, urban or urbanizing communities such as Stockton, Lathrop, and Manteca (U.S. Army Corps of Engineers 1999; California Department of Water Resources 2010:2-3). The SRFCP and Lower San Joaquin River Flood Control Project also protect islands within the Delta, such as Sherman Island, Jones Tract, Upper Roberts Island, Middle Roberts Island, and Lower Roberts Island.

Most of the levees in the Delta (i.e., 720 of 1,110 miles of levees) are local non-project levees (Delta Stewardship Council 2017:7-1). Wat. Code Section 12980(e) defines these local levees in the Delta as “nonproject levee[s]” in contrast to “project levee[s]”—which are defined in Wat. Code Section 12980(f) and referred to as SPFC levees in the Delta. For consistency and clarity in this chapter, non-project levees are referred to as non-SPFC levees.

These non-SPFC levees were built by landowners or local reclamation districts to reclaim the lands for agricultural and economic development purposes. Non-SPFC levees also protect portions of the deep-water ship channels to the two major inland ports. The Stockton Deep Water Ship Channel was built in 1933 for navigation purposes and follows the San Joaquin River past Rough and Ready Island to the Port of Stockton via Stockton Channel (County of Contra Costa 2012:10-8). The Sacramento River Deep Water Ship Channel follows the Sacramento River and Cache Slough prior to entering the excavated deep-water channel that extends to the Port of Sacramento in West Sacramento. The levees on the east sides of the Sacramento River, Cache Slough, and the Sacramento River Deep Water Ship Channel are SPFC levees. The levees on the west side of the Sacramento River upstream of Rio Vista, west side of Cache Slough, and a portion of the west side of the excavated channel near Cache Slough are non-SPFC levees.

1 Levee inspection and maintenance for non-SPFC levees in the Delta is the responsibility of
2 landowners or local reclamation districts. The SPFC levees in the Delta are inspected by DWR and
3 designated local maintenance agencies according to their corresponding O&M agreements, and the
4 findings are documented in the *Flood Control System Status Report*, which is updated every 5 years
5 (California Department of Water Resources 2017c:2-5).

6 Until recently, communities protected were eligible for FEMA disaster assistance in a flooding event
7 if their non-SPFC levees met the design guidelines in the 1983 *Flood Hazard Mitigation Plan for the*
8 *Sacramento–San Joaquin Delta* (Delta HMP) developed by DWR for the Governor’s Office of
9 Emergency Services (CalOES) and approved by in negotiations between DWR and FEMA (California
10 Wat. Code § 12984; Delta Stewardship Council 2017:ES-6). This was considered a short-term
11 mitigation. In 2014, FEMA did not renew the Delta HMP, and thus the assistance eligibility would be
12 for communities with levees meeting the Delta-specific PL 84-99 standards or Bulletin 192-82. Costs
13 for improvement and frequent maintenance of non-SPFC levees can be beyond the financial capacity
14 of property owners and local reclamation districts. The estimated state-subsidized expenditures to
15 maintain non-SPFC Delta levees, including local matching funds, averages about \$11.6 million
16 annually (Delta Stewardship Council 2020:25). The next subsection provides additional information
17 on applicable levee standards.

18 **7.1.3.3 Levee Standards and Compliance**

19 Levees are an important element of flood protection; however, levees are not constructed to
20 withstand all hydrologic conditions. Levees are designed to accommodate specific design channel
21 capacities or WSE profiles. Therefore, levee performance could have a strong correlation to channel
22 performance (i.e., channel capacity). Over the last few decades, state and federal agencies have
23 developed guidelines, standards, and permitting requirements for levees. These standards and
24 guidelines generally establish minimum criteria for levee design and maintenance. Levee geometry
25 standards and requirements in the Delta vary based on SPFC versus non-SPFC levees and for urban
26 versus nonurban levees. Urban levees are those that protect an urban area, which means a
27 developed area in which there are 10,000 residents or more (Government Code § 65007(j)). Figure
28 7-2 shows the distribution of urban and nonurban levees in the north Delta.

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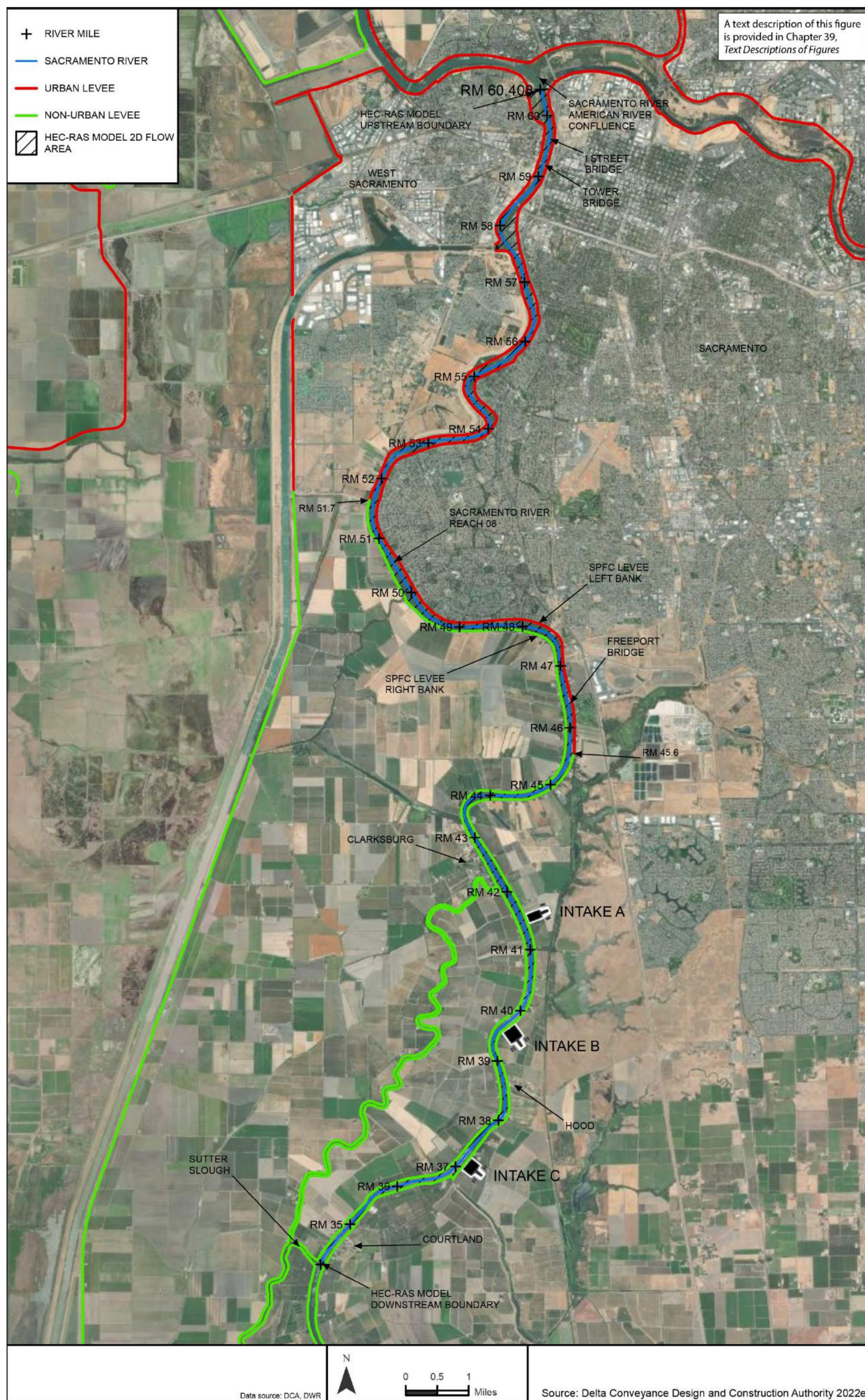


Figure 7-2 Map of the Urban and Nonurban Levees along the Sacramento River between the American River Confluence and Sutter Slough

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1 There are different design standards applicable to a Delta levee depending on the combination of its
2 status as a SPFC facility and the area it provides protection. The relevant design standards are
3 generally summarized below (Delta Stewardship Council 2020:16-19).

- 4 • DWR Urban Levee Design Criteria: This standard goes beyond criteria for levee height and
5 geometric design to include requirements for freeboard, slope stability, seepage/underseepage,
6 erosion, settlement, and seismic stability (California Department of Water Resources 2012b:7-1
7 to 7-50). It is intended to protect against an 0.5% AEP flood (i.e., a 200-year level of flood
8 protection) and is the only levee standard that specifically links land uses to levee criteria. State
9 law requires that by 2025, land use agencies cannot enter into a development agreement for a
10 property within a flood hazard zone unless the city or county finds, based on substantial evidence
11 in the record, that the facilities of the SPFC or other flood management facilities protect the
12 property to the urban level of flood protection in urban and urbanizing areas or the FEMA
13 standard of flood protection in nonurbanized areas or other conditions allowed in Government
14 Code Section 65865.5.
- 15 • FEMA 100-year Protection: This “insurance” standard, often called the “1% annual chance flood”
16 level of protection, provides criteria that levees must meet to protect against the flooding that is
17 the basis for FEMA’s FIRMs (44 Code of Federal Regulations § 65.10). It is often used with
18 established USACE criteria to prescribe requirements for levee freeboard, slope stability,
19 seepage/underseepage, erosion, and settlement. The standard generally does not address seismic
20 stability. In communities where levees provide this level of flood protection, new developments
21 are not required to meet federal floodproofing standards and can obtain federally guaranteed
22 mortgages without purchasing flood insurance.
- 23 • Bulletin 192-82: Bulletin 192 was first completed by DWR in 1975 and adopted by the
24 Legislature in 1976 as a conceptual plan to guide the formulation of projects to preserve the
25 integrity of the Delta levee system (Wat. Code § 12225). Bulletin 192-82, its update, refined the
26 plan and provided recommendations to the Legislature for implementation. The plan was
27 intended to eventually have all levees within the Delta—regardless of protecting urban or
28 agricultural areas—upgraded to a minimum configuration, thus reducing the chances for failure.
29 However, it recognized that on a few islands, levee improvements would be uneconomical, a
30 conclusion with which the Legislature concurred (Wat. Code § 128981(b)). Bulletin 192-82 was
31 thus formalized to provide guidance for the Delta Levees Maintenance Subventions Program
32 (Wat. Code § 12300(b)) and the referenced levee standard to receive the state’s financial
33 assistance. The design standard requires a freeboard of 3.0 feet and 1.5 feet above the expected
34 300-year flood stage for levees protecting urban and agricultural areas, respectively. Landside
35 geometry varies based on height of levee, thickness of peat, and if a berm is present. For example,
36 landside slopes without a berm range from 3H:1V to 7H:1V, whereas landside levee slopes with a
37 berm are 3H:1V and include berms that are half the levee height with slopes that range from
38 3H:1V to 13H:1V. The standard also includes a requirement of 16-foot minimum crown width
39 with a waterside slope of 1 vertical on 2 horizontal, and a landside slope of 1 vertical on 3
40 horizontal (California Department of Water Resources 1982:54–57). For the purposes of Delta
41 levee maintenance, an urban area means an area in which 10% or more of the land area within
42 the improvement project is used for residential use (Wat. Code § 12986(d)(2)). The recurrence
43 interval of 300 years was based on the benefit-cost analysis by USACE on extreme Delta inflow
44 and water stages as affected by high tide and wind. In areas with tidal dominated waters, the
45 difference between a 50-year flood and a 300-year flood was about 0.5 foot (California
46 Department of Water Resources 1982:54–57).

- PL 84-99: This is USACE’s program that establishes guidelines for levee design geometry, construction, operations, and maintenance. This guidance for levee geometry implies a minimum levee height and a slope stability factor of safety but is not associated with a level of protection (such as a 100-year flood) and does not address seismic stability. The minimum geometry criteria were not intended to become a “design standard” for non-SPFC levees, but rather a uniform procedure to establish eligibility for federal rehabilitation assistance for nonfederal flood control projects. Local maintaining agencies must apply to participate in the program and must regularly demonstrate that their levees and levee operations meet or exceed the program’s requirements in order to be eligible for federally funded emergency assistance, including flood fighting support and rehabilitation of levees damaged by flooding. USACE’s periodic inspection program incorporates other elements into eligibility, including presence of structure encroachments, vegetation, and rodent control programs.

PL 84-99 Delta-Specific Standards were developed for non-SPFC levees to qualify for rehabilitation under PL 84-99 and are intended to supplement the national guidelines. They were developed based on the Delta’s particular organic soils and levee foundations conditions and require a freeboard of 1.5 feet above the 100-year flood stage for all islands/tracts, a minimum 16-foot crown width with a waterside slope of 1 vertical on 2 horizontal, and a landside slope of 1 vertical on 3 to 5 horizontal (depending on the levee height and depth of peat soil). These standards are not intended to establish design standards for the non-SPFC levees in the Delta, but to provide uniform procedures to be used by USACE in determining eligibility under PL 84-99. The Delta-specific PL 84-99 standard uses a 100-year hydraulic profile that is used to establish a geometric cross section similar to Bulletin 192-82 (U.S. Army Corps of Engineers 1988:9-10).

As previously mentioned, until 2014, non-SPFC levee upgrades often sought improvement to meet design guidelines established by the Delta HMP as a step towards the Delta-specific PL 84-99 or Bulletin 192-82 standards. The 2000 CALFED Bay-Delta Program Record of Decision set a goal of improving Delta levees to meet the PL 84-99 criteria, as does the Delta Protection Commission’s Economic Sustainability Plan, but funding has been inadequate to attain this objective. Five Delta reclamation districts, protecting about 3% of the legal Delta’s land behind about 41 miles of levees, meet or exceed the Delta-specific PL 84-99 criteria, and 24 more districts are more than halfway to improving levees to this standard (Delta Stewardship Council 2020:17).

In 2014, this agreement between FEMA and CalOES on using standards of the Delta HMP was not renewed, despite the considerable state investment in its implementation. The agreement’s termination partly reflected FEMA’s concern that sufficient progress had not been made toward its long-term goal of bringing levees up to the USACE Delta-specific PL 84-99 standard and the growing realization of the costs that flood disasters nationwide are imposing on the federal government. As a result, current non-SPFC levee improvements generally aim to meet Delta-specific PL 84-99 or Bulletin 192-82 standards.

7.1.3.4 Seismic Activity

The Delta’s levees are threatened by the active seismic zones west of the Delta, including the San Andreas and Hayward faults. Less active faults, such as the Southern Midland Fault, underlie the Delta. A strong earthquake could damage Delta levees because of the potential for deformation or cracking of levees or the liquefaction of levee embankments and foundations during strong ground shaking. Moderate earthquakes between 1979 and 1984 damaged nearby Delta levees, and many Delta islands’ levees failed during floods within a year after the 1906 San Francisco earthquake

(Delta Stewardship Council 2020:7). If a levee failed on an island subsided below sea level or during high flows or if a flood were to occur soon after an earthquake, the protected area could be inundated.

The DWR Delta Risk Management Strategy Phase 1 study evaluated the performance of Delta levees under various seismic threat scenarios and analyzed potential consequences for water supply, water quality, ecosystem values, and public health and safety. The study cited a U.S. Geological Survey report that indicated that a major earthquake of magnitude 6.7 or greater in the vicinity of the Delta Region has a 62% probability of occurring sometime between 2003 and 2032 (California Department of Water Resources 2009:2). In 2016, as discussed in Chapter 10, *Geology and Seismicity*, the U.S. Geological Survey estimated there is a 72% probability of a 6.7 or greater magnitude earthquake occurring in the Bay Area by 2043 (U.S. Geological Survey 2016:1). More recent investigations suggest earthquake-induced ground shaking affecting Delta levees may be less serious but still worrisome (Delta Stewardship Council 2020:7). Although the probabilistic nature of earthquake prediction makes it difficult to quantify the timing and magnitude of seismic threats, it is important to address the threats posed by earthquakes to the Delta levee system because of the potential adverse effects of such events.

7.1.3.5 Land Subsidence

Delta island subsidence resulting from the biochemical oxidation of organic soils and wind disturbance could pose a significant threat to Delta levees. The areas that are most susceptible to subsidence are the central, western, and northern Delta, where thick organic peat layers predominate (Public Policy Institute of California 2008:9). As the landside ground elevation decreases because of subsidence, the resulting increase in elevation difference between the water surface and ground provides increased hydraulic loading on the levee and its foundation and associated risks related to seepage, piping, and slope instability. Recently, projects have been implemented in the western Delta for subsidence reversal, carbon sequestration, or both (California Department of Water Resources 2022b).

7.1.3.6 Sunny-Day Hazards

Even without an earthquake or flood, sunny-day levee failures do occasionally occur in the Delta. Generally, these failures may be the result of a combination of preexisting internal levee and foundation weaknesses caused by internal erosion of the levee and foundation over time and human interventions such as dredging or excavation at the toe of the levee (Delta Stewardship Council 2020:8). Internal erosion is often a result of seepage through the levee, which creates water pressure within the levee structure and is characterized through the formation of sand boils. Structural instability may also occur when seepage forces cause sloughing of the levee landside slope, shortening seepage paths that increase the probability of levee failure.

Other hazards that affect the performance of Delta levees include burrowing animals, encroachments, and penetrations. Burrowing animals, especially species such as beavers, ground squirrels, and owls, can weaken the structural integrity of a levee and increase the likelihood of piping. Encroachments, such as structures or farming practices on or close to the levee, can adversely affect a levee if they are not constructed or maintained in accordance with the requirements of federal, state, and local agencies. Penetrations of the levee, such as culverts or pipelines, can weaken the structural integrity of levees and lead to levee instability if the waterside opening does not have an appropriate closure device that seals the opening and prevents excessive

seepage. Because of unregulated historical construction, levees also contain many hidden hazards. Interaction among the factors listed above is also common and increases the probability of levee failure.

7.1.3.7 High-Water Conditions

The same hazards present during sunny-day conditions are exacerbated during high-water events (e.g., winter atmospheric river storms), which are expected to increase in number and frequency under climate change conditions (Delta Stewardship Council 2021:3-17). Moreover, water levels in the Delta are influenced by the tide level at the Golden Gate Bridge. When these storms coincide with extreme winter tides (i.e., king tides), storm surges and high wind waves can cause levee failure (Maendly 2018:12–13, 46). Increased seepage is also common during these events. As sea levels rise in the future, tides and water levels will increase hydraulic stress on the levees and increase flood risk in the Delta.

7.1.3.8 Potential Climate Change Effects

Climate change has major implications for the Delta, and especially for flood risk management. The California Ocean Protection Council's (OPC) most conservative, risk-averse climate change scenario (H++) estimates 10.2 feet of sea level rise at the San Francisco tide gage by the year 2100 (California Natural Resources Agency and California Ocean Protection Council 2018:18). By 2050, rising sea levels will more than double the probability of flooding if levees are not only well-maintained, but also improved (Delta Stewardship Council 2020:10). Drainage of Delta islands will also be more difficult, impairing agriculture on which the finances of many reclamation districts rely. This projected sea level rise could be expected to be exacerbated during high-water events, which are discussed in Section 7.1.3.7, *High-Water Conditions*.

7.1.3.9 Regional Planning Efforts Related to Delta Flood Management

Many planning efforts addressing flood management and emergency preparedness, response, and mitigation are under way, including the following.

- Central Valley Flood Protection Plan (CVFPP).** The Central Valley Flood Protection Act of 2008 directed DWR to develop, and CVFPB to adopt, the CVFPP—which was first published in 2012 and updated in 2017 and 2022 (California Department of Water Resources 2012a, 2017b, 2022a). The CVFPP, developed under DWR's FloodSAFE California, established a systemwide approach to improving flood management in areas currently receiving protection from SPFC facilities (California Department of Water Resources 2012a:3-21). Following adoption of the 2012 CVFPP, DWR funded six regionally led Regional Flood Management Plans (RFMPs) that describe local and regional flood management priorities and challenges. These RFMPs also identified potential funding mechanisms and site-specific improvement needs. In the 2017 CVFPP (California Department of Water Resources 2017b), DWR refined analyses and updated flood risk estimates for the Central Valley. Without continued implementation of the recommended plan, the estimated expected annual damage for 2017 (the existing condition for the 2017 CVFPP update) is about \$329 million per year in the Central Valley, with a potential 66 lives lost per year in the Sacramento River Basin and a potential 149 lives lost in the San Joaquin River Basin (California Department of Water Resources 2017b:3-35). As clarified by DWR, expected annual life loss is not a predictor of life loss for a given year but rather an indicator of potential life loss for any given year considering the full range of potential flood events and the likelihood of those

1 occurring. CVFPP results are informative indices of life risk but do not forecast deaths expected
2 to occur from flood events. Neither are these indicators to be used for emergency planning or
3 other purposes. Potential life loss would require more detailed analyses and supporting data than
4 that used in the CVFPP or its update (California Department of Water Resources 2012a:2-21,
5 2017b:3-35, 2017c:3-2). DWR recently released the public draft 2022 CVFPP Update in April
6 2022 to document the continued implementation of the State Systemwide Investment Approach
7 with a focus on climate resilience, performance tracking, and integration and alignment with
8 other state water management plans.

- 9 • Delta Stewardship Council's *Delta Plan*. To reduce flood risk to people, property, and state
10 interests in the Delta, the Delta Reform Act requires that the Delta Stewardship Council's *Delta*
11 *Plan* promote effective emergency response and preparedness, appropriate land use, and
12 strategic investments in levees (Wat. Code § 85305). The Delta Reform Act also directs the Delta
13 Stewardship Council, in consultation with CVFPB, to recommend priorities for state investments
14 in levee operation, maintenance, and improvements in the Delta, including both SPFC and non-
15 SPFC levees (Wat. Code § 85306). In spring 2014, the Delta Stewardship Council began
16 developing the Delta Levees Investment Strategy, which combines risk analysis, economics,
17 engineering, and decision-making techniques to identify funding priorities and assembled a
18 comprehensive investment strategy for the Delta levees. In March 2020, the Delta Stewardship
19 Council amended Chapter 7 of the *Delta Plan*, which provides an overview of flood risk in the
20 Delta, current flood management efforts, and the most pertinent agencies and regulations.
- 21 • Sacramento-San Joaquin Delta Multi-Hazard Coordination Task Force Report. This report
22 responds to Wat. Code Section 12994.5, which called for the task force to make recommendations
23 to the Governor about Delta multi-hazard emergency response and recovery issues. The task
24 force was directed to make recommendations to CalOES about creating an interagency unified
25 command system organizational framework in accordance with the guidelines of the National
26 Incident Management System and the Standardized Emergency Management System; coordinate
27 development of a draft emergency preparedness and response strategy for the Delta; and
28 develop and conduct all-hazard emergency response exercises and training in the Delta that
29 would test or facilitate implementation of regional coordination protocols (Delta Stewardship
30 Council 2020:39). In 2018, CalOES released the *Northern California Catastrophic Flood Response*
31 *Plan*, which provides a framework outlining how local, state, and federal governments would
32 respond and coordinate in anticipation of and following a catastrophic flood event, with
33 emphasis on impacts on the Delta (California Governor's Office of Emergency Services 2018).
- 34 • CVP and SWP Reoperation Studies. DWR's Forecast-Coordinated Operations Program and
35 Systems Reoperation Program address reservoir operational criteria.

36 State expenditures on Delta levees have greatly reduced the frequency of levee failures (Delta
37 Stewardship Council 2017:ES-7). State funding programs for levee improvements on Delta islands
38 and tracts vary based on location and type of levee. Since the 1980s, state funds for Delta levees are
39 available through state-managed programs including the Delta Levees Maintenance Subventions
40 Program and the Delta Levees Special Flood Control Projects Program, both of which are managed
41 by DWR. These grant monies helped fund levee maintenance and improvements in many areas of
42 the Delta.

43 During floods, DWR emergency response activities and local maintenance agencies could prevent
44 and have prevented many potential levee failures (California Department of Water Resources

2012a:4-2 to 4-3). Therefore, the realized levee failures were often less than predicted in typical flood risk assessments.

DWR, CVFPB, and USACE each play unique and critical roles in Delta flood risk management. Frequent, ongoing collaboration with other state, federal, and local agencies to improve communication and coordination is essential to meeting the Delta's flood management objectives.

7.2 Applicable Laws, Regulations, and Programs

The applicable laws, regulations, and programs considered in the assessment of project impacts on flood protection are indicated in Section 7.3.1, *Methods for Analysis*, or the impact analysis, as appropriate. Applicable laws, regulations, and programs associated with state and federal agencies that have a review or potential approval responsibility have also been considered in the development of CEQA impact thresholds or are otherwise considered in the assessment of environmental impacts. A listing of some of the agencies and their respective potential review and approval responsibilities, in addition to those under CEQA, is provided in Chapter 1, *Introduction*, Table 1-1. A listing of some of the federal agencies and their respective potential review, approval, and other responsibilities, in addition to those under NEPA, is provided in Chapter 1, Table 1-2.

7.3 Environmental Impacts

This section describes the direct and cumulative environmental impacts on flood protection that would result from project construction, operation, and maintenance. This section also describes the methods used to determine the impacts of the project and lists the thresholds used to conclude whether an impact would be significant. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) potentially significant impacts are also provided.

7.3.1 Methods for Analysis

This section describes the qualitative and quantitative methods used to evaluate flood protection-related impacts of the project alternatives within the study area. These impacts would be associated with construction, operation, and maintenance of the project, and implementation of compensatory mitigation.

7.3.1.1 Process and Methods of Review for Flood Protection

As described in Chapter 3, *Description of the Proposed Project and Alternatives*, the project alternatives do not include any changes in flood control operations. Flood control operation and associated rules are under the jurisdiction of USACE. Therefore, the operations of project alternatives would have no impacts on flood protection upstream of the Delta, and the level of flood protection under project alternatives would remain the same. Since the project would not affect the Sacramento River upstream of the Delta or the San Joaquin River Basin outside of the Delta, the study area associated with flood protection focuses on the specific areas in the Delta that may be affected by project facilities—including the intakes, launch/maintenance/reception shafts, and Southern Forebay (although the Southern Forebay is applicable to Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c only).

Consistent with the evaluation of potential impacts on other resources, the qualitative and quantitative analyses discussed in this section assess the significance of project impacts in relation to existing conditions. Effects on flood protection were assessed by identifying flood risks within the study area to evaluate whether flood protection would be affected temporarily by construction or permanently by operations of permanent facilities of the project.

Many major components of project construction and facilities are underground. The assessment for potential flood protection impacts from construction and operations of permanent facilities were for aboveground facilities only. Specifically, the assessment for flood protection impacts associated with the project alternatives examined: (1) changes that may increase flooding or flood risk in the Delta, and (2) changes to the potential rate or amount of runoff that may impede or redirect localized flood flows. However, these two areas of review require different settings to accommodate the different regulatory frameworks associated with applicable flood management practices. The following subsections summarize these two areas of impact assessments, including the reasons for selecting the associated existing conditions and No Project Alternative and the resulting impacts on flood management.

Process and Method of Review for Potential Increase in Delta Flood Risks

There are many contributing factors to Delta risks of flooding, and they would continue to play a role in Delta flood risks. All project alternatives are for water supply purposes and include no changes in flood management infrastructure in the Sacramento River Basin and in the Delta, including the reservoirs of the SRFCP and CVP, and associated flood operation rules and management. Therefore, changes from project alternatives that may increase flooding or flood risk in the Delta are related to the construction and operation of the intakes on the Sacramento River, which is often the primary source of flood flow from upstream watersheds.

The intakes located along the Sacramento River where SPFC levees are present may affect the drainage of the Sacramento River flow during flooding conditions. Therefore, the preference and consistency with regulatory requirements for SPFC levees and CVFPB's jurisdiction would be followed, including the consistency with the CVFPP. The CVFPP, prepared by DWR in accordance with the Central Valley Flood Protection Act of 2008 and adopted by the CVFPB, is California's strategic blueprint to improve flood risk management in the Central Valley and guides the state's participation in managing flood risk in areas protected by the SPFC. The CVFPP is updated every 5 years, and thus, for this Final EIR, tools and methods consistent with those for the 2022 CVFPP Update were used for evaluating the potential impacts on the SPFC facilities and their resulting flood protection.

The 2022 CVFPP Update has a 50-year planning horizon that begins in 2022 for analysis purposes and for developing assessment strategy (California Department of Water Resources 2022a). For consistency with the governing regulatory framework, the analysis for potential flood control impacts on the area protected by the SPFC should be conducted using a similar planning horizon. In other words, the portion of the impact analyses that evaluates areas protected by the SPFC uses the years 2022 and 2072 as reference years for existing conditions and the No Project Alternative, respectively. Additional detail on the data and analytical tools used to assess the impacts of the project on flood control is provided within the impact assessments below.

In addition to the increase in WSEs, effects on the localized velocity pattern changes near the intakes and the resulting erosion and scouring could also affect the SPFC levee stability. The final design of project alternatives would include detailed evaluation and measures to minimize these effects.

Process and Method of Review for Impeding or Redirecting Localized Flood Flow

Many other facilities of the project alternatives are in the flood hazard zone, and thus it is necessary to evaluate the potential impacts from these facilities on impeding or redirecting localized flood flow.

The project alternatives include design criteria to protect the facilities during flooding. As described in Chapter 3 and detailed in the Engineering Project Reports (EPRs) (Delta Conveyance Design and Construction Authority 2022a:16, 18, 39, 47, 54, 66; 2022b:29, 42, 45-46), permanent project facilities would be designed for long-term operations and be protected from a 200-year flood event (i.e., 0.5% AEP) with climate-change-induced hydrology, sea level rise for 2100 conditions, freeboard criteria, and wind fetch wave run-up. These design criteria are not related to impacts on adjacent areas; however, the incorporated protection would prevent potential inundation of water conveyance structure and avoid redirected impacts.

The overall approach to flood management associated with facility construction and permanent operations includes a combination of nonstructural and structural flood risk management measures to reduce the risk of flooding during construction and operations, including at tunnel shafts. In this context, nonstructural measures could involve staging of temporary facilities or equipment, but such facilities or equipment would not significantly affect the construction footprint or on-site activities. Nonstructural measures would involve fully integrating the project construction team with existing Delta flood preparation, response, and recovery systems using methods that range from safety training to safety kits for sheltering in place, especially in the case of a levee failure (Delta Conveyance Design and Construction Authority 2022d:8-10). This would occur in coordination with reclamation districts, levee maintaining agencies, and state and federal agencies with direct responsibilities, authorities, or emergency support roles over Delta levees, including USACE, FEMA, Reclamation, CalOES, DWR, and CVFPB. During construction, measures to minimize effects on existing levees would be implemented, including avoiding or minimizing the use of existing levees as construction haul routes for the project and establishing setbacks to separate project activities from existing levees that are to be determined during the design phase, based on site-specific investigation and analyses.

Most construction sites contain local irrigation and drainage facilities installed by existing or previous private landowners or reclamation districts. These systems may serve parcels that would be acquired for the project and adjacent parcels. Many of these existing facilities are buried and therefore not visible on aerial photographs. Consequently, for project feature locations without site access, no further analyses can be conducted at this time. During the design phase, when the project can acquire access to specific parcels, irrigation and drainage facilities would be mapped for each site. If the facilities used by adjacent properties to move water from the existing diversion are located on a parcel to be used for a project feature, pipelines or canals would be installed to maintain service to the adjacent properties.

The intakes and associated facilities would be located in the 100-year floodplain within DWR Maintenance Area 9, Reclamation District 744, and Reclamation District 813. The temporary and permanent infrastructure would affect the flow pattern and drainage of local floodwater, which would drain to Stone Lakes Canal during flooding conditions. The project alternatives would redesign the local drainage canals that are affected and would potentially upgrade the existing pumps to maintain adequate drainage in the areas protected by levees. Therefore, no further analyses are required for impact assessment.

1 Structural measures for flood management and facility protection may rely on existing levees that
2 would be improved to meet PL 84-99 standards unless the surrounding levees already meet PL 84-
3 99 standards. Given the long duration of work at the Bouldin (central alignment) and Lower Roberts
4 Islands (eastern and Bethany Reservoir alignments), tunnel launch sites, improvements of the island
5 perimeter levee to meet PL 84-99 geometric standards, as well as addressing any known
6 geotechnical weaknesses, are warranted to limit long-term flood risk. The extent and types of
7 recommended levee repairs would be refined prior to construction and in coordination with the
8 local reclamation districts. This approach would present an improvement to existing conditions.
9 Therefore, no additional evaluation is required. The Twin Cities Complex is one exception to this
10 approach. A ring levee configured in compliance with PL 84-99 standards would be used for the
11 Twin Cities Complex since it is not fully protected by perimeter levees. Therefore, a site-specific
12 evaluation of potential impacts from the proposed facilities on flood flows in the 100-year floodplain
13 is required using a methodology consistent with that for FEMA FIRMs.

14 The Southern Forebay facilities would be designed in accordance with the DSOD requirements for
15 jurisdictional dams based on the anticipated maximum height and storage volume. The levees on
16 Byron Tract around the Southern Forebay are maintained by Reclamation District 800 and have met
17 PL 84-99 standards. Therefore, there will be no need for improvements to the surrounding levees or
18 a ring levee. However, as part of the design requirements for DSOD jurisdiction dams, an overflow
19 emergency spillway would be used in the unlikely condition that the forebay water level continued
20 to rise above the design maximum elevation. The emergency spillway would discharge flow from the
21 Southern Forebay into Italian Slough, which flows into Old River. The evaluation of impacts on flood
22 protection focuses on the flow path of the emergency release per DSOD requirements and potential
23 effects on adjacent levees and associated protected areas.

24 Consistent with the evaluation of potential impacts on other resources, the qualitative and
25 quantitative analyses discussed in this section assess the significance of project impacts in relation
26 to existing conditions. Existing conditions include existing facilities and ongoing programs that
27 existed as of January 15, 2020 (i.e., the publication date of the Notice of Preparation). The No Project
28 Alternative includes reasonably foreseeable changes in existing conditions (e.g., sea level rise,
29 climate change) and changes that could be expected to occur in the year 2040 if the project were not
30 approved.

31 Unique to this chapter, existing conditions and the No Project Alternative require an additional
32 planning horizon that is different from the conditions (i.e., 2020 and 2040) previously discussed.
33 This is done to better align with applicable flood management frameworks, in particular, the 2022
34 CVFPP Update, which is the long-term plan for the area protected by the SPFC (California
35 Department of Water Resources 2022a). The 2022 CVFPP Update has a 50-year planning horizon
36 that begins in 2022 for analysis purposes and for developing assessment strategy. Therefore, the
37 analysis for potential flood control impacts on the area protected by the SPFC should be conducted
38 using a similar planning horizon. To maintain consistency with the planning horizon used in the
39 2022 CVFPP Update, impact analyses that evaluate areas protected by the SPFC use the years 2022
40 and 2072 as reference years for existing conditions and the No Project Alternative, respectively.

41 For potential flood protection impacts on areas that do not receive protection from the SPFC (i.e.,
42 Impact FP-2), the year 2020 was used for existing conditions and the project alternatives while the
43 year 2040 was used for the No Project Alternative—consistent with the evaluation of other resource
44 areas in this Final EIR. For potential flood protection impacts on areas that do receive protection
45 from the SPFC (i.e., Impact FP-1), the year 2022 was used for existing conditions and the project

alternatives while the year 2072 was used for the No Project Alternative—consistent with available flood tools and other planning efforts associated with the 2022 CVFPP Update (California Department of Water Resources 2022a). Project alternatives for each impact analysis were evaluated under the same reference year used for their respective existing conditions. That is, project alternatives for Impact FP-1 were evaluated under 2022 conditions while project alternatives for Impact FP-2 were evaluated under 2020 conditions. Table 7-1 includes a comparison of the reference years used for the existing and future conditions associated with each impact analysis in this chapter.

A more detailed description of the existing conditions, No Project Alternative, and the assumptions associated with each are included in Appendix 3C, *Defining Existing Conditions, No Project Alternative, and Cumulative Impact Conditions*. More details on the data and analytical tools are provided in later impact assessments under operations and construction.

Where appropriate, different permitting requirements for construction and operations of project alternatives were utilized to ensure compliance with flood protection regulations, which in some cases required customized analyses.

7.3.1.2 Assessing Potential Flood Protection Impacts from Construction

Construction of the project alternatives could affect: (1) WSEs of the Sacramento River between the confluence of the American River and Sutter Slough (near the proposed north Delta intakes), and (2) the depth and areal extent of the 100-year flood event at the Twin Cities Complex site.

The Southern Forebay is located on Byron Tract, an area that is already protected by levees that substantially meet the PL 84-99 criteria (Figure 7-1). Therefore, no further analysis on construction impacts on flood protection at Byron Tract was conducted

North Delta Intakes on Sacramento River (Impact FP-1)

To evaluate the potential impacts from construction of the proposed north Delta intakes on the drainage of Sacramento River flows during flood conditions, a Sacramento River hydraulic river model was prepared and used to evaluate river reaches in the Sacramento River between the American River confluence and Sutter Slough, where WSEs could potentially be affected by construction of the proposed north Delta intakes as part of the project alternatives. The upstream boundary (i.e., the confluence of the Sacramento River and American River) was selected due to its relevance as a major control point for flood management; moreover, there was no indication of additional upstream effects on WSEs beyond this upstream boundary. The downstream boundary (i.e., Sutter Slough) was selected because Sutter Slough is sufficiently downstream from the proposed north Delta intakes, and there are no significant inflows or flow splits between the American River confluence and Sutter Slough. The use of this reach for impact assessment was supported by modeled results.

The areas adjacent to this reach of the Sacramento River are protected by SPFC levees and thus are under USACE's, DWR's, and CVFPB's jurisdictions. Therefore, the best available information, tools, and evaluation methods used for project impact assessment are consistent with those for the 2022 CVFPP Update (California Department of Water Resources 2022a). The Sacramento River hydraulic river model used for project impact analysis was extracted from the full Sacramento River system model developed by DWR for use in the preparation of the 2022 CVFPP Update. This 1-D model used for the 2022 CVFPP Update was enhanced to a full 2-D steady-state Sacramento River system

Hydrologic Engineering Center River Analysis System (HEC-RAS) model using new bathymetry data and light detection and ranging topography collected by DWR in 2018 and 2019 (Delta Conveyance Design and Construction Authority 2022e:3, 8–9). The CVFPP provided the flood hydrology from the 2022 CVFPP Update for use in this assessment. These profiles are similar to the flood profiles used in the 2017 CVFPP Update, based on 1997 flood hydrology with a scaling factor, but include more conservative estimates for climate-change-induced hydrology and sea level rise.

The impact assessment used model assumptions and data that are consistent with the 2022 CVFPP Update. This included the use of existing conditions and future conditions considered in the 2022 CVFPP Update. The planning horizon for the CVFPP is 50 years; therefore, for the 2022 CVFPP Update, existing conditions are set in 2022 and future conditions in 2072. Although different from the existing (i.e., 2020) and future conditions (i.e., 2040) used for the other analysis in this chapter (i.e., Impact FP-2) and the other resource areas in the Final EIR, the use of CVFPP existing conditions in 2022 and future conditions in 2072 are considered important to stay consistent with governing regulatory framework, and the use of best available tools and information for environmental review purposes. Correspondingly, 2022 conditions are used for existing conditions and all project alternatives to evaluate the potential impacts on WSEs of the Sacramento River from construction. The No Project Alternative scenario for this analysis assesses WSE impacts in the Sacramento River under 2072 conditions relative to existing conditions (i.e., 2022).

While no current guidance exists for use of specific climate scenarios under CEQA, per OPC, the H++ scenario, or extreme risk aversion scenario, is recommended and relevant for high-stakes, long-term decisions and for projects with a lifespan beyond 2050 that have a low risk tolerance. The 2072 conditions for the 2022 CVFPP Update include climate change conditions, reflected in hydrology and sea level rise, that are used for the Final EIR's 2040 conditions for the No Project Alternative—although further in the future and with more pronounced effects. For example, the H++ sea level rise projection in 2040 is 1.8 feet, while the sea level rise projection in 2072 used by the 2022 CVFPP Update is 3.7 feet. This is considered more conservative for project impact assessment. A more detailed description of the climate change and sea level rise projections for this Final EIR can be found in Chapter 4, *Framework for the Environmental Analysis*, Chapter 30, *Climate Change*, and the 2022 CVFPP Update (California Department of Water Resources 2022a).

As previously mentioned, the modeled reach of the Sacramento River includes urban levees extending south from the American River confluence to around the town of Freeport that are for protecting Sacramento urban areas; these areas are subject to Urban Level of Flood Protection (i.e., 200-year level of flood protection) (Figure 7-2). Within the modeled reach, the remaining levees downstream of the town of Freeport are considered rural or nonurban levees that are not subject to the Urban Level of Flood Protection. Therefore, for completeness of the construction assessment for each project alternative, it is necessary to evaluate the impacts on WSEs of the Sacramento River for 100- and 200-year flood events under existing conditions (i.e., 2022). Figure 7-2 includes a map of the urban and nonurban levees along the Sacramento River between the American River confluence and Sutter Slough.

For evaluating impacts from construction of the project alternatives, the construction footprint, including cofferdams, was evaluated in the Sacramento River hydraulic river model. All WSE differences except the No Project Alternative were calculated based on the model differences between the flood event run with and without project facilities in place. The maximum WSE differences in the reach of the Sacramento River from the American River confluence to Sutter Slough for both the 100-year and 200-year flood events were used for comparative purposes.

Alternatives 1, 2a, 3, 4a, and 5 were specifically modeled using the Sacramento River hydraulic river model to evaluate the impact from construction of the intakes on WSEs of the Sacramento River. Alternatives 2b, 2c, 4b, and 4c, with their smaller capacities (3,000 cfs and 4,500 cfs) and smaller footprints, were not modeled because the resulting WSE increases would be similar to or less than the corresponding alternative of the same alignment but larger capacity. After a project alternative is selected, and in consideration of any changes made to the intake configuration during design, the modeling would be reconducted to support project permitting and final design. More detailed hydraulic evaluations concerning hydraulic loading, scour, and erosion forces at the interface between the intake structures and the river terrain as a result of increased WSEs would be done as part of the final project design for construction phase and for operation phase with final installed facilities. During these evaluations, the specific size and extent of slope protection would be verified and revised, if needed. The construction impacts were evaluated only for existing conditions (i.e., 2022 conditions) but not future conditions (i.e., 2072 conditions). A more detailed description of the modeling tool and analysis are included in the Sacramento River Flood Flow Hydraulic Modeling Technical Memorandum in Attachment A of the C-E EPR (Delta Conveyance Design and Construction Authority 2022e).

For 408 permit requirements, the assessment for potential flood protection impacts from construction was also evaluated using flood flows consistent with those used to develop the 1957 USACE Sacramento River Project Levee design profiles, which was the basis of the levee design when the SRFCP was constructed, representing the anticipated level of performance in terms of channel flow carrying capacity. The 1957 design profile assessment will be utilized by USACE and CVFPB as part of their permitting process to demonstrate that project construction would not impede the continued functions of the levees and channels as originally designed. The evaluation for the potential impacts on the 1957 levee design profile is not considered part of the CEQA analysis because the 1957 levee design profile was defined in association of a specific design flow used in the original facility construction. However, it is a necessary evaluation for the permitting process in addition to the CEQA analysis. The detail of the analysis using the 1957 levee profiles are provided in Appendix 7B.

Additional analyses for velocity near intakes and potential risks of erosion and scouring will be performed for the final design to meet permit requirements.

Twin Cities Complex (Impact FP-2)

The Twin Cities Complex site is located on the Glanville Tract in the Mokelumne River watershed just north of the confluence of the Cosumnes River. Due to the unregulated Cosumnes River, limited Mokelumne River channel conveyance, and downstream tidal conditions, the area around the Twin Cities Complex site has a history of flooding. The potential impacts on flood extents and depths in the area surrounding the Twin Cities Complex site that could result from the construction footprint were evaluated using the north Delta hydraulic model.

The north Delta hydraulic model was first created for Sacramento County and was later applied by DWR in the McCormack-Williamson Tract Project (Delta Conveyance Design and Construction Authority 2022d:Att 3-3). This coupled 1-D/2-D HEC-RAS model incorporates topographic and bathymetric data collected by DWR between 2007 and 2016 and was applied to evaluate the effects of the construction footprint around the Twin Cities Complex site on the 1% AEP flood (Delta Conveyance Design and Construction Authority 2022d:Att 3-2).

The north Delta hydraulic model was used for this evaluation because the model was calibrated to historical flood event gage data and high-water marks for floods at this location while applied to project evaluation for the McCormack-Williamson Tract Project, which is part of the DWR's North Delta Flood Control and Ecosystem Restoration Project for floodplain restoration and flood peak reduction. When the McCormack-Williamson Tract Project is completed, the potential flood depth near the Twin Cities Complex site is expected to be lower than the existing conditions. However, the completion date for the McCormack-Williamson Tract Project is not known at this time, so analysis was conducted assuming there was no such project, which results in a conservative evaluation.

The potential impacts from construction of the project alternatives at the Twin Cities Complex were evaluated by examining the effects of the construction footprint that includes a ring levee surrounding all facilities during construction. The ring levee height was designed based on a FEMA 100-year flood depth outside of Glanville Tract within the adjacent floodway, so several feet of freeboard are available for the current analysis. Construction impacts were evaluated for existing conditions (i.e., 2020 conditions) but not future conditions (i.e., 2040 conditions). A more detailed description of the flood effect analysis for the Twin Cities Complex site can be found in the Flood Risk Management Technical Memorandum in Attachment H of the C-E EPR (Delta Conveyance Design and Construction Authority 2022d, 2022f).

Indicators of Potential Impacts

The potential impacts from the construction of the project alternatives were evaluated based on:

- Changes in the resulting WSEs of the Sacramento River between the confluence of the American River and Sutter Slough (Impact FP-1). The increase in WSEs in the Sacramento River was used as an indicator for potential impacts on flood protection for the adjacent urban and nonurban areas.
- Changes in the extent of flooding at the proposed north Delta intakes, Southern Complex, tunnel shaft sites, or other project feature (Impact FP-2). The increase in flood depth or area was used as an indicator for potential impacts on Delta flood protection.
- Changes in the flood depth and areal extent of the 100-year flood event surrounding the Twin Cities Complex site (Impact FP-2). The increase in flood depth or area was used as an indicator for potential impacts on Delta flood protection.

Refer to Section 7.3.2, *Thresholds of Significance*, for more information about the significance criterion associated with this impact on riverine flooding from operations of the project alternatives.

7.3.1.3 Assessing Potential Flood Protection Impacts during Operations Phase

Based on the above process and methods of review, operation of the project alternatives could affect: (1) WSEs of the Sacramento River between the confluence of the American River and Sutter Slough (near the proposed north Delta intakes); (2) the depth and areal extent of the 100-year flood event at the Twin Cities Complex site; and (3) a channel (i.e., Italian Slough) and adjacent areas located downstream of the Southern Forebay Emergency Spillway. The first effect is related to the placement of north Delta intakes along the Sacramento River with SPFC levees and, therefore, the data, tools, and analyses would be consistent with the 2022 CVFPP Update. The other two are related to impeding or redirecting localized flood flow by project permanent facilities, and thus FEMA NFIP methodology is followed. The following provides location-specific analyses.

North Delta Intakes on Sacramento River (Impact FP-1)

The tools and methods for evaluating potential impacts on WSEs of the Sacramento River between the American River confluence and Sutter Slough during operations of the project alternatives are generally the same as those described in Section 7.1.3.2, *Assessing Potential Flood Protection Impacts from Construction*, for evaluating potential impacts from construction of the proposed north Delta intakes. Therefore, the reasons and choices of tools, data, and methods are not repeated herein. However, the analysis is based on the permanent intake infrastructure—that includes the intake training walls, cylindrical tee screen structure, and log boom—instead of the construction footprint. WSE differences are due to the permanent footprint of the intake facilities and are not directly related to diversions at the proposed north Delta intakes; modeling was completed without diversions occurring to provide a more conservative estimate of potential impacts. Unlike the evaluation of potential impacts from construction of the proposed north Delta intakes, the impacts during operations were evaluated for both existing conditions (i.e., 2022 conditions) and future conditions (i.e., 2072 conditions) with climate change, including corresponding hydrologic change and sea level rise. Appendix 7A, *Flood Protection 2040/2072 Analysis*, presents potential impacts on flood protection that could result from the project alternatives under future conditions.

The assessment for potential flood protection impacts during operations was also evaluated using flood flows consistent with those used to develop the 1957 USACE Sacramento River Project Levee design profiles. As previously mentioned, this analysis is expected to be used by USACE and CVFPB for permitting purposes. The detail of the analysis using the 1957 levee profile are provided in Appendix 7B.

Twin Cities Complex (Impact FP-2)

The tools and methods for evaluating potential impacts on local flood flows in the 100-year floodplain during operations of the project alternatives at the Twin Cities Complex site are the same as those described for evaluating potential impacts from construction of the permanent facilities at the Twin Cities Complex site for the central, eastern, and Bethany Reservoir alignments. Therefore, the reasons and choices of tools, data, and methods are not repeated herein. The difference is that the analysis would be based on the effects of the permanent shafts and stockpile storage areas for the eastern and Bethany Reservoir alignments after the temporary ring levee is removed. The permanent stockpile for the central alignment is smaller than that of the eastern alignment and thus would have less of an effect in increasing flood depth adjacent to the facility during flooding. A more detailed description of the flood effect analysis and hydraulic model scenarios for the Twin Cities Complex site can be found in the Flood Risk Management technical memoranda of the EPRs (Delta Conveyance Design and Construction Authority 2022d, 2022f).

Southern Forebay (Impact FP-2)

The Southern Forebay is located on Byron Tract—an area that is already protected by levees that substantially meet the PL 84-99 criteria. Consequently, the Southern Forebay would not include any facilities within the 100-year flood hazard area and would instead be located in an area that is considered a reduced risk (Figure 7-1). During the design phase, local irrigation and drainage facilities near the proposed Southern Forebay will be evaluated in detail for potential localized impacts from the forebay construction and operation, and associated mitigation needs, if any. If the facilities used by adjacent properties to move water from the existing diversion are located on a

1 parcel to be used for a project feature, pipelines or canals would be installed to maintain service to
2 the adjacent properties.

3 As previously mentioned, the Southern Forebay would be designed to meet the requirements of
4 DSOD for jurisdictional dams, including an emergency spillway. The hydraulic design of the
5 Southern Forebay Emergency Spillway would be based on controlling events, including rare
6 emergency operation of the system (e.g., if the pumps were on and the downstream gates closed
7 unexpectedly such as with a power outage) or uncontrolled flood flow through the conveyance
8 system (e.g., system intake gates open accompanied by power outage during high river stage leading
9 to uncontrolled gravity flow into the Southern Forebay). These control events are based on facility
10 design, and the resulting flow conditions will not change from existing conditions to future.

11 An inflow of 7,500 cfs was selected for this analysis because it represents the highest possible inflow
12 for all project alternatives. All other project alternatives would result in lower spillway flows and
13 lower potential hydraulic impact. Uncontrolled gravity flow through the system with the intake
14 gates open would potentially result in a longer event but at lesser flow due to frictional head losses
15 through the system. A qualitative analysis was conducted for the resulting flow path for assessing
16 the potential effects on flood protection. To assess the hydraulic impact of operating the Southern
17 Forebay Emergency Spillway on the existing levee system of Italian Slough and Old River, a 1-D
18 model was developed of the channel and levees using HEC-RAS. The probability of the emergency
19 spillway being operated is very low due to project operations and is assumed to be independent of
20 hydrologic conditions. Nevertheless, two hydrologic conditions were analyzed to estimate a
21 potential range of WSE impacts: a 100-year flood event and a mean higher high-water event if the
22 emergency spillway was used. The downstream WSE on Old River was assumed to be 10 feet for the
23 100-year event and 5 feet for the mean higher high-water event. A range of operational scenarios
24 were modeled to assess potential impacts on the existing levee system during a Southern Forebay
25 spill event. Spillway releases were assumed to be equal to the project pumping capacities of 3,000,
26 4,500, 6,000, and 7,500 cfs over a 12-hour period. See the Southern Forebay Emergency Spillway
27 Siting Analysis Technical Memorandum in Attachment D of the C-E EPR for additional detail on the
28 analysis (Delta Conveyance Design and Construction Authority 2022c).

29 Indicators for Potential Impacts

30 The potential impacts from the operations of the project alternatives were evaluated based on:

- 31 • Changes in the resulting WSEs of the Sacramento River between the confluence of the American
32 River and Sutter Slough (Impact FP-1). The increase in WSEs in the Sacramento River was used
33 as an indicator for potential impacts on flood protection for the adjacent urban and nonurban
34 areas.
- 35 • Changes in the depth and areal extent of the 100-year flood event surrounding the Twin Cities
36 Complex site (Impact FP-2). The increase in flood depth or area was used as an indicator for
37 potential impacts on Delta flood protection.
- 38 • Increases in risk of flooding by emergency release through the Southern Forebay Emergency
39 Spillway (Impact FP-2). The indicator is based on evaluation if the emergency releases could
40 affect levees and associated protected area.

41 Refer to Section 7.3.2 for more information about the significance criterion associated with this
42 impact on riverine flooding from operations of the project alternatives.

7.3.2 Thresholds of Significance

Based on Appendix G of the CEQA Guidelines, the impact analysis for flood protection would assume a project alternative would have a significant impact under CEQA if the project would do any of the following.

- Cause a substantial increase in WSEs of the Sacramento River between the American River confluence and Sutter Slough (Impact FP-1).
- 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 that would result in flooding on-site or off-site or impede or redirect flood flows (Impact FP-2).

For purposes of this analysis, WSE modeling results that show less than a 0.1-foot increase in WSE would not be considered a substantial increase. Table 7-1 includes a comparison of the reference years used for the existing and future conditions associated with each impact analysis in this chapter.

Table 7-1. Comparison of Reference Years Used for Flood Protection Impact Analyses

Impact	Existing Conditions/ Project Alternatives	No Project Alternative	Notes (see Section 7.3.1.1 for more detail)
Impact FP-1: Cause a Substantial Increase in Water Surface Elevations of the Sacramento River between the American River Confluence and Sutter Slough	2022	2072	Consistent with the planning horizon used in the 2022 CVFPP Update
Impact FP-2: 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 That Would Result in Flooding On- or Off-Site or Impede or Redirect Flood Flows	2020	2040	Consistent with all other resource impact assessments in the Final EIR

Note: For potential flood protection impacts on areas that receive protection from the SPFC in the study area (i.e., Impact FP-1), reference years were selected to maintain consistency with the planning horizon used in the 2022 CVFPP Update. For potential flood protection impacts on areas that do not receive protection from the SPFC in the study area (i.e., Impact FP-2), reference years were selected to maintain consistency with all other resource assessments in this Final EIR.

7.3.2.1 Evaluation of Mitigation Impacts

CEQA also requires an evaluation of potential impacts caused by the mitigation measures. Following the CEQA conclusion for each impact, the chapter analyzes potential impacts associated with implementing both the Compensatory Mitigation Plan (CMP) and the other mitigation measures required to address potential impacts caused by the project. Mitigation impacts are considered in combination with project impacts in determining the overall significance of the project. Additional information regarding the analysis of mitigation measure impacts is provided in Chapter 4.

7.3.3 Impacts and Mitigation Approaches

7.3.3.1 No Project Alternative

As described in Chapter 3, CEQA Guidelines Section 15126.6 directs that an EIR evaluate a specific alternative of “no project” along with its impact. The No Project Alternative in this Final EIR represents the circumstances under which the project (or project alternative) does not proceed and considers predictable actions, such as projects, plans, and programs, that would be predicted to occur in the foreseeable future if the Delta Conveyance Project is not constructed and operated, which are identified in Appendix 3C, *Defining Existing Conditions, No Project Alternative, and Cumulative Impact Conditions*, Section 3C.3.2, *No Project Alternative Conditions*, including Table 3C-2. This includes the water-supply-related actions that would be pursued by public water agencies participating in the Delta Conveyance Project in their respective service areas. This section considers how flood protection in the Delta could change over time, discusses how other predictable actions described in Appendix 3C, Section 3C.3.2.5, *No Project Alternative Assumptions for Water Agency Actions*, could affect flood protection, and summarizes the modeled changes in flood protection that may occur in the project study area under the No Project Alternative.

Predictable Water-Supply Related Actions by Public Water Agencies

A list and description of actions included as part of the No Project Alternative are provided in Appendix 3C, Section 3C.3.2.5. As described in Chapter 4 and Appendix 3C, the No Project Alternative analyses focus on the additional water-supply-related actions public water agencies may opt to follow if the project does not occur.

Public water agencies participating in the project have been grouped into four geographic regions. The water agencies within each geographic region would likely pursue a similar suite of water supply projects under the No Project Alternative (Appendix 3C, Section 3C.3.2.5). Activities associated with the various water supply projects could temporarily alter localized drainage patterns and stream courses, resulting in changes to surface water runoff and elevations, all of which could potentially exceed the capacities of stormwater management facilities. Construction impacts are expected to be primarily associated with construction of distribution pipelines; however, construction of these facilities would not be expected to result in substantial changes to drainage patterns or increases in surface water runoff because disturbed areas would generally be returned to pre-project conditions. In addition, distribution pipelines would mostly be below-ground and would not affect drainage patterns.

It is expected that water supply facilities would be located in upland areas to the greatest extent possible and would not be situated within flood inundation zones so as not to alter existing drainage patterns. Operational activities typically include inspection, monitoring, testing, maintenance, and facility operations. These activities are not expected to affect the ability of river, stream, or drainage channels to safely pass high-flow events; expose people or structures to a significant risk of loss, injury, or death involving flooding; or result in substantial changes in the rate or amount of runoff or impede or redirect flood flows. O&M activities for the water supply projects are not expected to require substantial or sustained discharge of water to existing waterbodies. Operation of desalination plants includes discharge of brine and distribution of product water. Discharge of brine is typically accomplished through isolated discharge pipes to the ocean or into injection wells and would not increase flows in rivers, streams, or drainage channels.

Future Conditions of Flood Protection in the Delta

Under the No Project Alternative, various factors contributing to Delta flood risks remain, and existing levee maintenance requirements and practices in the Delta are assumed to continue. These practices include continued improvements to overcome subsidence and sea level rise with potentially substantial costs, as the usable areas within Delta islands would continue to reduce (assuming no future improvements in levee crest elevations). Implementation of projects to reverse the trend of subsidence will also continue where opportunities exist. The threat of seismic activities on Delta levees will also persist, possibly with an increasing chance of occurrence, but without specific predictions of when and where.

The high variability of precipitation makes it difficult to detect a strong signal in future projections and is one of the least certain aspects of climate models, especially when applied at the regional level because climate models do not resolve many of the fine-scale and complex interactions that occur locally (Delta Stewardship Council 2021:3-13). Uncertainty regarding precipitation projections is greatest in the northern part of California, where most of the snowfall and rainfall in the state occurs. However, climate models do project precipitation to change under warming conditions, resulting in more frequent rainfall events and less frequent snowfall events (He et al. 2019:11). Warming air temperatures are expected to shift the timing and volume of snowmelt in the Sierra Nevada to earlier in the spring as well. Changing precipitation patterns and an earlier snowmelt would lead to shorter, more intense spring periods of river flow and freshwater discharge, consequently affecting inflows into the Delta.

Future surface water conditions are expected to change considerably when compared to existing conditions due to sea level rise and a shift in hydrologic patterns as a result of climate change. Within the study area, sea level rise conditions under the No Project Alternative could be expected to increase the duration of high-water conditions in Delta channels, decrease flood protection, and increase flood risk relative to existing conditions. The trend would be further amplified by changing hydrology and storm patterns under climate change.

Sea level rise and changes in hydrologic patterns in Delta watersheds could be expected to increase peak water levels and flooding in the Delta in the coming decades, exposing additional land to flooding in the future (Delta Stewardship Council 2021:5-6). In some parts of the Delta, the existing freeboard—while effective in reducing current flood risk—will decrease and potentially be exceeded in the future as peak water levels increase in response to climate change (assuming no future improvements in levee crest elevations).

As previously discussed in Section 7.3.1, *Methods for Analysis*, and shown in Table 7-1, two different sets of reference years are used for flood impact assessments to be consistent with corresponding regulatory frameworks. For potential flood protection impacts on areas that do receive protection from the SPFC (i.e., Impact FP-1), the year 2072 was used for the No Project Alternative, consistent with the 2022 CVFPP Update. For potential flood protection impacts related to impeding or redirecting localized flood flow (i.e., Impact FP-2), the year 2040 was used for the No Project Alternative, consistent with the evaluation of other resource areas in this Final EIR.

The analysis for Impact FP-1 is closely related to the potential impact on Delta flood risks with hydrologic conditions and sea level rise under climate change. The changes in WSE of the Sacramento River between the American River confluence and Sutter Slough under the No Project Alternative (2072 conditions) compared to the existing conditions (2022 conditions) were evaluated using the previously mentioned Sacramento River hydraulic model with climate change

hydrology and a projected sea level rise of 3.7 feet by 2072, conditions consistent with the 2022 CVFPP Update. Because of this, future WSEs under the No Project Alternative were evaluated at 2072. Under the No Project Alternative, WSEs for the 100-year flood event would increase by a maximum of 0.40 foot (River Mile [RM] 45.6; see Figure 7-2 for the corresponding location) in the river reaches with urban levees and 0.60 foot (RM 37.0) in the river reaches with nonurban levees when compared to existing conditions (Table 7-2). Under the No Project Alternative, WSEs for the 200-year flood event would increase by a maximum of 0.70 foot (RM 45.6) in the river reaches with urban levees and 0.90 foot (RM 37.0) in the river reaches with nonurban levees when compared to existing conditions. As shown in Table 7-2, increases in WSEs simulated in the Sacramento River under the No Project Alternative would result in increases in flood risk in the Delta. These increases in WSEs are contributed to by increases in flood flow due to changes in hydrology and sea level rise because of climate change since the high-water stage in the Delta channels is mostly influenced by tide and storm surges.

There was no specific analysis conducted for Impact FP-2. Under the No Project Alternative for FP-2, the projected sea level rise would be up to 1.8 feet

The No Project Alternative encompasses water supply projects adopted during the early stages of development of this Final EIR, facilities that are permitted or under construction during the early stages of development of this Final EIR, and projects that are permitted or are assumed to be constructed by 2040/2072. The above-identified local and regional water supply projects could result in localized impacts on flood protection and may require mitigations before implementation. Because these projects are expected to be within the service areas of public water agencies, they would not result in additional flood protection impacts in the Delta.

7.3.3.2 Impacts of the Project Alternatives on Flood Protection

Impact FP-1: Cause a Substantial Increase in Water Surface Elevations of the Sacramento River between the American River Confluence and Sutter Slough

All Project Alternatives

All nine project alternatives (i.e., Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) would have similar impact levels and are discussed together. This impact analysis discusses potential impacts on flood protection that could result from the project alternatives when compared to existing conditions. Because the area being evaluated for this impact (i.e., the Sacramento River between the American River confluence and Sutter Slough) receives protection from the SPFC, the project alternatives and existing conditions are both evaluated under 2022 conditions to maintain consistency with the planning horizon used in the 2022 CVFPP Update. Appendix 7A presents potential impacts on flood protection that could result from the project alternatives when compared to the No Project Alternative under future conditions. See Table 7-1 for a comparison of the reference years used for the existing and future conditions associated with each impact analysis in this chapter.

Project Construction

Intake construction would include on-bank facilities that could encroach into the existing river cross section in the Sacramento River at the northern end of the Delta and require work on the SPFC levee nearby as described in Chapter 3. During construction, a temporary levee designed to comply with California Code of Regulations Title 23 and Urban Levee Design Criteria would be built at the intake

1 site adjacent to but landward of the existing SPFC levee. This temporary levee would provide an
2 equivalent, or higher, level of flood protection to adjacent properties as the existing SPFC levee and
3 allow the intake facilities to be constructed along the Sacramento River while maintaining
4 continuous flood protection. State Route (SR) 160 would be relocated on top of the temporary levee.
5 As excavation continues on the intake site, a new permanent SPFC levee would be constructed
6 around the perimeter of the sedimentation basin and intake outlet channel. The new SPFC levee
7 would extend to the existing jurisdictional levee at the north and south ends of the intake structure
8 and would be designed to protect the site and surrounding area to flood control standards that could
9 accommodate a 200-year flood event with sea level rise. This level of protection exceeds the
10 requirements of both USACE and CVFPB. Following construction of the intake structure, SR 160
11 would be relocated to approximately its original location east of the intake structure near the
12 Sacramento River.

13 To minimize encroachment of the intake structure into the river flow cross section and minimize the
14 associated impact on flood flow WSEs, the bathymetry and riverbank configuration must
15 accommodate construction of the intake structure and associated training walls while meeting flood
16 criteria. Because the Sacramento River has overlapping jurisdictions across various federal and state
17 agencies, the intake facilities would be evaluated using the CVFPB flood profiles and be designed in
18 compliance with USACE goals to limit the rise of maximum WSEs to within the original design profile
19 with minimal impacts, in accordance with multiple-dimensional modeling results.

20 Project construction would require temporary in-river cofferdam structures at the proposed north
21 Delta intakes. The cofferdams would enable construction of the intakes and provide a contractor-
22 selected level of construction phase flood protection within the confines of the cofferdams. The
23 cofferdam would be placed in a configuration to reduce hydraulic impacts on the Sacramento River.
24 Temporary measures that would be in place during certain construction sequences, such as the
25 cofferdam or the temporary jurisdictional levee, would be removed either fully or partially after the
26 completion of applicable construction tasks. Partially removed temporary features would not be
27 included as part of permanent SPFC facilities. While there may be minor increases in WSE at the
28 proposed north Delta intakes during construction, any construction would be done to limit the rise
29 in WSEs and therefore avoid a substantial increase.

30 The potential impacts on WSE from the construction of the intake structures (where a cofferdam is
31 used along the riverbank of the Sacramento River) were examined using a hydraulic model covering
32 the Sacramento River between the American River confluence and Sutter Slough. The proposed
33 north Delta intakes are located in a river reach of the Sacramento River with nonurban levees (100-
34 year level of flood protection), although project construction could affect river reaches with urban
35 levees (200-year level of flood protection) upstream that are under CVFPB's jurisdiction. Figure 7-2
36 includes a map of the urban and nonurban levees along the Sacramento River between the American
37 River confluence and Sutter Slough.

38 Under Alternatives 1, 3, and 5, WSEs for the 100- and 200-year flood event would increase by a
39 maximum of 0.08 foot (RM 45.6; see Figure 7-2 for the corresponding location) in the river reaches
40 with urban levees and 0.10 foot (RM 40.0) in the river reaches with nonurban levees when
41 compared to existing conditions (Table 7-2). Under Alternatives 2a and 4a, WSEs for the 100-year
42 flood event would increase by a maximum of 0.10 foot (RM 47.6) in the river reaches with urban
43 levees and 0.11 foot (RM 42.0) in the river reaches with nonurban levees when compared to existing
44 conditions. Under Alternatives 2a and 4a, WSEs for the 200-year flood event would increase by a
45 maximum of 0.10 foot (RM 47.6) in the river reaches with urban levees and 0.12 foot (RM 42.0) in

the river reaches with nonurban levees when compared to existing conditions. Alternatives 2b, 2c, 4b, and 4c (3,000-cfs and 4,500-cfs capacity alternatives) were not modeled because WSE impacts would be similar to, or less than, Alternatives 1 and 3 (6,000-cfs capacity alternatives). Table 7-2 presents the WSE differences between the project alternatives and existing conditions in the Sacramento River during project construction that are discussed here. See the Sacramento River Flood Flow Hydraulic Modeling Technical Memorandum in Attachment A of the C-E EPR for additional detail (Delta Conveyance Design and Construction Authority 2022e).

All increases in WSEs of the Sacramento River due to construction of the conveyance facilities are relatively small. Therefore, construction of the conveyance facilities under Alternatives 1, 2b, 2c, 3, 4b, 4c, and 5 would not substantially increase WSEs near the intakes. However, construction of the conveyance facilities under Alternatives 2a and 4a (i.e., 7,500-cfs alternatives with all three intakes) would result in increases in WSEs near the intakes that are considered significant. For a multiyear period during construction, a sheet pile cofferdam must be installed in the river to allow construction of the concrete structure at each facility. While the construction cofferdam of two intake facilities built at the same time does not significantly increase the WSE during a flood event, the concurrent construction of a third intake cofferdam (as is the case in Alternatives 2a and 4a) does raise the WSE slightly over the 0.10-foot threshold. Supported by the analyses of other alternatives, phased construction of three intakes would alleviate the significant WSE increases.

Mitigation Measure FP-1: *Phased Construction of the Proposed North Delta Intakes* would address substantial changes in Sacramento River WSEs estimated to occur during construction of Alternatives 2a and 4a.

Postconstruction Effects during Operation

The nature of the proposed north Delta intake structures requires placement along the bank of the Sacramento River, with the structure projecting into flowing water. This effectively constricts a portion of the conveyance capacity of the river along the respective length of each intake. This in turn may cause a rise in WSE upstream of the intakes. This rise in WSE is dependent on the combination of intakes used to achieve the project needs. The major features of the intake structures that affect Sacramento River hydraulics are the intake training walls and the structural elements supporting the fish screens that encroach into the river. The structure's protective log boom and debris fender pile system could also affect river hydraulics. The debris fender and log boom—provided to protect the fish screen structures from damage by floating and near surface debris—may collect debris periodically, especially during or after storm runoff.

The potential impact on WSE in the Sacramento River between the American River confluence and Sutter Slough during operation of the intake structures was examined using the same hydraulic model for assessing impacts during construction discussed in the preceding subsection. As previously discussed, the potential impact on WSEs during operations of the project alternatives are not directly related to diversions at the proposed north Delta intakes. Instead, the following discussion related to “operational” impacts evaluates the effects that are a result of the permanent facility footprint. The proposed north Delta intakes are located in a river reach of the Sacramento River with nonurban levees (100-year level of flood protection), although the permanent footprint of the intake facilities could affect river reaches with urban levees (200-year level of flood protection) upstream, which are under CVFPB jurisdiction. Figure 7-2 includes a map of the urban and nonurban levees along the Sacramento River between the American River confluence and Sutter Slough.

1 Under Alternatives 1 and 3, WSEs for both the 100- and 200-year flood event would increase by a
2 maximum of 0.03 foot (RM 45.6; see Figure 7-2 for the corresponding location) in the river reaches
3 with urban levees and 0.04 foot (RM 40.0) in the river reaches with nonurban levees when
4 compared to existing conditions (Table 7-2). Under Alternatives 2a and 4a, WSEs for the 100-year
5 flood event would increase by a maximum of 0.04 foot (RM 47.6) in the river reaches with urban
6 levees and 0.05 foot (RM 40.4) in the river reaches with nonurban levees when compared to existing
7 conditions. Under Alternatives 2a and 4a, WSEs for the 200-year flood event would increase by a
8 maximum of 0.05 foot (RM 47.6) in the river reaches with urban levees and 0.05 foot (RM 40.4) in
9 the river reaches with nonurban levees when compared to existing conditions. Under Alternative 5,
10 WSEs for the 100- and 200-year flood event would increase by a maximum of 0.03 foot (RM 45.6) in
11 the river reaches with urban levees and 0.04 foot (RM 40.4) in the river reaches with nonurban
12 levees when compared to existing conditions. Alternatives 2b, 2c, 4b, and 4c (3,000-cfs and 4,500-cfs
13 capacity alternatives) were not modeled since WSE impacts would be similar to, or less than,
14 Alternatives 1 and 3 (6,000-cfs capacity alternatives). Table 7-2 presents the WSE differences
15 between the project alternatives and existing conditions in the Sacramento River during project
16 operations that are discussed here. See the Sacramento River Flood Flow Hydraulic Modeling HEC-
17 RAS 2D Technical Memorandum in Attachment A of the C-E EPR for additional detail (Delta
18 Conveyance Design and Construction Authority 2022e).

19 The permanent footprint of the conveyance facilities under all project alternatives would not
20 substantially increase WSEs of the Sacramento River near the intakes. WSE increases during project
21 operations would be less than the WSE increases exhibited during project construction due to the
22 removal of the sheet pile cofferdam(s) when construction is complete. While operations of the
23 project alternatives could divert flood flows, this would not necessarily provide a beneficial flood
24 protection effect and was not modeled in this analysis.

Table 7-2. Water Surface Elevation Differences for the Project Alternatives at Select Locations in the Sacramento River between the American River Confluence and Sutter Slough Relative to 2022 Conditions

Project Alternative and Flood Flow Scenario	River Reaches with Urban Levees, Max WSE Difference Relative to EC (feet)	River Mile of Greatest WSE Difference in Urban Levee Section	River Reaches with Nonurban Levees, Max WSE Difference Relative to EC (feet)	River Mile of Greatest WSE Difference in Nonurban Levee Section
Construction Phase				
<i>Alternatives 1, 3, and 5</i>				
100-year Flood Event	0.08	45.6	0.10	40.0
200-year Flood Event	0.08	45.6	0.10	40.0
<i>Alternatives 2a and 4a</i>				
100-year Flood Event (without mitigation)	0.10	47.6	0.11	42.0
200-year Flood Event (without mitigation)	0.10	47.6	0.12	42.0
100-year Flood Event (with mitigation)	0.08	47.6	0.08	42.0
200-year Flood Event (with mitigation)	0.08	47.6	0.09	42.0
Operations Phase (i.e., Postconstruction)				
<i>No Project Alternative (2072)</i>				
100-year Flood Event	0.40	45.6	0.60	37.0
200-year Flood Event	0.70	45.6	0.90	37.0
<i>Alternatives 1, 3, and 5</i>				
100-year Flood Event	0.03	45.6	0.04	40.0
200-year Flood Event	0.03	45.6	0.04	40.0
<i>Alternatives 2a and 4a</i>				
100-year Flood Event	0.04	47.6	0.05	40.4
200-year Flood Event	0.05	47.6	0.05	40.4

Source: Delta Conveyance Design and Construction Authority 2022e.

Note: Because the Sacramento River between the American River confluence and Sutter Slough is protected by the SPFC, WSE differences between the project alternatives and existing conditions were evaluated under 2022 conditions to maintain consistency with the planning horizon in the 2022 CVFPP Update. WSEs for the No Project Alternative were modeled under 2072 conditions (to maintain consistency with the CVFPP's 50-year planning horizon) before being compared to existing conditions under 2022 conditions. Alternatives 2b, 2c, 4b, and 4c (3,000-cfs and 4,500-cfs capacity alternatives) were not modeled because WSE impacts would be similar to, or less than, Alternatives 1 and 3 (6,000-cfs capacity alternatives). The results presented in the table only examine the WSE differences within the modeled reach (i.e., the Sacramento River between the American River confluence and Sutter Slough).

cfs = cubic feet per second; EC = existing conditions; WSE = water surface elevation.

CEQA Conclusion—All Project Alternatives

The intake, sedimentation basin, and outlet channel would be designed to flood control standards that could accommodate a 200-year flood event with sea level rise for year 2100 (i.e., 10.2 feet of sea level rise at the Golden Gate Bridge) as defined by DWR. The temporary levee developed during intake construction and the new, permanent SPFC levee that would remain after project construction is complete would provide an equivalent or higher level of flood protection to the area currently receiving protection from the existing levee near the intakes. Therefore, the impacts of the project alternatives on the degree of flood protection near the intakes would be less than significant.

The nature of the water intake structures requires their placement along the bank of the Sacramento River, with the structure projecting into the flowing water. This effectively constricts a portion of the conveyance capacity of the river along the respective length of each intake. This in turn may cause a rise in WSE in the Sacramento River between the American River confluence and Sutter Slough. This rise in WSE is dependent on the river flow rate, the combination of intakes used to achieve project needs, and the phase of construction for each intake. As shown in Table 7-2, construction of the proposed north Delta intakes during the 100- and 200-year flood events would increase WSEs between 0.08 and 0.10 foot in the river reaches with urban levees and 0.10 and 0.12 foot in the river reaches with nonurban levees of the modeled study area. Operation of the proposed north Delta intakes during the 100- and 200-year flood events would increase WSEs between 0.03 and 0.05 foot in the river reaches with urban levees and 0.04 and 0.05 foot in the river reaches with nonurban levees of the modeled study area. Currently, the facility footprint includes riprap (along the intake structure, existing levee, and river bottom interface) and slope protection that is typically sufficient to mitigate localized scour and erosion forces (Delta Conveyance Design and Construction Authority 2022a:76, Appendices 7–Appendices 8, Appendices 76). More detailed hydraulic evaluations concerning hydraulic loading, scour, and erosion forces at the interface between the intake structures and the river terrain as a result of increased WSEs would be completed as part of the final project design. During these evaluations, the specific size and extent of slope protection would be verified and revised, if needed.

Construction of Alternatives 2a and 4a (i.e., 7,500-cfs alternatives with three intakes) has a potentially significant impact on WSEs during a portion of the construction phase. For a multiyear period during construction, a sheet pile cofferdam must be installed in the river to allow construction of the concrete structure at each facility. The riverside sheet pile wall of the cofferdam encroaches about 5 feet further into the river than the permanent facility, thereby increasing river velocities through the area and slightly raising WSEs due to the additional hydraulic head loss. While the construction cofferdam of two intake facilities built at the same time does not significantly increase the WSE during a flood event, the concurrent construction of a third intake cofferdam does further raise the WSE. This increase in WSE could be considered substantial when assessing flood protection impacts; therefore, based on the initial design, this impact would be considered significant.

If Alternatives 2a or 4a are selected, DWR will perform additional hydraulic modeling based on the final design, prior to construction of the intakes. If this future modeling indicates a substantial increase in WSE of the Sacramento River (greater than 0.10 foot) during the construction period of Intake A (the most upstream intake), Mitigation Measure FP-1: *Phased Construction of the Proposed North Delta Intakes* would be applied to reduce the impact to less than significant.

With Mitigation Measure FP-1: *Phased Construction of the Proposed North Delta Intakes*, Alternatives 2a and 4a—in addition to the project alternatives that would not require mitigation (i.e., Alternatives 1, 2b, 2c, 3, 4b, 4c, and 5)—would have less-than-significant impacts on the level of flood protection between the American River confluence and Sutter Slough. See the Sacramento River Flood Flow Hydraulic Modeling HEC-RAS 2D Technical Memorandum in Attachment A of the C-E EPR for model results that support the efficacy of Mitigation Measure FP-1 and the significance determination (Delta Conveyance Design and Construction Authority 2022e).

Mitigation Measure FP-1: Phased Construction of the Proposed North Delta Intakes

DWR will delay the installation of the intake cofferdam at Intake A until the complete removal of the construction cofferdam at Intake C (or Intake B, whichever was installed first). This will delay Intake A construction approximately 2 years under Alternatives 2a and 4a. By having only two intake cofferdams installed in the river at the same time, the resulting increase in WSEs in the Sacramento River will be 0.08 foot for the 100-year flood event and 0.09 foot for the 200-year flood event and, therefore, will render the impact less than significant. The 2-year increase in the construction timeframe for the intakes will not increase the overall schedule for project construction for Alternatives 2a and 4a.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F, *Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources*, does not act as mitigation for impacts on flood protection from project construction or operations, its implementation could result in impacts on flood protection.

Actions undertaken for compensatory mitigation would restore three freshwater ponds along Interstate (I-) 5, wetland, open water, and upland natural communities on Bouldin Island, and tidal wetland and channel margin restoration sites within the North Delta Arc. Compensatory mitigation would convert existing agriculture land on Bouldin Island to wetlands, riparian habitat, ponds, and grassland. For the I-5 ponds, it is proposed that the existing grasslands, riparian habitat, wetlands, and ponds would be replaced by improved grassland, wetland, riparian, and open-water habitat. Tidal wetland and channel margin habitat would be restored within the North Delta Arc. Appendix 3F describes the CMP in detail.

Channel margin enhancements associated with compensatory mitigation actions would likely occur along migration corridors that also provide a certain level of flood protection for adjacent properties. Channel margin restoration would improve channel geometry, similar to what is currently practiced by USACE and other flood management agencies when implementing levee improvements. Channel margin restoration associated with federal project levees would not be implemented on the levee but rather on benches to the waterward side of such levees, and flood conveyance would be maintained as designed. Channel margin enhancements associated with federal project levees may require permission from USACE in accordance with USACE's authority under the Rivers and Harbors Act (33 United States Code [USC] § 408) and levee vegetation policy. Any restoration activities associated with compensatory mitigation would be designed, constructed, and maintained to ensure no reduction in performance of the federal flood project.

The construction and operations of water conveyance facilities would potentially affect tidal perennial aquatic habitat and alter hydrodynamics at Georgiana Slough for migrating Chinook

salmon juveniles and would potentially reduce habitat extent and possibly habitat access for delta smelt spawning. Restoration of tidal wetlands is one approach to mitigate for these impacts. Tidal wetland habitat mitigation would generally be achieved at suitable locations by reconnecting former wetland areas to adjacent tidal sloughs and rivers. Restoration would primarily occur through breaching or setback of levees, thereby restoring tidal fluctuation to land parcels currently isolated behind those levees. Where practicable and appropriate, portions of restoration sites would be raised to elevations that would support tidal marsh vegetation following levee breaching.

Depending on the location of tidal wetland restoration, it may be necessary to construct an entirely new flood control levee along portions of the project perimeter to protect adjacent properties. This new flood control levee could affect WSEs in the adjacent waterbody, although the final design would ensure that resulting WSEs do not increase by more than 0.1 foot relative to existing conditions. Any restoration activities associated with tidal wetlands would be designed, constructed, and maintained to ensure no reduction in channel performance.

Accordingly, compensatory mitigation combined with the project alternatives would not change the overall impact conclusion of less than significant.

Other Mitigation Measures

Other mitigation measures proposed would not have impacts on increased WSEs because a temporary levee would be constructed to provide equivalent or higher level of flood protection to adjacent properties as the existing SPFC levee and allow the intake facilities to be constructed along the Sacramento River while maintaining continuous flood protection. Other mitigation measures would be implemented in accordance with USACE criteria specifically to maintain flood protection and limit the rise of maximum WSEs to within the original design profile. Therefore, mitigation measures are unlikely to cause substantial increase in WSE, and there would be no impact.

Overall, increased WSE impacts for construction of compensatory mitigation and other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant for Alternatives 1, 2b, 2c, 3, 4b, 4c, and 5 and less than significant with mitigation for Alternatives 2a and 4a.

Impact FP-2: 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 That Would Result in Flooding On- or Off-Site or Impede or Redirect Flood Flows

All Project Alternatives

All nine alternatives (i.e., Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) would have similar impact levels and are discussed together. This impact analysis discusses potential impacts on flood protection that could result from the project alternatives when compared to existing conditions. Because the area being evaluated for this impact does not receive protection from the SPFC, the project alternatives and existing conditions are both evaluated under 2020 conditions, similar to the other resource areas in the Final EIR. Appendix 7A presents potential impacts on flood protection that could result from the project alternatives under future conditions.

Project Construction

Construction of the earthen embankments, pumping plants, levees, tunnels, tunnel shafts, forebay, and access roads would require excavation, grading, or stockpiling at project facility sites or at temporary worksites. In addition, site grading needed to construct any of the proposed facilities has the potential to block, reroute, or temporarily detain and impound surface water in existing drainages and velocities.

All project features would be constructed to not increase peak runoff flows into adjacent storm drains, drainage ditches, rivers, or sloughs. At the proposed north Delta intakes, tunnel shafts, Southern Complex, and Bethany Complex, all water from dewatering (i.e., groundwater removal) activities and stormwater runoff would be collected, treated, and stored on-site to reduce the need for off-site water sources (Chapter 3 and Chapter 8, *Groundwater*). On-site reuse and storage would be maximized to reduce peak runoff rate from project construction sites. If additional stored water is not needed, the treated runoff flows would be released in a manner that would not increase peak flow rates in local drainage channels or rivers on-site. Dispersion facilities would be used to reduce the potential for channel erosion due to the discharge of dewatering or stormwater runoff flows. The discharge rates of water collected during construction would be relatively small compared to the capacities of most of the Delta channels where discharges would occur. Permits for the discharges would be obtained from the Regional Water Quality Control Board or the State Water Resources Control Board (State Water Board).

Shallow, localized flooding has historically occurred at the sites of the proposed north Delta intakes due to natural depressions. This flooding could be exacerbated during storm and high-water events and may be due to stormwater runoff, increased groundwater levels, or through-seepage in levee and railroad embankments.

For all intake locations, drainage and irrigation would be rerouted to accommodate the project footprint. Similar to the dewatering activities described above, project facilities would be designed to capture runoff on-site to minimize off-site impacts during construction and operation. The project alternatives include drainage and pump enhancements to ensure intake facilities would not be subject to localized flooding during operation. During construction, the local drainage at intake facility sites would be managed to minimize local flooding through installing temporary pumps if necessary to allow continued construction activities.

These temporary changes in drainage would be minimized, and in some cases avoided, by construction of new or modified drainage facilities, as described in Chapter 3. Drainage studies, as part of the final design, would be prepared for each construction location to assess the need for, and to finalize, other drainage-related design measures, such as a new on-site drainage system or new cross drainage facilities. The project alternatives would include installation of temporary drainage bypass facilities, long-term cross drainage, and replacement of existing drainage facilities that would be disrupted by construction of new facilities. These new facilities would be constructed prior to disconnecting or crossing existing drainage facilities. Locations of stockpiles and other temporary construction features were selected and refined in the design phase to minimize flow impedance under flood flow conditions.

The project alternatives would include permanent facilities within the 100-year flood hazard area; these structures—such as the intake structures and surrounding levees and Southern Complex facilities, tunnel shafts—would be designed to withstand a 200-year flood event with sea level rise and climate change hydrology for 2100 (Delta Conveyance Design and Construction Authority

2022a:66). The levee systems surrounding each Delta island along the central, eastern, and Bethany Reservoir alignments where various shafts and facilities are located provide the first line of defense against flooding during construction. The levee reliability was evaluated in terms of its compliance with PL 84-99 criteria under existing conditions (i.e., year 2020).

The Southern Complex and Bethany Complex would include large construction sites and substantial numbers of personnel and equipment; however, these sites either have adequate levee heights (Southern Complex) or are not located in the potential flood area (Bethany Complex). The two Southern Complex tunnel launch shaft sites near the northern embankment of the Southern Forebay (Southern Forebay Inlet Structure Launch Shaft and Working Shaft) are already protected by levees that substantially meet the PL 84-99 criteria, primarily on the east side of the Southern Complex. The western side of the Southern Complex would be located on higher ground. In the area protected by levees, the time to flood in the event of a catastrophic failure has been conservatively estimated as being very short (Delta Conveyance Design and Construction Authority 2022a:68). However, the chance of levee failure is relatively low, and a sudden, catastrophic structural failure is unlikely at the Southern Complex due to portions of the levee system on mineral soil foundations when compared to Bouldin and Lower Roberts Islands. Because it is an area of reduced risk, further levee improvements on Byron Tract would not be warranted as part of the comprehensive flood risk management strategy for the tunnel construction corridor (Figure 7-1).

Launch shaft sites at Bouldin Island, Lower Roberts Island, and the Twin Cities Complex site would be much larger and involve more personnel and equipment than at maintenance and reception shaft construction sites. Accordingly, DWR would improve existing levees (Bouldin Island or Lower Roberts Island) or build a ring levee (at the Twin Cities Complex site) to protect workers, facilities, and equipment at those locations. These tunnel launch shaft sites would be active worksites for a 7- to 9-year construction period. During construction, all tunnel shaft pads would be constructed to an elevation at, or slightly above, the adjacent levee height, thus providing a high ground refuge above the local 100-year flood elevation. All launch, maintenance, and reception shaft sites would enact nonstructural flood risk management measures (Delta Conveyance Design and Construction Authority 2022d:8-10).

Based on the flood risk evaluation, tunnel shaft sites on Bouldin Island (central alignment) and Lower Roberts Island (eastern and Bethany Reservoir alignments) would be located in a higher risk category due to the combined effects of levee geometric deficiencies and potential inundation time and depth of flooding. Therefore, levee modifications on the inland side of the island levees would be constructed prior to construction of the tunnel shafts. Use of the existing levees with improvement would result in no impacts on existing drainage flows around the islands or within the island. The total size of the construction site and postconstruction site for the Bouldin Island levee modifications would be approximately 251 acres, with an additional 90 acres for temporary levee modification access roads. The total size of the construction site and postconstruction site for the Lower Roberts Island levee modifications would be approximately 30 acres, plus an additional 37 acres for temporary levee modification access roads. To account for ongoing work by levee maintaining agencies, the extent of levee repairs would be reevaluated during the design phase and coordinated with the local levee maintaining agency. Levee modifications at Bouldin Island or Lower Roberts Island would remain in place after project construction, providing a higher level of flood protection to surrounding areas than currently exists.

Given the long duration of work at these launch shaft sites, island perimeter levee improvements to meet PL 84-99 geometric standards, as well as to address any known geotechnical weaknesses, are

1 warranted to limit long-term flood risk. The extent and types of recommended levee repairs would
2 be refined prior to construction and in coordination with the local reclamation districts. The levee
3 improvements would be initiated in the early phases of project construction and may overlap to
4 some extent with the initiation of shaft pad construction at the shaft sites. However, if critical
5 weaknesses were identified in these levee systems, remediation would be completed before shaft
6 sites were constructed. Ongoing and continuous levee maintenance and monitoring would be critical
7 to reducing flood risk at the shaft sites during project construction and would be closely coordinated
8 with the reclamation districts. It is anticipated that levee maintaining agencies would continue
9 making levee improvements to maintain geometric standards after repairs are completed and as sea
10 level rise can be expected to increase in the future.

11 The exception to this flood management approach is the ring levee for the Twin Cities Complex site,
12 which requires a separate evaluation. As described in Chapter 3, the Twin Cities Complex would be
13 located on the eastern portion of Glanville Tract in an upland area vulnerable to overland flow
14 flooding from the Sacramento, Cosumnes, and Mokelumne Rivers as well as Morrison Creek.
15 Historically, Glanville Tract has been subject to flooding along the local levees and surrounding
16 roadways of I-5, SR 99, Twin Cities Road, and Lambert Road. Glanville Tract is not fully protected by
17 perimeter levees as the railroad embankment on the eastern side of Glanville Tract was not
18 designed to perform as a flood control structure but is relied upon by the reclamation district to
19 protect Glanville Tract from backwater flooding upstream of the confluence of the Cosumnes and
20 Mokelumne Rivers. Therefore, a ring levee would be used to protect the Twin Cities Complex in the
21 event of a levee failure on Glanville Tract. It would be configured to minimize impedance of flood
22 flows from nearby streams, including the Cosumnes River, and minimize the inundation effects on
23 the surrounding land during a potential overland flooding event within Glanville Tract. The ring
24 levee and modifications to existing drainage features would convey floodwater around the ring
25 levee to the west side of I-5 and eventually toward Snodgrass Slough. After project construction, the
26 ring levee at Twin Cities Complex would be deconstructed except for a portion adjacent to the
27 reusable tunnel material (RTM) storage area.

28 The flood effects analysis for the Twin Cities Complex site found that the ring levee would increase
29 the 100-year flood depth directly adjacent to the ring levee by a maximum of approximately 0.3 foot
30 for the central and eastern alignments and 0.4 foot for the Bethany Reservoir alignment, when
31 compared to existing conditions with approximate flood depth of 3 feet. The resulting 100-year
32 floodplain would increase by approximately 10 acres for the central and eastern alignments and 15
33 acres for the Bethany Reservoir alignment. However, the flood effect is confined to an open space
34 area north of the Twin Cities Complex site for grazing purposes that are subject to flooding under
35 the existing conditions. The inundation would last about 2.5 days (Delta Conveyance Design and
36 Construction Authority 2022d:Att 3-16, 2022f:Att 4). The flood depth of the narrow space between
37 the ring levee and existing railroad embankment would increase by 3 feet with potential
38 overtopping of the existing railroad embankment, compared to existing conditions; however, the
39 flow volume is fairly low, and the flood depth increase is mainly due to the limited space between
40 Franklin Boulevard and the railroad embankment, and the impacts are localized to this area.
41 Dierssen Road would be overtopped by approximately 3.5 feet under existing conditions and
42 become unusable; the conditions remain the same under project alternatives. Modeling results show
43 that the ring levee would not change flood depth west of I-5, south of the Twin Cities Complex site,
44 or north of Lambert Road.

45 The ring levee would increase the 100-year floodplain by approximately 10 acres for the central and
46 eastern alignments and 15 acres for the Bethany Reservoir alignment, in the open space to north of

the Twin Cities Complex. However, this increase in the 100-year floodplain would affect grazing land that is mostly inundated under existing flood conditions without the project facilities as well. The depth of flow with the project would overtop Dierssen Road by approximately 3.5 feet for all alignments evaluated. However, Dierssen Road would be inundated (to the same depth with or without the project facilities) and unusable under existing flood conditions without the project facilities. After the McCormack-Williamson Tract Project is completed, the hydraulic profile would be reduced approximately 1 to 1.5 feet within the adjacent floodway, which reduces the likelihood of flooding within Glanville Tract. As a result, the overtopping of the existing railroad embankment would not occur.

The launch site associated with Byron Tract near the South Delta Pumping Plant and Southern Forebay Inlet Structure would include two shafts—the Southern Forebay Inlet Structure launch shaft and an intermediate working shaft approximately 1 mile to the north. This site would be protected by levees that substantially meet the PL 84-99 criteria and have levees primarily only on the east side, with high ground on the west side. Although the time to flood in the event of a catastrophic failure has been conservatively estimated as being short, the chance of failure would be relatively low, and a sudden, catastrophic structural failure would be unlikely because portions of the levee system are on mineral soil foundations and substantially higher ground elevations compared to Bouldin Island and Lower Roberts Island. For these reasons, further levee improvements on Byron Tract would not be warranted as part of the comprehensive flood risk management strategy for the tunnel construction.

The DSOD is the state agency with jurisdiction over the design, construction, and safe operation of the planned Southern Forebay for Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c. The Southern Forebay would be designed in accordance with the DSOD requirements for jurisdictional dams based on the anticipated maximum embankment height and storage volume. The embankments and spillway crest elevations would be established based on interior freeboard considerations mandated by DSOD and exterior sea level rise and flood condition data provided by DWR. The embankment, outlet works, emergency spillway, and their appurtenances would be designed to protect the forebay from the 200-year flood event with sea level rise and climate change hydrology for year 2100 (i.e., 10.2 feet of sea level rise at the Golden Gate Bridge) as defined by DWR, including wave run-up and appropriate freeboard for the Southern Forebay to reduce risk of overtopping the embankment from external flooding. Riprap would be placed along the inside embankment slopes, and native grasses would be planted along the outside embankment slopes for erosion protection. Seepage collectors and drainage layers would be installed within the outboard toe of the embankment. Within the Southern Forebay, internal WSEs could be higher than external WSEs; therefore, the embankments would be of adequate height to contain maximum water elevation, wave run-up, and freeboard on the interior side of the embankment (except at the emergency spillway location).

Postconstruction Effects During Operation

Shallow, localized flooding has historically occurred at the sites of the proposed north Delta intakes due to natural depressions. This flooding could be exacerbated during storm and high-water events and may be due to stormwater runoff, increased groundwater levels, or through-seepage in levee and railroad embankments.

1 For all intake locations, drainage and irrigation would be rerouted to accommodate the project
2 footprint. The project alternatives include drainage and pump enhancements to ensure intake
3 facilities would not be subject to flooding during operation.

4 The flood effect analysis for the Twin Cities Complex site found that the stockpile storage areas
5 would increase the 100-year flood depth by approximately 0.1 and 0.15 foot for the eastern and
6 Bethany Reservoir alignments, respectively, when compared to existing conditions with a flood
7 depth of approximately 3 feet; however, the flood effect is confined to an open space area north of
8 the Twin Cities Complex site that is subject to flooding under existing conditions with no effect on
9 residential development and/or critical facilities (Delta Conveyance Design and Construction
10 Authority 2022d:Att 3-16, 2022f).

11 The stockpile storage areas would increase the 100-year floodplain by approximately 4 acres for
12 both the eastern and Bethany Reservoir alignments in the open space to north of the Twin Cities
13 Complex. However, this increase in the 100-year floodplain would affect grazing land that is mostly
14 inundated under existing flood conditions without the project facilities. The permanent stockpile for
15 the central alignment is smaller than that of the eastern alignment and thus would have less of an
16 effect in increasing flood depth adjacent to the facility during flooding. Modeling results show that
17 the stockpile storage areas would not change flood depth west of I-5 or south of the Twin Cities
18 Complex site. With the eventual completion of the McCormack-Williamson Tract Project, the
19 hydraulic profile would be reduced approximately 1 to 1.5 feet within the adjacent floodway, which
20 reduces the likelihood of flooding within Glanville Tract.

21 Permanent RTM stockpiles expected at some tunnel launch shaft sites other than the Twin Cities
22 Complex would extend above the surrounding grades and would be planted with native grasses
23 primarily for erosion control or to create a natural habitat area. Recommended treatments for
24 permanent RTM stockpiles would include spreading topsoil, cross disking, and planting native
25 grasses. As previously mentioned, the surrounding levees of these launch shaft sites would be
26 improved to meet PL 84-99 standards and no additional analysis is required.

27 The Southern Forebay includes an overflow emergency spillway that would be used under the
28 unlikely condition that the forebay water level continued to rise above the design maximum
29 elevation. The emergency spillway would discharge flow from the Southern Forebay into Italian
30 Slough, which flows into Old River. To accommodate this, a portion of the existing Italian Slough
31 levee would be removed. New levees would be constructed to channelize and contain the spillway
32 discharge flows between the outboard toe of the spillway and the existing levee along Italian Slough.
33 The discharge channel and levees would be expected to settle and require maintenance over time.
34 The design of the emergency spillway would accommodate the controlling event where 7,500 cfs
35 inflow continues and the outlet structure was closed (Delta Conveyance Design and Construction
36 Authority 2022c:1). In addition, the capacity of draining the Southern Forebay with the combined
37 capacity of the emergency spillway and the outlet structure meets the DSOD requirements for
38 emergency drawdown for minimizing the risk of catastrophic failure of the Southern Forebay (Delta
39 Conveyance Design and Construction Authority 2022g:10). The discharge into Italian Slough would
40 initially be contained within the slough's existing levees but would, over a short distance, converge
41 with Old River. The connection to Old River and the broader Delta waterways would allow spillway
42 flows to be absorbed during discharge.

43 The potential hydraulic impact of the Southern Forebay Emergency Spillway on the existing levee
44 system of Italian Slough and Old River was evaluated using a 1-D hydraulic model. The change in

WSEs was compared between the different operational scenarios (i.e., spillway releases of 3,000, 4,500, 6,000, and 7,500 cfs) and the baseline (i.e., no spill event). The 7,500-cfs scenario exhibited the largest increases in WSEs when compared to the baseline for both the 100-year flood event and the mean higher high-water event (Delta Conveyance Design and Construction Authority 2022c:Att 2-5). For the 100-year flood event, the 7,500-cfs scenario increased WSEs by 0.44 foot when compared to the baseline, with the affected area extending 2.47 miles upstream and 1.55 miles downstream of the spillway location. For the mean higher high-water event, the 7,500-cfs scenario increased WSEs by 0.67 foot when compared to the baseline, with the affected area extending 2.47 miles upstream and 1.94 miles downstream of the spillway location. Although the spillway was assumed to flow for 12 hours, peak WSEs were achieved in 2 hours or less for the modeled scenarios. In the modeled scenarios, the peak WSE was located upstream of the spillway location due to backwater effects from the additional flow entering Italian Slough from the spillway. None of the scenarios analyzed resulted in overtopping levees of the main Italian Slough channel or Old River due to the releases from the Southern Forebay Emergency Spillway.

CEQA Conclusion—All Project Alternatives

The project alternatives would involve placing structures within 100-year SFHAs that would impede or redirect flood flows. The impact assessment uses a conservative approach assuming the ongoing McCormack-Williamson Tract Project is not implemented. The results show limited increases in flood depth and inundation in areas primarily used for open space/grazing that are subject to flooding under existing conditions. Therefore, the potential impacts from project alternatives would be less than significant because flooding would occur in a limited area, be of relative short duration, and would primarily affect open space/grazing uses. In the event the McCormack-Williamson Tract Project is completed, as discussed in the cumulative conditions (Section 7.3.4, *Cumulative Analysis*), potential impacts would be avoided.

Glanville Tract has historically been subject to flooding, particularly along the local levees and surrounding roadways. The McCormack-Williamson Tract Project, when completed, would reduce the hydraulic profile in the adjacent floodway by approximately 1 to 1.5 feet, which would reduce the likelihood of flooding on Glanville Tract. The conservative flood effect analysis for the Twin Cities Complex site, which is based on the assumption that the McCormack-Williamson Tract Project would not be implemented, found that the ring levee (during construction) and stockpile storage areas (during operations) for all project alternatives would increase the 100-year flood depth of 3 feet under the existing conditions by a maximum of approximately 0.4 foot and would increase the 100-year floodplain by approximately 15 acres in open space for grazing purposes only. The flood effect analysis also found that stockpile storage areas (during operations) for all project alternatives would increase the 100-year flood depth by a maximum of approximately 0.1 foot of 3 feet under the existing conditions and would increase the 100-year floodplain by approximately 4 acres in open space for grazing purposes only. Based on the limited increases in flood depth and inundated areas and the fact that the McCormack-Williamson Tract Project is being implemented, this impact would be less than significant for all project alternatives.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on flood protection from project construction or operations, its implementation could result in impacts on flood protection.

Actions undertaken for compensatory mitigation would restore three freshwater ponds along I-5, wetland, open water, and upland natural communities on Bouldin Island, and tidal wetland and channel margin restoration sites in the North Delta Arc, as described in Appendix 3F. Compensatory mitigation would convert existing agriculture land on Bouldin Island to wetlands, riparian habitat, ponds, and grassland. For the I-5 ponds, it is proposed that the existing grasslands, riparian habitat, wetlands, and ponds would be replaced by improved grassland, wetland, riparian, and open-water habitat. Tidal wetland and channel margin habitat would be restored within the North Delta Arc. The CMP is described in detail in Appendix 3F.

Channel margin enhancements associated with compensatory mitigation actions would likely occur along migration corridors that also provide a certain level of flood protection for adjacent properties. Channel margin restoration would improve channel geometry, similar to what is currently practiced by USACE and other flood management agencies when implementing levee improvements. Channel margin restoration associated with federal project levees would not be implemented on the levee but rather on benches to the waterward side of such levees, and flood conveyance would be maintained as designed. Channel margin enhancements associated with federal project levees may require permission from USACE in accordance with USACE's authority under the Rivers and Harbors Act (33 USC § 408) and levee vegetation policy. Any restoration activities associated with compensatory mitigation would be designed, constructed, and maintained to ensure no reduction in performance of the federal flood project.

The construction and operations of water conveyance facilities would potentially affect tidal perennial aquatic habitat and alter hydrodynamics at Georgiana Slough for migrating Chinook salmon juveniles and would potentially reduce habitat extent and possibly habitat access for delta smelt spawning. Restoration of tidal wetlands is one approach to mitigate these impacts. Tidal wetland habitat mitigation will generally be achieved at suitable locations by reconnecting former wetland areas to adjacent tidal sloughs and rivers. Restoration would primarily occur through breaching or setback of levees, thereby restoring tidal fluctuation to land parcels currently isolated behind those levees. Where practicable and appropriate, portions of restoration sites will be raised to elevations that will support tidal marsh vegetation following levee breaching.

Depending on the location of tidal wetland restoration, it may be necessary to construct an entirely new flood control levee along portions of the project perimeter to protect adjacent properties. This new flood control levee could affect WSEs in the adjacent waterbody, although the final design would have a less-than-substantial increase on WSEs relative to existing conditions. Any restoration activities associated with tidal wetlands would be designed, constructed, and maintained to ensure no reduction in channel performance.

Some of the compensatory mitigation efforts would require developing temporary facilities, such as staging areas, access haul roads, work areas, and borrow sites. These facilities could involve clearing and grubbing, excavation, and other grading activities that entail soil disturbance. Unless measures are implemented to control erosion, these construction activities could result in accelerated water

runoff rates. The hazard and potential impact on receiving waters of accelerated water erosion would be greatest in sloping project features, such as new and modified existing levees, particularly on the waterside.

As with the project alternatives, construction related to the CMP would be required to gain coverage under the State Water Board Stormwater Construction General Permit, compliance with which would ensure that there would be no excessive accelerated erosion or runoff caused by the project. Construction of setback levees, foundations for water control structures, and similar features would be required to be designed and constructed in accordance with resource agency and professional engineering specifications to avoid the effects of subsidence.

Accordingly, compensatory mitigation in combination with the project alternatives would not change the overall impact conclusion, and the specific impact on localized runoff and flood protection from the project alternatives combined with the CMP would be less than significant.

Other Mitigation Measures

Some mitigation measures would involve the use of heavy equipment such as graders, excavators, dozers, and haul trucks that would have the potential to result in altering drainage patterns or increasing surface runoff. The mitigation measures with potential to result in altering drainage patterns are: Mitigation Measures BIO-2c: *Electrical Power Line Support Placement*; AG-3: *Replacement or Relocation of Affected Infrastructure Supporting Agricultural Properties*; AES-1c: *Implement Best Management Practices in Project Landscaping Plan*; CUL-1b: *Prepare and Implement a Built-Environment Treatment Plan in Consultation with Interested Parties*; and AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP Operational Pumping to Net Zero*. Temporary alterations in drainage patterns or surface runoff resulting from mitigation measures would be similar to construction effects of the project alternatives in certain construction areas and would contribute to drainage pattern impacts of the project alternatives. Mitigation measures would result in no increase of peak runoff flows into adjacent storm drains, drainage ditches, or rivers and sloughs. On-site reuse and storage would be maximized to reduce peak runoff rate from mitigation measures. If additional stored water is not needed, the treated runoff flows would be released in a manner that would not increase peak flow rates in local drainage channels or rivers on-site. Dispersion facilities would be used to reduce the potential for channel erosion due to the discharge of dewatering or stormwater runoff flows. The discharge rates of water would be relatively small compared to the capacities of most of the Delta channels where discharges would occur, and in accordance with applicable State Water Board permits. Therefore, other mitigation measures are unlikely to alter drainage patterns or substantially increase surface runoff, and the impact of drainage patterns would not be substantial.

Overall, the impact of altering drainage patterns from construction of compensatory mitigation and other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant.

7.3.4 Cumulative Analysis

The cumulative effects analysis addresses the potential for the project to act in combination with other closely related past, present, and reasonably foreseeable future projects or programs to create a cumulatively significant impact on flood risks. It is anticipated that some changes related to flood flows would take place—even assuming that future projects would be designed to avoid such

impacts to the extent feasible. For this analysis, the plans, policies, and programs listed in Table 7-3 were considered. These plans, policies, and programs were selected from a compilation of past, present, and reasonably foreseeable projects included in Appendix 3C.

Table 7-3. Cumulative Impacts on Flood Protection from Plans, Policies, and Programs

Program/Project	Agency	Status	Description of Program/Project	Impacts on Flood Protection
Delta Dredged Sediment Long-Term Management Strategy/Pinole Shoal Management Study	USACE	Ongoing	Maintenance and improvement of channel function, levee rehabilitation, and ecosystem restoration.	Could alter the existing drainage pattern of sediment reuse sites and directly affect flood protection.
California Water Plan Update 2018	DWR	Updated in 2018, ongoing	Provides a framework for water managers, legislators, and the public to consider options and make decisions regarding California's water future.	Could modify surface water flow patterns and indirectly affect flood protection.
Bay-Delta Water Quality Control Plan Update (Delta Outflows, Sacramento River and Delta Tributary Inflows, Cold Water Habitat and Interior Delta Flows)	State Water Board	Planning phase	Would establish flow objectives for the Sacramento River and its tributaries, Delta eastside tributaries (including the Calaveras, Cosumnes, and Mokelumne Rivers), Delta outflows, and interior Delta flows.	Could modify surface water flow patterns, increase instream flows, increase minimum Delta outflows, and indirectly affect flood protection.
Delta Flood Protection Fund	DWR	Ongoing	Provides funding to levee maintaining agencies for their use to maintain and improve critical levees in the Delta.	Could modify surface water flow patterns or alter the existing drainage pattern and indirectly affect flood protection.
North Delta Flood Control and Ecosystem Restoration Project	DWR	Ongoing	Will improve flood management and provide ecosystem benefits in the North Delta area through actions such as construction of setback levees and configuration of flood bypass areas to create quality habitat for species of concern.	Will reduce flooding and provide contiguous aquatic and floodplain habitat along the downstream portion of the Cosumnes River Preserve.
McCormack-Williamson Tract Flood Control and Ecosystem Restoration Project	DWR	Ongoing	Will implement flood control improvements principally on and around McCormack-Williamson Tract in a manner that benefits aquatic and terrestrial habitats, species, and ecological processes.	Will reduce flooding and improve flood control and management.
Sacramento River Bank Protection Project	USACE	Planning phase	A long-term flood risk management project designed to enhance public safety and help protect property along the Sacramento River and its tributaries.	Could modify surface water flow patterns or alter the existing drainage pattern and indirectly affect flood protection.

Program/Project	Agency	Status	Description of Program/Project	Impacts on Flood Protection
Lookout Slough Tidal Habitat Restoration and Flood Improvement Project	DWR	Planning phase	Designed to be a multi-benefit project to restore approximately 3,100 acres of tidal marsh, increase flood storage and conveyance in the Yolo Bypass, increase levee resilience, and decrease flood risk.	While the project would breach and degrade an SPFC levee (i.e., Shag Slough), which would lead to hydraulic changes during flood events, it would reduce local flood risk and improve local flood control. Therefore, the project would not substantially alter the drainage pattern of the area; this effect would be less than significant.
Incidental Take Permit for Long-Term Operation of the State Water Project in the Sacramento-San Joaquin Delta 2020	CDFW	Ongoing	CDFW issued an ITP to DWR for long-term operations of the SWP.	Potential effects on flood management could be from required conservation actions, and activities in the floodways (e.g., Yolo Bypass), flood control channels, or floodplain would, if necessary, be mitigated to be less than significant when implemented.
2019 National Marine Fisheries Service Biological Opinion on the Long-term Operations of the Central Valley Project and State Water Project	NMFS	Ongoing	On October 21, 2019, NMFS issued a final BiOp finding that continued operations of the CVP/SWP is not likely to jeopardize several listed species, including Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, Southern Distinct Population Segment of North American green sturgeon, and Southern Resident killer whales.	Potential effects on flood management could be from required conservation actions, and activities in the floodways (e.g., Yolo Bypass), flood control channels, or floodplain would, if necessary, be mitigated to be less than significant when implemented.
2019 U.S. Fish and Wildlife Service Biological Opinion on the Long-Term Operations of the Central Valley Project and State Water Project (Delta Smelt)	Reclamation, USFWS, and DWR	Ongoing	On October 21, 2019, USFWS delivered its BiOp to Reclamation on the effects of continued operation of the federal components of CVP and SWP on delta smelt and its designated critical habitat.	Potential effects on flood management could be from required conservation actions, and activities in the floodways (e.g., Yolo Bypass), flood control channels, or floodplain would, if necessary, be mitigated to be less than significant when implemented.
Central Valley Flood Protection Plan	DWR	Ongoing	The plan lays out strategies to prioritize the state's investment in flood management over the next 3 decades, promote multi-benefit projects, and integrate and improve ecosystem functions associated with flood risk reduction projects. The plan is updated every 5 years and is currently undergoing a 2022 update.	Implementation of the plan has improved flood risk management in the Central Valley. Implementation of the recommended plan has reduced the estimated expected annual damage and potential life loss.

1 BiOp = Biological Opinion; CDFW = California Department of Fish and Wildlife; CVP = Central Valley Project;
2 DWR = California Department of Water Resources; EIS = Environmental Impact Statement; ITP = Incidental Take Permit;

1 NMFS = National Marine Fisheries Service; SWP = State Water Project; USACE = U.S. Army Corps of Engineers;
2 USFWS = U.S. Fish and Wildlife Service.

3 **7.3.4.1 Cumulative Impacts of the No Project Alternative**

4 The No Project Alternative in combination with other cumulative projects is expected to
5 cumulatively affect flood protection. Ongoing and reasonably foreseeable future projects may affect
6 flood protection; however, several of the projects considered in the cumulative impact analysis are
7 being developed in accordance with project objectives to improve flood control and management
8 (e.g., Sacramento River Bank Protection Project, McCormack-Williamson Tract Project, and Lookout
9 Slough Tidal Habitat Restoration and Flood Improvement Project). Nevertheless, a shift in
10 hydrologic patterns and sea level rise as a result of climate change would decrease flood protection
11 and increase flood risk.

12 **7.3.4.2 Cumulative Impacts of the Project Alternatives**

13 Construction of the project alternatives could result in alterations to channel conveyance capacity,
14 drainage patterns, the rate or amount of surface runoff, or the placement of structures within an
15 SFHA. However, construction of temporary and permanent levees would provide an equivalent (or
16 higher) level of flood protection for the areas where construction is occurring, and increased WSEs
17 related to constricted conveyance capacity of the Sacramento River would be similar to existing
18 conditions. All project structures placed within a 100-year SFHA would be designed to not impede
19 or redirect flood flows. Most of the effects associated with these impact mechanisms are restricted
20 to the specific impact sites and therefore would not act in combination with other projects.

21 While most of the projects considered in the cumulative impact analysis would not affect flood
22 control and management in the study area, several of the projects are being developed in accordance
23 with their specific project objectives to improve flood control and management (e.g., Sacramento
24 River Bank Protection Project, McCormack-Williamson Tract Project, and Lookout Slough Tidal
25 Habitat Restoration and Flood Improvement Project). The effects of other cumulative impact
26 projects on flood protection are not known at this time. The changes due to the project alternatives
27 would remain small, beneficial, or localized and therefore would not be cumulatively considerable
28 relative to past, present, and reasonably foreseeable future projects.

Chapter 10

Geology and Seismicity

This chapter describes the environmental setting and study area for geology and seismicity; analyzes impacts that could result from construction, operation, and maintenance of the project; and provides mitigation measures to reduce the effects of potentially significant impacts. This chapter also analyzes the impacts that could result from implementation of compensatory mitigation required for the project and describes any additional mitigation necessary to reduce those impacts and analyzes the impacts that could result from other mitigation measures associated with other resource chapters in this Final Environmental Impact Report (EIR).

10.0 Summary Comparison of Alternatives

Table 10-0 provides a summary comparison of important impacts on geology and seismicity by alternative. The table presents the CEQA findings after all mitigation is applied. If applicable, the table also presents quantitative results after all mitigation is applied. Important potential impacts that were considered include any differences in the potential for surface fault rupture, level of earthquake shaking, liquefaction susceptibility, ground failure, tunnel flotation, and likelihood for a seiche to occur for a given alternative. Only Alternative 5 would not be subject to a potential earthquake-induced seiche. The potential hazard of a seiche for Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c would be addressed through detailed design, such that there would be a less-than-significant impact for all alternatives with respect to a seiche.

Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c vary from Alternative 5 with respect to the location of a given impact mechanism, but all the alternatives have similar impact mechanisms and magnitudes in common and therefore have the same impact conclusions.

Table ES-2 in the Executive Summary provides a summary of all impacts disclosed in this chapter.

1 **Table 10-0. Comparison of Impacts on Geology and Seismicity by Alternative**

Chapter 10 – Geology and Seismicity	Alternative								
	1	2a	2b	2c	3	4a	4b	4c	5
Impact GEO-1: Loss of Property, Personal Injury, or Death from Structural Failure Resulting from Rupture of a Known Earthquake Fault or Based on Other Substantial Evidence of a Known Fault	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS
Impact GEO-2: Loss of Property, Personal Injury, or Death from Strong Earthquake-Induced Ground Shaking	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS
Impact GEO-3: Loss of Property, Personal Injury, or Death from Earthquake-Induced Ground Failure, including Liquefaction and Related Ground Effects	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS
Impact GEO-4: Loss of Property, Personal Injury, or Death from Ground Settlement, Slope Instability, or Other Ground Failure	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS
Impact GEO-5: Loss of Property, Personal Injury, or Death from Structural Failure Resulting from Project-Related Ground Motions	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS
Impact GEO-6: Loss of Property, Personal Injury, or Death from Seiche or Tsunami	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS

2 LTS = less than significant.

10.1 Environmental Setting

This section describes the environmental setting for the geology and seismicity study area. For the purposes of this chapter, the geology and seismicity study area refers to all areas that could involve excavation, filling, stockpiling, constructing, or otherwise disturbing the ground to design and construct the conveyance facilities and appurtenant features, such as tunnels, forebay, tunnel access shafts, levees, new and improved existing roads, power lines, reusable tunnel material (RTM) disposal and storage areas, and laydown/staging areas for all alternatives combined. The geology and seismicity study area also includes a 0.5-mile buffer beyond the footprints of these areas, with the exception of power transmission lines, metering areas, and park and ride sites, which have a 1/8-mile buffer. Additionally, the analysis also considers seismic sources located outside the study area that could cause seismic shaking within the study area.

This section describes the existing geologic and seismotectonic conditions and the associated potential geologic, seismic, and geotechnical hazards in the Sacramento–San Joaquin Delta (Delta) area (Figure 1-1 in Chapter 1, *Introduction*). The information presented is based on existing information from published and unpublished sources. Specifically, the regional and site information was compiled from maps and reports published by various agencies, researchers, and consultants, including the California Department of Water Resources (DWR), U.S. Army Corps of Engineers (USACE), U.S. Geological Survey (USGS), and California Geological Survey (CGS, formerly California Division of Mines and Geology).

This section describes the environmental setting for the following areas, each of which has the potential to be affected by activities under the project alternatives.

- Geologic setting focuses on the subsurface soils and the underlying bedrock units, including existing natural and man-made levees and channel deposits. Near-surface soils are fully discussed in Chapter 11, *Soils*, which describes surface erosion, subsidence processes, and other soil hazards. Mineral resources that could be affected by construction and operation of the project alternatives are fully discussed in Chapter 27, *Mineral Resources*.
- Seismotectonic setting describes seismic sources, historical seismic events, and the ground shaking potential during earthquakes.
- Geologic and seismic hazards, including ground shaking, fault displacement and fault rupture, seismic-induced liquefaction, and slope instability and ground failure, are identified. Potential levee instability and breaches related to geologic processes that could result in flooding are also described.

The setting information for geology and seismicity, except where otherwise noted, is derived from the project's *Volume 1: Delta Conveyance Final Draft Engineering Project Report—Central and Eastern Options* (C-E EPR) and the *Volume 1: Delta Conveyance Final Draft Engineering Project Report—Bethany Reservoir Alternative* (Bethany EPR), both prepared by the Delta Conveyance Design and Construction Authority (DCA) (Delta Conveyance Design and Construction Authority 2022a, 2022b) at the direction of DWR.

10.1.1 Study Area

The study area exists in California's Central Valley, which is approximately 465 miles long and 40–60 miles wide. The valley is bounded by the Sierra Nevada on the east and the Coast Ranges on the west (Figure 10-1).

Paleogeographic reconstructions of this region indicate that Miocene (Figure 10-2) sedimentation was similar to a modern forearc basin (a sea floor depression between a subduction zone and an associated volcanic arc), shedding arkosic (granular quartz and feldspar or mica) and volcanoclastic sediment westward from the continent.

In the mid-Pliocene epoch, a shift in plate tectonic movement triggered uplift of the Coast Ranges, which gradually closed the southern marine outlet to the basin. By the late Pliocene, subaerial conditions prevailed throughout the valley, resulting from marine regression (i.e., where shoreline shifts oceanward, exposing formerly submerged areas) and sedimentation from the west. During the Pleistocene epoch, the valley separated from the Pacific Ocean and developed internal drainage, the modern outlet being the Carquinez Strait, through which the Sacramento River flows to the San Francisco Bay (Lettis and Unruh 1991:164–176).

The historical Delta formed approximately 5,000 years ago at the inland margin of the San Francisco Bay Estuary as two overlapping geomorphic units: the Sacramento River Delta and the San Joaquin River Delta. The Sacramento River Delta comprises about 30% of the total Delta area and was influenced by the interaction of rising sea level and river floods that created channels, natural levees, and marsh plains. During large river flood events, silt and sand were deposited adjacent to the river channel, forming natural levees above the marsh plain. In contrast, the larger San Joaquin River Delta, located in the central and southern portions of the Delta and having relatively small flood flows and low sediment supply, formed as an extensive, natural levee-free freshwater tidal marsh dominated by tidal flows and peat and muck accretion (Deverel and Leighton 2010:18; California Department of Water Resources 2007a:3). Because the San Joaquin River Delta had less well-defined levees, sediments were deposited more uniformly across the floodplain during high water, creating an extensive tule marsh with many small, branching tributary channels. As a result of the different amounts of inorganic sediment supply, the peat and muck of the San Joaquin River Delta grade northward into peaty mud and then into mud as they approach the natural levees and flood basins of the Sacramento River Delta (Whipple et al. 2012:81; Atwater and Belknap 1980:5).



Figure 10-1. Geomorphic Provinces of California

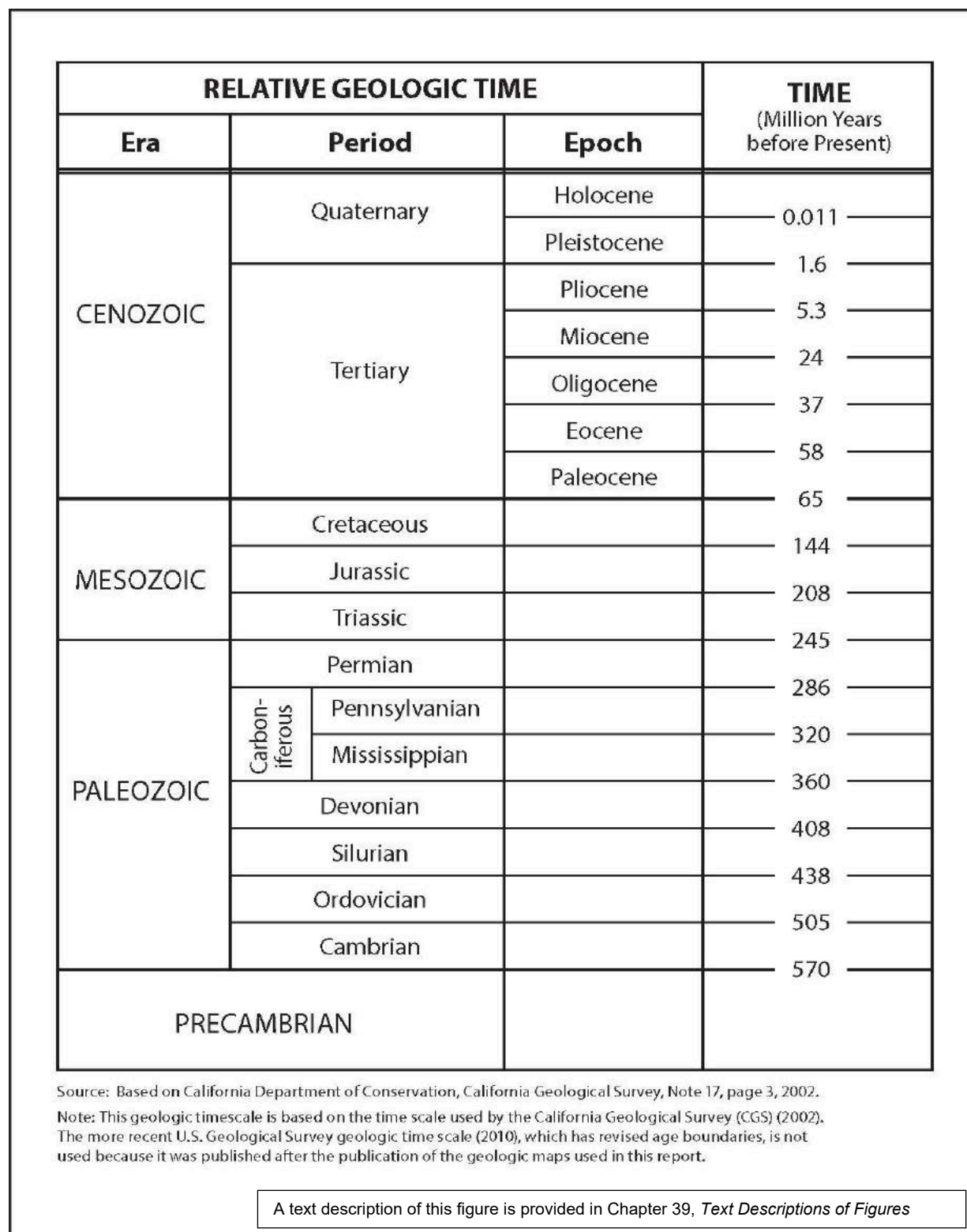


Figure 10-2. Geologic Time Scale

10.1.1.1 Regional Geology

The Great Valley is a northwest-trending structural basin separating the primarily granitic rock of the Sierra Nevada from the primarily Franciscan Formation (an assemblage of sandstone, shale, and conglomerate) rock of the Coast Ranges. The basin is filled with an approximately 3- to 6-mile-thick layer of sedimentary deposits deposited by streams originating in the Sierra Nevada, Coast Ranges, and South Cascade Range, and flowing to the San Francisco Bay.

The Delta received thick accumulations of sediment from the Sierra Nevada to the east and the Coast Ranges to the west after the Cretaceous and most of the Tertiary Period. The Delta has experienced several cycles of deposition, nondeposition, and erosion that has resulted in the accumulation of thick, poorly consolidated to unconsolidated sediment overlying the Cretaceous and Tertiary formations since late Quaternary Period. Shlemon and Begg (1975:265) believe that the peat and muck in the Delta began to form about 11,000 years ago at the start of the current phase of sea level rise, which started at the beginning of the Holocene epoch (Whipple et al. 2012:8). This rise created tule marshes that covered most of the Delta. These organic soils formed from the accumulated detritus of the tules and other marsh vegetation.

10.1.1.2 Local Geology

A geologic map of the study area is provided in Figure 10-3. It was necessary to use different sources to compile the geologic map and descriptions of the geologic map units (Tables 10-1 through 10-6) presented in this report. The map is primarily based on relatively detailed mapping derived from Atwater (1982) and covers most of the study area. The Atwater mapping, therefore, was the primary map used to compile Figure 10-3 since it provides the greatest detail and covers most of the study area. Geologic mapping of the southwestern edge of the study area not covered by Atwater is from the regional geologic map by Wagner et al. (1991:Sheet 1). Except where noted, the text descriptions of the geologic units provided in Tables 10-1 through 10-6 are from Atwater (1982). Where applicable, the geologic unit descriptions by Graymer et al. (2002:4–13) have been added to further round out and update the information provided in Tables 10-1 through 10-6. The work by Graymer et al. covers only a portion of the study area and contains much information already provided in Atwater (1982), but it does represent some of the more recent work done in the area. In general, the surficial geologic units of the study area include organic soils, alluvium, eolian deposits (i.e., dune sand), sedimentary bedrock, and hydraulic-dredge spoils, all of which are described in the sections below. The descriptions of the geologic units are organized by depositional environment and are generally described from youngest to oldest. As described in the Liquefaction and Ground Improvement Analysis (Final Draft) Technical Memorandum (Delta Conveyance Design and Construction Authority 2022c:2), the logs of 147 historical cone penetration test (CPT) soundings and soil borings¹ advanced by DWR provide information on soil and bedrock characteristics extending to depths much greater than that depicted in the mapping by Atwater (1982), Graymer et al. (2002), and Wagner et al. (1991). The borehole logs provide a detailed depiction of the soil and bedrock composition at depth, with alternating layers of sediments and bedrock of various composition. In the boring logs, peat soils are shown to occur to a maximum depth of approximately 15 feet below the ground surface, and organic mineral soils (e.g., organic silt) are shown to occur to a maximum depth of approximately 30 feet below the ground surface. Both the peat and organic mineral soil types are well above what would be the main tunnel invert elevation (i.e., -143 feet to -

¹ Of the 147 CPT soundings and soil borings, 24 were used as a partial basis for preparation of the Liquefaction and Ground Improvement Analysis Technical Memorandum.

163 feet North American Vertical Datum of 1988 [NAVD88] for the tunnel from the intakes to the proposed new Southern Forebay Inlet Structure and -145 feet to -164 feet National Geodetic Vertical Datum [NGVD] for the tunnel between Twin Cities Complex and the Bethany Complex).

Hydraulic-Dredge Spoils (post-1900)

The hydraulic-dredge spoil deposits are the result of human activity, as described in Table 10-1 (Atwater 1982:9).

Table 10-1. Hydraulic-Dredge Spoils

Map Unit Symbol	Map Unit Name	Age	Description
Qds	Hydraulic-dredge spoils	Post-1900	Sand deposits that are locally laminated and contain minor amounts of silt, clay, and peat, which formed as a result of human activity. Deposited during work to widen, deepen, or straighten the Sacramento and San Joaquin Rivers.

Source: Atwater 1982:9.

Organic Soils

The tule marshes created by sea level rise covered most of the Delta and led to the formation of peat and muck, which are both forms of organic soils.² Prior to reclamation, the peat was as thick as 65 feet in the western Delta (Whipple et al. 2012:9). Organic and high organic matter mineral soils and sediments were labeled on geologic maps as peaty muds and were mapped by USGS (Graymer et al. 2002:5) as Holocene Delta mud deposits, as described in Table 10-2. Atwater (1982:9) mapped the Delta mud deposits as Peat and Mud of Delta Wetlands and Waterways (map symbol Qpm) (Figure 10-3).

Table 10-2. Peat and Mud of Tidal Wetlands and Waterways

Map Unit Symbol	Map Unit Name	Age	Description
Qpm	Peat and mud of tidal wetlands and waterways	Holocene	Form soft, usually carbonaceous deposits that have a low bulk density. The unit was deposited as a result of sea level rise. According to Graymer et al. (2002:5), this mud and peat deposit has minor silt and sand deposited at or near sea level in the Delta. Much of the area underlain by this unit is now dry because of construction of dikes and levees and below sea level due to compaction and deflation of the now unsaturated Delta sediment.

Sources: Atwater 1982:9; Graymer et al. 2002.

² See Chapter 11, Section 11.1.1.1, *NRCS Soil Associations*, and Figures 11-1 and 11-8 for a more detailed description of the organic soils in the study area.

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Alluvium

Alluvium is sediment deposited by a river or other running water and typically is composed of a variety of materials, including fine particles of silt and clay and larger particles of sand and gravel. A river continually lifts and drops solid particles of rock and soil from its bed throughout its length. Where river flow is fast, more particles are suspended than are dropped out. Where the river flow is slow, more particles are dropped out than are suspended. Areas where more particles are dropped out develop into features called alluvial *plains* or *floodplains*, and the dropped particles are called *alluvium*. Even small streams make alluvial deposits, but it is in the floodplains and deltas of large rivers where large, geologically substantial alluvial deposits are found.

The ability of a river to carry (suspend) sediment varies greatly with its flow volume and velocity. When a river floods over its banks, the water spreads out, loses its velocity, and deposits its load of suspended sediment. Based on density variations, fine-grained sediments are deposited further from the channel, whereas coarser sediments are deposited nearer the channel. Over time, the river's banks are built up above the level of the rest of the floodplain. The resulting low ridges near the banks are called natural levees. Artificial, or human-made, levees are built to prevent flooding of lands along the river; these confine flow, resulting in higher and faster water flow than would occur naturally. Artificial levees impact sedimentation in the modern Delta (Moore and Shlemon 2010:105).

The deposits in the Alluvium of Supratidal Floodplains mapped by Atwater (1982:8) formed in the portion of the tidal flat that lies above the mean high water level. The deposits include Holocene deposits of natural levees, flood basins, and channels of the Sacramento and San Joaquin Rivers, both active and abandoned. They are made up mainly of silty clay, micaceous silt, and micaceous sand and have a low organic matter content (Table 10-3).

Similar to the Alluvium of Supratidal Floodplains, the alluvium mapped by Wagner et al. (1991:Sheet 1) in the southern portion of the study area outside the area mapped by Atwater (1982), is made up of unconsolidated stream and basin deposits of Holocene age. In the study area, these occur in the drainages on the eastern edge of the Coast Ranges.

Table 10-3. Alluvium

Map Unit Symbol	Map Unit Name	Age	Description
Qfp	Alluvial flood plain deposits undivided	Holocene	A unit in Atwater's (1982:8) Alluvium of Supratidal Floodplains. A floodplain of the San Joaquin River that was historically covered with tidal-wetland peat, but has now been uncovered. Includes small bodies of peaty mud and abandoned channels with clay loam. Also includes local areas of overbank alluvium, which is likely of historic age.
Ql	Natural levee deposits	Holocene	A unit in Atwater's (1982:8) Alluvium of Supratidal Floodplains. Dark grayish brown to yellowish brown sand, silt, and silty clay. Occurs on broad natural levees and crevasse splays of the Sacramento River and in the immediate vicinity of historic and prehistoric nontidal channels. Probably formed the interface between rapidly flowing water and very slow moving water. Overlies peat and peaty mud in some localities and likely predates hydraulic mining. (Atwater 1982:8)

Map Unit Symbol	Map Unit Name	Age	Description
Qb	Flood basin deposits	Holocene	A unit in Atwater's (1982:8) Alluvium of Supratidal Floodplains. Firm to stiff silty clay, clayey silt, and silt, which often contain nodules of calcium carbonate and sometimes spherules of manganese and irons. This unit grades laterally into the peaty muds. (Atwater 1982:8)
Q	Alluvium	Holocene	Unconsolidated stream and basin deposits. (Wagner et al. 1991:Sheet 1)

Sources: Atwater 1982:8; Wagner et al. 1991:Sheet 1.

Alluvial Fans

The deposits that make up the Alluvial Fans and Terraces from Unglaciaded Drainage Basins units mapped by Atwater (1982:4) consist of clayey silt, silt, sandy silt, as well as some sand and gravel. Atwater defined these units based on watershed of origin and relative age (Table 10-4) (Atwater 1982:4). These units were deposited where streams emerged from upland areas and flowed onto more gently sloping valley floors or plains. They are mostly undissected by later erosion and in places may form only a thin veneer over Pleistocene and older deposits (Graymer et al. 2002:4).

In the southern portion of the study area west of the area mapped by Atwater, the alluvial fan deposits mapped by Wagner et al. (1991:Sheet 1) are made up of gravel, sand, silt, and clay of Holocene age. This unit is assumed to correlate with the Alluvium of Corral Hollow to Brushy Creek described by Atwater (1982:5) because of their colocation and descriptions. Although Wagner et al. (1991:Sheet 1) indicates the unit is Holocene in age, the more detailed mapping by Atwater indicates the unit may extend into the upper Pleistocene.

Table 10-4. Alluvial Fans and Terraces from Unglaciaded Drainage Basins

Map Unit Symbol	Map Unit Name	Age	Description
Qymc	Younger Alluvium of Marsh Creek	Holocene – Upper Pleistocene	Forms alluvial fans in the southwestern portion of the study area. Consists of 5 to 15 feet of overbank silt that overlies channel sand and gravel. It locally contains shells of freshwater gastropods (the class of mollusks that contains snails, slugs, and whelks). The unit overlies and grades into the eolian deposits of the Modesto Formation (Atwater 1982:5).
Qch	Alluvium – Corral Hollow to Brushy Creek	Holocene – Upper Pleistocene	Alluvium deposited by the Corral Hollow drainage, Mountain House Creek, and Brushy Creek (Atwater 1982:5).
Qf	Alluvial fan deposits	Holocene	Alluvial gravel, sand, silt, and clay in the southwestern portion of the study area (Wagner et al. 1991:Sheet 1).
Qcr	Alluvium of Calaveras River	Holocene – Upper Pleistocene	Alluvium deposited by the Calaveras River, Bear Creek, and several other streams between the Mokelumne and Stanislaus Rivers (Atwater 1982:5).

Sources: Atwater 1982:5; Wagner et al. 1991:Sheet 1.

Eolian Deposits

Atwater used Eolian Deposits to classify windblown dune deposits of uncertain relative age. These units are largely related to the Modesto Formation. Holocene sand may discontinuously overlie the latest Pleistocene sand, both of which may form a mantle of varying thicknesses over older materials. Most of the deposits are thought to be associated with the latest Pleistocene to early Holocene periods of low sea level, during which large volumes of fluvial (i.e., pertaining to a river or stream) and glacially derived sediment from the Sierra Nevada were blown into dunes. Dune sand deposits are described in Table 10-5. (Atwater 1982:7, 8)

Table 10-5. Eolian Deposits

Map Unit Symbol	Map Unit Name	Age	Description
Qm2e	Eolian Deposits of Upper Modesto Formation	Upper Pleistocene	Forms a large dune field that fans out to the east and south of Antioch. A smaller field is also located between Hood and Walnut Grove and in isolated hills in the central Delta. In the southern part of the study area, it is widely overlain by the Marsh Creek alluvium and tidal-waterway deposits. According to Graymer et al. (2002:5), the dunes display as much as 100 feet of erosional relief and are being buried by basin deposits and delta mud.
Qoe?	Older Eolian Deposits	Upper Pleistocene?	This unit serves as a catchall for other Pleistocene windblown deposits.

Sources: Atwater 1982:7,8; Graymer et al. 2002:5.

Note: Question marks (?) are in the original source literature and denote uncertainty by the author of the literature in the determination of the age of the geologic unit.

Alluvial Fans from Glaciated Basins

The deposits that make up the Alluvial Fans from Glaciated Basins units are silt, sand, and minor gravel deposited by major rivers of the Sierra Nevada. These deposits record major episodes of glaciation during the Pleistocene in the Sierra Nevada (Atwater 1982:5) (Table 10-6).

This older alluvium consists of the Pleistocene-aged Modesto and Riverbank Formations that were deposited during separate episodes of glacially derived sediment from the glaciated core of the Sierra Nevada (Lettis and Unruh 1991:174; Cherven and Graham 1983:33).

Lithologically, the two units are nearly identical arkosic fine-grained alluvium from the Sierra Nevada. However, the upper Modesto frequently has finer-grained silt and sand with a notable eolian component at the surface, capped by a weakly developed soil. The Riverbank consists of coarser gravel and sand capped by a very well-developed soil profile, containing a subsurface cemented hardpan (i.e., duripan). The timing of their deposition remains uncertain, but the Riverbank is probably Illinoian (roughly 300,000–130,000 years before present [B.P.]), while the Modesto is probably Late Wisconsin to early Holocene (roughly 21,000 to 10,000 years B.P.).

The Pleistocene Mokelumne River channels that deposited older alluvium show little relation to the present stream. The modern river channels meander in its floodplain and carry fine-grained sediment, whereas the Pleistocene rivers cut deep, canyon-like channels into underlying, older fan deposits. These ancient rivers had greater hydraulic force and carried glacially derived boulders and cobbles much farther downstream than the present river (Shlemon 1971:431).

Table 10-6. Alluvial Fans from Glaciated Basins

Map Unit Symbol	Map Unit Name	Age	Description
Qm	Modesto Formation	Pleistocene	Alluvial fans formed by deposition of the Mokelumne and Stanislaus Rivers. It overlies the Riverbank Formation and is overlain by tidal-wetland deposits. It generally ranges in thickness from 10 to 15 feet. The unit is made up of both fluvial (river lain) deposits and eolian (windblown) deposits.
Qr	Riverbank Formation undivided	Upper Pleistocene	Forms low rises that are surrounded by Holocene alluvium. The Holocene alluvium also forms a veneer over the unit.
Qry	Riverbank Formation–younger	Upper Pleistocene	The unit can be divided into an older unit and a younger unit in many places east of the Delta. The younger unit forms a slightly to moderately dissected surface and has a slightly lower surface than the older unit. It was deposited primarily by the Cosumnes and Mokelumne Rivers.
Qro	Riverbank Formation–older	Upper Pleistocene	The older unit forms moderately dissected surfaces. It was possibly deposited in large part by the American River.

Source: Atwater 1982:6.

Older Units at Southwestern Edge of Study Area

Several Tertiary and Cretaceous units occur in the foothills along the southwestern edge of the study area outside the area mapped by Atwater (1982). The older units occur where the valley floor transitions to the foothills.

The Tehama Formation is a poorly consolidated nonmarine sandstone, tuff, and conglomerate of Pliocene age. The unit also includes volcanoclastic rocks (Wagner et al. 1991:Sheet 1; Graymer et al. 2002:10). In the study area, it occurs as a narrow band along the western edge of the valley. The unit is derived from Coast Ranges and overlies Cretaceous rocks of the Great Valley Sequence (Helley and Harwood 1985:15–16).

The Miocene fanglomerate is a conglomerate, sandstone, and siltstone, which includes the Oro Loma and Carbona Formations. The unit occurs in a wide band along the base of the foothills in the southwestern portion of the study area (Wagner et al. 1991:Sheet 1). The Oro Loma Formation probably formed as a complex of alluvial fans along the central Diablo Range. These fans formed from material eroded from the Franciscan Formation. Similarly, the Carbona Formation was likely derived from the Franciscan Formation and also the Great Valley Sequence (Lettis 1982:29–39).

The San Pablo Group is a marine sandstone of similar age as the fanglomerate and found in association with that unit. The San Pablo Group is made up of sandstone, mudstone, siltstone, and shale with minor tuff that occurs in the low foothills in the southwestern portion of the study area. The group includes the Neroly Sandstone, Cierbo Sandstone, and Briones Sandstone (Wagner et al. 1991:Sheet 1).

The Markley Sandstone is a marine unit of Eocene age that is present in the low foothills on the western edge of the study area (Wagner et al. 1991:Sheet 1). It is a white to light-gray quartz-mica sandstone characterized by plates of white mica and carbonized plant debris.

The Moreno and Panoche Formations are both marine units of Cretaceous age on the westernmost edge of the study area in the low foothills. The Moreno Formation is an organic shale, siltstone, and sandstone, and the Panoche Formation is a sandstone and shale with siltstone and conglomerate lenses (Wagner et al. 1991:Sheet 1).

10.1.1.3 Regional and Local Seismicity

The California Coast Ranges physiographic province lies along the complex boundary between two tectonic plates: the North American Plate and the Pacific Plate. The geologic and tectonic conditions in the Delta and Suisun Marsh have been, and continue to be, controlled primarily by the interaction of these two massive blocks of the Earth's crust. Under the current tectonic regime, the Pacific Plate moves northwestward relative to the North American Plate at a rate of about 2.0 inches per year (U.S. Geological Survey 2015:1). Although relative motion between these two plates is predominantly lateral (strike-slip), an increase in convergent motion along the plate boundary within the past few million years has resulted in the formation of mountain ranges and structural valleys of the Coast Ranges province (DeCourten 2008:19).

The Delta is in the eastern portion of the greater San Francisco Bay Area, one of the most seismically active areas in the United States. This eastern portion of the greater Bay region is near several major active fault systems, including the San Andreas, Hayward-Rodgers Creek, Calaveras, Concord-Green Valley, and Greenville Faults. Many named and unnamed regional faults also exist in the vicinity (U.S. Geological Survey 2021) (Figure 10-4). The U.S. Geological Survey estimated that there is a 72% probability of at least one earthquake of magnitude 6.7 or greater occurring in the San Francisco Bay region before 2043 (U.S. Geological Survey 2016:1). The majority of the seismic sources underlying the Delta are blind thrusts that are not expected to rupture at the ground surface during an earthquake. The known blind thrusts in the Delta and immediate vicinity include the Midland, Thornton Arch, West Tracy,³ and Vernalis Faults. Blind thrust faults with a discernible geomorphic expression/trace at the surface near the southwestern boundary of the Delta are the Black Butte and Midway Faults (U.S. Geological Survey 2021). The Delta is vulnerable to seismic events as a result of these San Francisco Bay Area and western Delta faults.

Seismologists believe it is likely that the Delta will experience periodic moderate to large earthquakes (magnitude 6.5 or greater) in the next 50 years. A magnitude 6.5 or greater earthquake on the major seismic sources in the San Francisco Bay Area would affect the Delta with minor-to-moderate ground shaking and could potentially induce damage in these areas. A magnitude 6.25 to 6.75 earthquake on the West Tracy Fault (Lettis Consultants International, Inc. 2021:3) would produce strong shaking in the Delta. Ground shaking is typically expressed in terms of peak ground acceleration (PGA) (i.e., the maximum acceleration by a soil particle at the ground surface during an earthquake).

As discussed in the following sections, the known active seismic sources located within the Delta area are mostly blind thrust faults (described above).

Figure 10-5 provides a general overview of the relative intensity of ground motions for 1-second spectral acceleration (expressed as a fraction of gravity [g]) from future earthquakes with a 2%

³ Ongoing and planned fault investigations for West Tracy Fault may identify surface or near-surface expressions of the fault.

1 exceedance probability in 50 years for the study area and vicinity.⁴ The map incorporates
2 anticipated amplification of ground motions by local soil conditions (California Geological Survey
3 2016:1).

4 **Past Earthquake Ground Motion Intensity and Damage**

5 The San Francisco Bay Area has been subjected to damaging ground shaking during past
6 earthquakes. Table 10-7 lists the largest earthquakes that have affected the greater San Francisco
7 Bay Area since 1700 and the damage caused by these earthquakes (California Department of
8 Conservation 2021).

9 As Figure 10-4 shows, several earthquakes with magnitude 5.0 or greater have occurred in the
10 immediate San Francisco Bay Area since 1800, including the 1868 magnitude 6.8 earthquake on the
11 Hayward Fault, the 1906 magnitude 7.9 San Francisco earthquake on the San Andreas Fault, and the
12 more recent 1989 moment magnitude 6.9 Loma Prieta earthquake and moment magnitude 6.0
13 South Napa earthquake that occurred in the Santa Cruz Mountains and southern Napa County,
14 respectively. Magnitude 5.5 and 5.8 earthquakes on January 24, 1980, and January 26, 1980,
15 respectively, were recorded near Livermore. These earthquakes were attributed to the Greenville
16 Fault and the ground shaking may have caused levee slope rotational failures on Bacon Island and
17 Empire Tract, although high water conditions were present at the time (California Department of
18 Water Resources 1992:5-22–5-24). Since 1800, no earthquake with a magnitude greater than 5.0
19 has been recorded in the Delta, as shown in Figure 10-4.

⁴ Figure 10-5 is intended to provide the reader with a broad overview of variations in the earthquake shaking hazard across the study area.

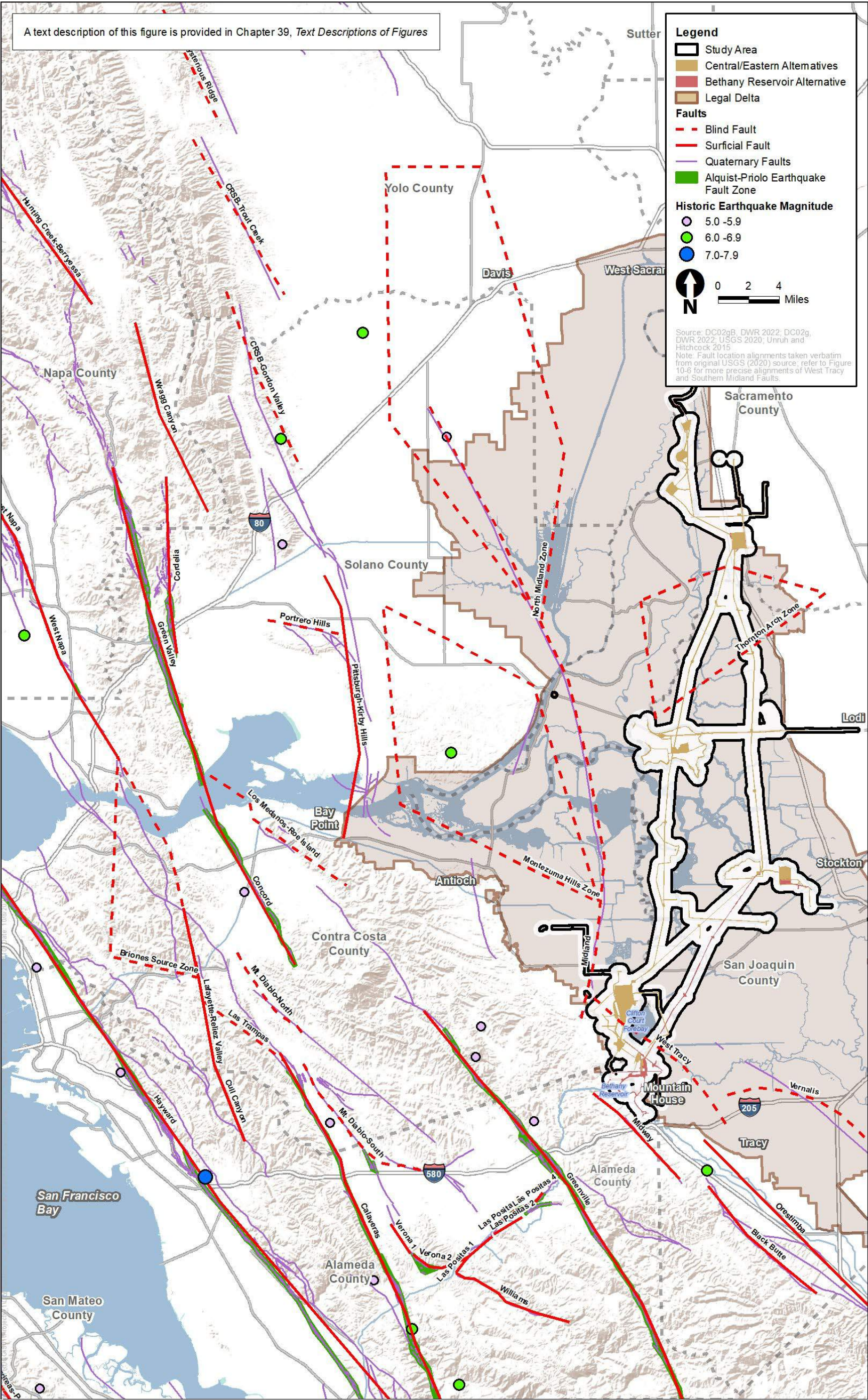
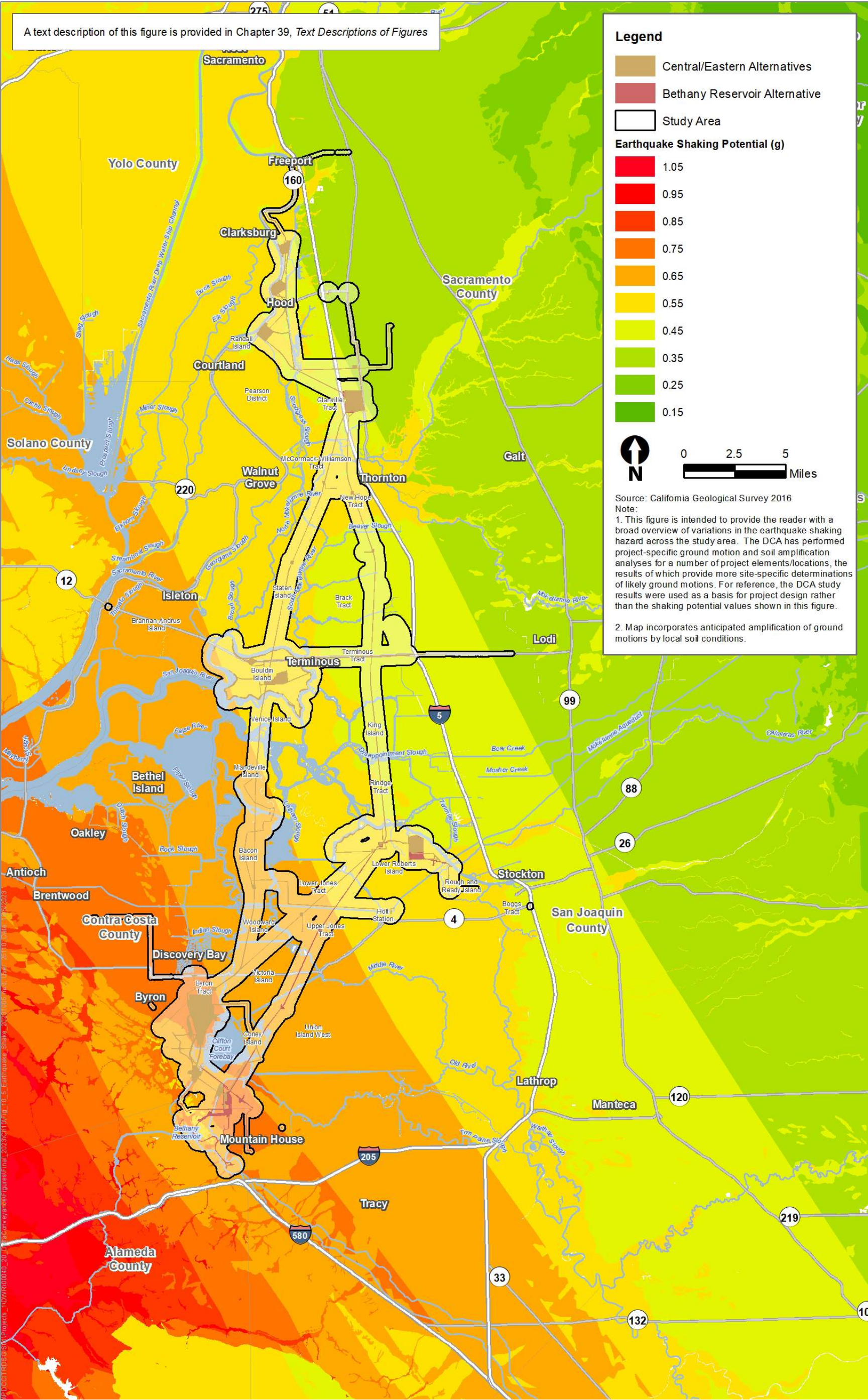


Figure 10-4. Active Faults and Historical Seismicity of the Bay and Delta Region, 1800–2021



1

2 **Figure 10-5. Overview of Earthquake Shaking Potential based on California Geological Survey Data**

Table 10-7. Largest Earthquakes Having Affected the Greater San Francisco Bay Area

Date	Magnitude	Name, Location, or Region Affected	Epicenter Latitude	Epicenter Longitude	Loss of Life and Property
2014, August 24	6.0	South Napa	38.22	-122.31	2 dead; total economic losses estimated at \$443 million to \$800 million
1989, October 17	6.9	Loma Prieta	37.04	-121.88	63 dead; 3,737 injured; \$6 billion in property damage
1984, April 24	6.2	Morgan Hill	37.31	-121.68	\$8 million in property damage
1911, July 1	6.6	Morgan Hill area	37.25	-121.75	–
1906, April 18	7.8	Great 1906 San Francisco Earthquake and Fire	37.70	-122.50	3,000 dead; \$524 million in property damage (includes damage from fire)
1898, March 31	6.4	Mare Island	38.20	-122.50	\$350,000 in property damage
1892, April 19	6.6	Vacaville	38.40	-122.00	1 dead; \$225,000 in property damage
1868, October 21	7.0	Hayward Fault	37.70	-122.10	30 dead; \$350,000 in property damage
1865, October 8	6.5	Santa Cruz Mountains	37.20	-121.90	\$0.5 million in property damage
1838, June	Uncertain; 7.4 estimated	San Francisco to San Juan Bautista	37.30	-122.15	Damage to San Francisco and Santa Clara

Source: California Department of Conservation 2021.

Note: Data sorted chronologically (most recent first). Table shows earthquakes of magnitude greater than or equal to 6.0 or that caused loss of life or more than \$200,000 in damage. Magnitude scale is unknown. Damage estimates not adjusted for inflation.

Active Seismic Sources

Seismic sources or faults can generally be described by one of three activity classes as defined by CGS: active, potentially active, or inactive. “Active” describes historical and Holocene faults that display evidence of rupture during the Holocene (i.e., within the past 11,000 years). “Potentially active” describes faults showing evidence of displacements during Quaternary time (the past 1.6 million years). Pre-Quaternary age faults with no subsequent offset are classified as inactive. An “inactive” classification by CGS does not mean that a fault will not rupture in the future, but only that it has not been shown to have ruptured within the past 1.6 million years. Seismologists assume that the probability of fault rupture by inactive faults is low. For this reason, only the potential seismic impacts from active or potentially active faults are discussed in this chapter.

A seismology study by the California Department of Water Resources (2007b:7, 18) considered the following three categories of active and potentially active seismic sources that could produce ground motions in the study area.

- Crustal fault
- Seismic zone

• Subduction zone

The following characterization of these seismic sources, which are important to the Delta earthquake hazard potential, is based on the *Seismic Hazard Analyses and Development of Conceptual Seismic Design Ground Motions for the Delta Conveyance* (Lettis Consultants International, Inc. 2021) (hereafter referred to as Seismic Hazard Analyses study).

Crustal Faults

The approximate locations of the active and potentially active seismic sources in the greater San Francisco Bay Area are plotted in Figure 10-4.

Other major crustal faults in the greater San Francisco Bay Area (shown on Figure 10-4) that have the potential for generating substantial earthquake ground shaking in the Delta include the San Andreas, Hayward–Rodgers Creek, Calaveras, Concord–Green Valley, and Greenville Faults. The San Andreas, Hayward–Rodgers Creek, and Calaveras Faults are regional seismic sources that, although large distances away from the study area, can induce considerable ground shaking because of their potential for generating large-magnitude earthquakes.

The Seismic Hazard Analyses study (Lettis Consultants International, Inc. 2021:2) was based on a time-independent source model of active and potentially active seismic sources in a version of the source model that was updated from the Delta Risk Management Strategy (DRMS) seismology study (California Department of Water Resources 2007b). In a time-independent model, the likelihood of having an earthquake at a specific future time does not depend on the elapsed time since the last earthquake. The seismic source model used in support of the Seismic Hazard Analyses study includes the fault sources used for the DRMS study. As appropriate, the geometry of some of the fault sources, and other parameters such as seismogenic crustal thickness and slip rate, were modified from the DRMS model to incorporate new data and interpretations, some of which are included in the Uniform California Earthquake Rupture Forecast, Version 3. Significant local fault sources are summarized below.

The maximum earthquake moment magnitude, closest distance to the study area, long-term geologic slip rate, and faulting style assigned to these major active faults are presented in Table 10-8. Earthquake moment magnitude is a measure of earthquake size based on the energy released. This definition was developed in the 1970s to replace the Richter magnitude scale, and it is considered a better representation of earthquake size. The geologic slip rate is the rate that the sides of fault move with respect to one another. It is used to predict the frequencies of future earthquakes. Faulting style describes the direction of movements and relative magnitudes of various forces acting along the fault. A strike-slip faulting style indicates lateral sliding of the sides of a fault past each other.

Table 10-8. Characteristics of Major Seismic Sources in San Francisco Bay Area, UCERF3

Fault (closest to farthest)	Distance from Study Area ^a (miles)	Maximum Earthquake (moment magnitude)	Faulting Style
Calaveras	36.2	6.9	Strike-slip
Hayward–Rodgers Creek	44.5	7.3	Strike-slip
San Andreas–North	65.0	8.1	Strike-slip
San Andreas–South	61.3	7.9	Strike-slip

Source: Field et al. 2015:527.

Note: Faults shown are those for which time-dependent model data are available in the third Uniform California Earthquake Rupture Forecast (UCERF3).

^a Distance shown is nearest section of a fault trace to the mid-point of the study area (includes both conveyance facilities and compensatory mitigation areas).

The seismic sources underlying the Delta are mostly blind thrusts. Thrust faults are a type of crustal fault. A blind thrust is a seismic source that is not expected to rupture to the ground surface during an earthquake event, but is still capable of producing large and damaging ground shaking. The known blind thrusts in the Delta include the Midland, Montezuma Hills, Thornton Arch, West Tracy,⁵ and Vernalis Faults. The Black Butte and Midway Faults are thrust faults, with a discernible geomorphic expression/trace at the surface.

The following discussion of faults and seismic sources in the Delta region is generally based on the Seismic Hazard Analyses study (Lettis Consultants International, Inc. 2021) and *Seismic Hazard Analyses of Metropolitan Water District Emergency Freshwater Pathway* (Wong et al. 2021).

Table 10-9 summarizes the probabilities of activity, maximum earthquake magnitudes, and long-term geologic slip rates assigned to the major seismic sources in the Delta as described in Wong et al. (2021:7–15).

Table 10-9. Seismic Sources in the Study Area Vicinity

Seismic Source (closest to farthest)	Probability of Activity	Slip Rate (mm/year)	Earthquake Magnitude (M)	Rupture Scenario
Montezuma Hills	0.5	0.02–0.2	6.0–6.5	Floating earthquake
Thornton Arch (zone) (buried)	0.2	0.05–0.15	6.0–6.5	Floating earthquake
Midland (northern and southern) (buried)	0.9	0.02–0.2	6.8–7.4	Unsegmented and floating earthquake
West Tracy (buried)	0.9	0.2 to 0.6	6.25 to 6.75	Floating earthquake
Greenville	1.0	0.2–0.6	6.6–7.2	Unsegmented
Mt. Diablo	1.0	0.2–0.6	6.1–6.9	Unsegmented and segmented
Pittsburgh-Kirby Hills	1.0	0.3–0.7	6.0–7.1	Unsegmented

Source: Wong et al. 2021:8, 9.
mm/yr = millimeters per year.

West Tracy Fault. The West Tracy Fault is a northwest-striking, southwest-dipping blind reverse or reverse-oblique fault along the southwestern margin of the Delta that was originally identified during exploration for natural gas. The trace of the fault passes beneath the southwestern part of Clifton Court Forebay (Figures 10-4 and 10-6).

The West Tracy Fault near the Southern Complex may have experienced movement within the past 35,000 years and therefore is potentially active. As defined by the California Geological Survey under the Alquist–Priolo Earthquake Fault Zoning Act,⁶ *potentially active* faults are those that

⁵ Among the studies described in the Future Field Investigations Technical Memorandum are fault trenching and geophysical surveys directed to determining whether the West Tracy Fault is not a blind thrust fault and is instead capable of surface rupture. See a more detailed discussion of this issue below.

⁶ California Pub. Resources Code as Division 2, Chapter 7.5.

display evidence of displacement during the Quaternary and late Quaternary (i.e., approximately 1.6 million to 11,000 years before present).

It is currently unknown whether the West Tracy Fault is capable of rupturing to the ground surface to the south of the Southern Forebay area in a large earthquake (Delta Conveyance Design and Construction Authority 2022a:2), but based on the results of the probabilistic fault displacement hazard analysis described in the West Tracy Fault Preliminary Displacement Hazard Analysis (Final Draft) Technical Memorandum (Delta Conveyance Design and Construction Authority 2022d:9), the principal fault displacement hazard at the proposed tunnel is low to very low. The width of the permanent deformation of soils in the shallow subsurface, caused by a surface rupture on the West Tracy Fault during a large earthquake, is uncertain. Broad folding and tilting, where differential vertical displacement may be distributed over hundreds of feet, may result if the West Tracy Fault locally is blind, in which the top of the fault is hundreds to thousands of feet deep. If the West Tracy Fault extends to the shallow subsurface (i.e., to within 100 feet to tens of feet below ground), the width of deformation in the shallow subsurface may be about 30 feet or less. The preliminary probabilistic fault displacement analysis determined that fault displacements would be about 1 inch and 9.8 feet, corresponding to mean return periods of approximately 3,100 years and 130,000 years, respectively (Delta Conveyance Design and Construction Authority 2022a:799).

Geologic investigations and research conducted since the DRMS study (California Department of Water Resources 2007b) have developed additional data in support of late Quaternary activity of the West Tracy Fault and have revised the average late Quaternary average separation rate to about 0.3 ± 0.1 millimeters per year (mm/yr) (Unruh and Hitchcock 2014:24). The Seismic Hazard Analyses study adopted a range of fault slip rate values between 0.2 to 0.6 mm/yr (weighted average 0.4 mm/yr) to encompass uncertainty in the timing of ground deformation and the potential for a component of strike-slip displacement on the fault. Analysis of light detection and ranging (LiDAR) and other remote sensing data suggest that the fault may branch into two splays northwest of Clifton Court Forebay (Wong et al. 2021:7); the revised fault trace for the analysis includes two options for the northern termination of the fault to model this geometry. The range of modeled earthquake magnitudes was also revised to magnitude 6.25 to 6.75 to reflect current interpretations of the fault dip and crustal thickness in this region.

Midland Fault. The Midland Fault is an approximately north-to-northwest-striking, blind reverse or reverse-oblique fault that borders the western margin of the central Delta region and dips west and southwest beneath the Montezuma Hills north of the Sacramento River at the latitude of Rio Vista. The southern end of the fault is located near Byron in the southwestern Delta. Although some studies show the Midland Fault extending over 63 miles north into the southwestern Sacramento Valley, experts in the oil and gas industry interpret the northern termination of the fault to be at about the latitude of the northern Montezuma Hills. Based on subsurface mapping of the Midland Fault for oil and gas exploration, the southern 17-mile reach of the fault is characterized as a single fault trace or a narrow, discrete fault zone. At about the latitude of the southern Montezuma Hills, the fault is interpreted to branch into multiple splays. In the vicinity of Lindsay Slough, the main trace of the fault steps or bends sharply to the west and assumes a more northwesterly strike. The northern Midland Fault has been interpreted to break up into a series of right-stepping *en echelon* splays. Based on these south-to-north variations in the subsurface geometry, the DRMS study modeled the southern 17 miles of the Midland Fault as a discrete fault source (i.e., as the “Southern Midland fault”). The less-well-documented, right-stepping northern splays of the Midland Fault were captured in an areal source zone (i.e., the “Northern Midland fault zone”), which was extended north to the latitude of Davis and Winters to capture buried faults associated with numerous gas fields

1 between the Delta and the southwestern Sacramento Valley. The DRMS model assumed similar
2 activity rates for the Southern Midland Fault and structures in the Northern Midland areal zone and
3 assigned a range of weighted slip rates from 0.1 to 1.0 mm/yr to both sources (with a weighted
4 average 0.5 mm/yr).

5 **Montezuma Hills Source Zone.** The DRMS study defined an areal source zone west of the Midland
6 Fault to encompass the possibility that potentially seismogenic blind faults are present and
7 responsible for uplift and northeast tilting of the surface of the Montezuma Hills during the
8 Quaternary. Given the uncertainty about the origin of the hills, the DRMS source model assigned a
9 $P(a) 0.5$ to the possibility that presently unknown seismogenic faults, independent of the Midland
10 Fault, are present beneath the Montezuma Hills. The DRMS model adopted a range of slip rates from
11 0.05 to 0.5 mm/yr (weighted average 0.27 mm/yr) for the Montezuma Hills source zone, with the
12 assumption that the activity rate of faults beneath the hills is likely to be similar to that of the
13 Midland Fault. For the Seismic Hazard Analyses (Lettis Consultants International, Inc. 2021:6), the
14 range of slip rates for the Montezuma Hills source zone was revised downward to be the same as the
15 revised rates for the Midland Fault (0.02 to 0.2 mm/yr; weighted average 0.08 mm/yr). The DRMS
16 model assumed that the preferred orientations of potentially seismogenic faults beneath the
17 Montezuma Hills strike approximately north-south, subparallel to the southern part of the Midland
18 Fault. Exploration for oil and gas has documented that the Montezuma Hills are underlain by a
19 system of early Tertiary west-northwest-east-southeast-striking normal faults. Consequently, the
20 *Seismic Hazard Analyses* study revised the preferred orientation of potential fault sources beneath
21 the hills to be subparallel to the buried structural fabric.

22 **Thornton Arch Source Zone.** The DRMS study defined an areal zone (the Thornton Arch source
23 zone) in the northeastern part of the Delta to encompass the possibility that a buried structure
24 associated with the Thornton and West Thornton gas fields may be a potential seismic source. The
25 motivation for assuming that an active fault may be present is the observation that the Mokelumne
26 River does not continue along a straight course across the Delta from the point where it exits the
27 western Sierran foothills, but rather it appears to be deflected to the north in an anomalous loop
28 north and west of Thornton, approximately around the gas fields. The DRMS study assigned a low
29 probability of activity (i.e., 0.2) to the Thornton Arch areal source, and it adopted a range of
30 maximum magnitudes with a weighted mean of magnitude 6.25. No new information bearing on the
31 seismic potential of the Thornton Arch zone has been published since the DRMS and the *Seismic*
32 *Hazard Analyses* study (Lettis Consultants International, Inc. 2021) did not update or reevaluate this
33 seismic source.

34 The Vernalis Fault is mapped at the southern end of the Delta area, extending between Tracy and
35 Patterson, at a minimum length of about 19.2 miles. Similar to the West Tracy Fault, the Vernalis
36 Fault is a moderately to steeply west-dipping fault (California Department of Water Resources
37 2007b:15). The Black Butte Fault is a northwest-southeast striking fault approximately 6 miles
38 southeast of Tracy. It dips moderately to steeply to the west. The Midway Fault similarly strikes
39 northwest-southeast and is separated from the northwest end of the Black Butte Fault by an *en*
40 *echelon* step across a small west-northwest-trending anticline. The seismology study (California
41 Department of Water Resources 2007b:16, 17) characterized the Black Butte and Midway Faults as
42 a single structure.

Background Seismic Sources

The *Seismic Hazard Analyses* study (Lettis Consultants International, Inc. 2021) also evaluated the hazard of background seismicity in the Delta region. Background (floating or random) earthquakes are not associated with known or mapped faults. In most of the western United States, the maximum magnitude of earthquakes not associated with known faults usually ranges from magnitude 6 to 6.5. Repeated earthquake events larger than these magnitudes generally produce recognizable fault-or-fold-related features at the Earth's surface (e.g., the October 31, 2007, magnitude 5.4 Alum Rock earthquakes, both of which occurred east of San Jose and resulted in no discernable surface rupture).

Background earthquakes occur on crustal faults that exhibit no surficial expression (buried faults) or are unmapped due to inadequate studies. In the *Seismic Hazard Analyses* study, the hazard from background earthquakes was modeled through two seismic source zones: the Coast Ranges Zone and the Central Valley Zone. The two seismic source zones are delineated based on similar seismotectonic characteristics such as style(s) of faulting, seismogenic thickness, estimated maximum earthquake magnitude (for earthquakes not occurring on the fault sources within that seismic source zone), and historical and instrumental seismicity rate. The earthquake shaking hazard at the conveyance facilities was evaluated for each seismic source zone, described in Section 10.1.1.4, *Geologic and Seismic Hazards*, under *Earthquake Ground Shaking*.

Subduction Zone

A subduction zone consists of interface and intraslab seismic sources. The interface seismic source is along the convergent plate boundary, while the intraslab is a deeper seismic source on the subducting plate.

The Cascadia subduction zone extends from Cape Mendocino, California, to Vancouver Island, British Columbia. Although this seismic zone is a great distance from the Delta, its contributions to the ground shaking cannot be ignored because of its potential for generating very large-magnitude earthquakes (earthquakes with moment magnitudes of about 9.0).

A large-magnitude earthquake tends to produce strong, long-period motions even at great distances from the energy source. Long-period ground motions are important for assessments of linear structures, such as tunnels and levee deformations.

10.1.1.4 Geologic and Seismic Hazards

The geologic and seismic hazards discussed in this section include fault rupture, earthquake ground shaking, seismic-induced liquefaction and its related soil instability, and slope instability.

Fault Ruptures

Fault Trace and Rupture Zones

The Alquist–Priolo Earthquake Fault Zoning Act, passed in 1972, required the establishment of earthquake fault zones (known as *Special Studies Zones* prior to January 1, 1994) along known active faults in California. The state guidelines for assessing fault rupture hazards are explained in CGS Special Publication 42 (California Geological Survey 2018a:30–35), which is described in Section 10.2, *Relevant Laws, Regulations, and Programs*. Strict regulations for development in these fault

zones are enforced to reduce the potential for damage resulting from fault rupture. Special Publication 42 does not show any Alquist–Priolo Fault Zones delineated in the study area.

As discussed previously, the Delta is underlain by blind thrusts that are considered active or potentially active, but they are not expected to rupture to the ground surface, other than possibly the West Tracy Fault. Blind thrust fault ruptures generally terminate before they reach the surface. They may produce ground manifestations (i.e., below ground shear zone or ground surface bulging) during fault displacement; however, in most cases, no clear ruptures.

Those faults that could cause subsurface ground deformation, but not surface rupture are discussed in the following section.

Fault Offsets

An estimate of fault offset (displacement during a seismic event) is important for assessing possible future effects. The amount of fault offset depends mainly on earthquake magnitude and location along the fault trace. Fault offset can take place on a single fault plane, or displacements can be distributed over a narrow zone. Fault rupture can also be caused by rupture on a neighboring fault (secondary fault rupture).

Empirical relationships are typically used to estimate fault offsets. The relationships provide estimates of fault displacements, such as average and maximum offsets, as a function of fault parameters. As shown in Table 10-10, based on the results of a deterministic fault displacement hazard analysis as presented in the *West Tracy Fault Preliminary Displacement Hazard Analysis (Final Draft)* (Delta Conveyance Design and Construction Authority 2022d:8), the West Tracy Fault is estimated to have displacement of 2.3 to 6.0 feet during an earthquake on the fault.

Table 10-10. Estimated Fault Offsets for West Tracy Fault

Maximum Credible Earthquake (Mw)	Fault Displacement Model Used and Associated Weighting			50th Percentile	84th Percentile
	WC94 All ^a	WC94 SS ^a	HEA13 ^b	Feet	Feet
6.7	0.5	0.2	0.3	2.3	6.0

Source: Delta Conveyance Design and Construction Authority 2022d:8.

Mw = moment magnitude.

^a WC94 model developed by Wells and Coppersmith 1994, as cited in Delta Conveyance Design and Construction Authority 2022d.

^b HEA13 model developed by Hecker et al. 2013, as cited in Delta Conveyance Design and Construction Authority 2022d.

Although the Midland Fault is characterized as a blind thrust, there seems to be anomalous relief near the base of the peat (or top of the sand layer) across the fault traces. The available data indicate a modest 6.6–9.8-foot west-side-up step at the base of the peat across the surface trace of the Midland Fault (California Department of Water Resources 2007b:10).

The West Tracy Fault appears to contain secondary east-dipping splays (branches) in the hanging wall (i.e., overhanging block) of the fault, positioned west of the Clifton Court Forebay, some of which are beneath the intake channel to the Banks Pumping Plant. CGS and USGS show the West Tracy Fault as not active. However, Fugro Consultants (2011:13) indicate that the fault may have experienced movement within the past 35,000 years and therefore would be potentially active. If movement occurred along the fault, uplift of the hanging wall of the fault could cause surface

1 deformation in the western part of the existing Clifton Court Forebay and the proposed Southern
2 Forebay.

3 As described in Seismic Hazard Analyses and Development of Conceptual Seismic Design Ground
4 Motions for the Delta Conveyance (Lettis Consultants International, Inc. 2021:5), although the West
5 Tracy and Midland Faults both are part of the Coast Range Sierra Boundary zone and the northern
6 end of the West Tracy Fault is nearly coincident with the southern end of the Midland Fault, the two
7 faults have distinctly different strikes and possibly different slip rates, which suggests there may be
8 significant behavioral differences between the two faults that suggest that they would not rupture at
9 the same time (i.e., a combined rupture).

10 There is very little data regarding the timing, magnitude, and frequency of earthquakes on the West
11 Tracy and Midland Faults that would provide a clear assessment of the likelihood of a combined
12 rupture; however, the likelihood of a combined rupture appears to be low given the different
13 geometries of the faults and their likely different slip rates. Additional data on the magnitude and
14 timing of events on both the West Tracy and Midland Faults are required to rigorously evaluate the
15 combined rupture hypothesis (Lettis Consultants International, Inc. 2021:5). Such data would be
16 acquired as part of the field investigations described in the *Potential Future Field Investigations—*
17 *Central and Eastern Corridor Options (Final Draft)* (Delta Conveyance Design and Construction
18 Authority 2022e) and in the West Tracy Fault Preliminary Displacement Hazard Analysis Technical
19 Memorandum (Delta Conveyance Design and Construction Authority 2022d).

20 Earthquake Ground Shaking

21 The potential for earthquake ground shaking at 12 conveyance facility sites along the two
22 alignments at the top of the soil below any existing peat, muck, and basin deposits was evaluated in
23 the Seismic Hazard Analyses (Lettis Consultants International, Inc. 2021:1). The analyzed sites were
24 Intake B, Intake C, Twin Cities, New Hope, Canal Ranch, Bouldin Island, King Island, Lower Roberts
25 Island, Bacon Island, Southern Forebay North, Southern Forebay South, and Jones Connection.⁷ For
26 the Bethany Reservoir alignment, the potential for earthquake ground shaking was evaluated for the
27 Union Island Tunnel Maintenance Shaft, the Bethany Reservoir Pumping Plant, and the Bethany
28 Reservoir Discharge Structure in the Liquefaction and Ground Improvement Analysis for Bethany
29 Reservoir Alternative Technical Memorandum (Final Draft) (Delta Conveyance Design and
30 Construction Authority 2022f:2, 3). The analyses used recent geotechnical boring information.
31 Presented data for each site include seismic hazard curves at different ground accelerations;
32 acceleration distribution for each seismic source; magnitude and distance contributions for different
33 earthquake return intervals; mean uniform hazard spectra at different earthquake return periods;
34 and maximum design earthquake response. In general, the analyses found the shaking hazards
35 reflected proximity to major active faults in the San Francisco Bay Area and along the western edge
36 of the Delta. Consequently, the shaking hazard is lowest in the north and increases to the south and
37 increases from the east to the west.

38 The analyses performed both Probabilistic Seismic Hazard Analyses (PSHA) and Deterministic
39 Seismic Hazard Analyses. With the PSHA analysis, seismic hazard is expressed in terms of the
40 probabilities of exceeding peak and spectral accelerations and is computed by combining the
41 following three probability distributions for all seismic sources: (1) probability distribution of
42 earthquake magnitude in time (earthquake recurrence), (2) probability distribution of distance from

⁷ Intake A was not evaluated in the Seismic Hazard Analyses study (Lettis Consultants International, Inc. 2021).

the earthquake rupture area to the site given magnitude (geometry), and (3) probability distribution of peak and spectral accelerations given magnitude and distance (attenuation). Hazard curves are computed at 21 spectral periods between 0.01 (PGA) and 10 seconds.

With the Deterministic Seismic Hazard Analyses, the deterministic median, 69th, 84th, and 95th percentile acceleration response spectra were calculated for the significant faults at all 12 sites and a comparison of the spectra was made at five return periods (144, 200, 475, 975, and 2,475 years) of interest. The results of the analyses are discussed in the next section.

Controlling Seismic Sources

The seismic sources expected to dominate the ground motions at a specific location (known as *controlling seismic sources*) vary depending on the location, ground motion probability level (or return period), and ground motion frequency (or period).

Table 10-11 summarizes the primary controlling seismic source at the 12 modeled sites described in *Development of Conceptual Seismic Design Ground Motions for the Delta Conveyance* (Lettis Consultants International, Inc. 2021:1). The analysis for PGA source and 1.0-second spectral acceleration at ground motion return periods of 144 and 2,475 years shows multiple contributions (i.e., multiple controlling sources) for seismic shaking, especially for PGA at 144 years.

Table 10-11. Seismic Source Contributions at PGA and 1.0 Second Spectral Acceleration for 144-Year and 2,475-Year Return Periods

Location	Seismic Source Contribution (PGA)	Seismic Source Contribution (1.0 Second Spectral Acceleration)
144-Year Return Period		
Intake B	15% CRSB North	21% San Andreas
	11% Central Valley Background Seismicity	13% Hayward
	11% Berryessa-Green Valley	10% Berryessa-Green Valley
	10% Hayward	
	10% San Andreas	
Intake C	14% CRSB North	20% San Andreas
	11% Berryessa-Green Valley	13% Hayward
	10% Central Valley Background Seismicity	10% Berryessa-Green Valley
	10% Hayward	
	10% San Andreas	
Twin Cities Complex	11% Central Valley Background Seismicity	21% San Andreas
	10% CRSB North	13% Hayward
	10% Hayward	
	10% San Andreas	
Bouldin Island	16% Mt. Diablo	18% San Andreas
	10% Hayward	13% Hayward
		11% Mt. Diablo

Location	Seismic Source Contribution (PGA)	Seismic Source Contribution (1.0 Second Spectral Acceleration)
Southern Forebay North	25% Mt. Diablo	19% Mt. Diablo
	12% Greenville	13% Calaveras
	11% Calaveras	12% San Andreas
		11% Hayward
		10% Greenville
		10% Midway-Black Butte
Southern Forebay South	25% Mt. Diablo	19% Mt. Diablo
	13% Greenville	13% Calaveras
	11% Calaveras	11% San Andreas
		11% Greenville
2,475-Year Return Period		
Intake B	34% Central Valley Background Seismicity	24% San Andreas
	15% CRSB North	11% Hayward
		10% CRSB North
Intake C	32% Central Valley Background Seismicity	24% San Andreas
	13% CRSB North	11% Hayward
	12% Pittsburg-Kirby Hills	
Twin Cities Complex	34% Central Valley Background Seismicity	25% San Andreas
		11% Hayward
Bouldin Island	18% Mt. Diablo	18% San Andreas
	17% Central Valley Background Seismicity	14% Mt. Diablo
	15% West Tracy-Midland	11% West Tracy-Midland
		10% Hayward
Southern Forebay North	38% Mt. Diablo	32% Mt. Diablo
	19% West Tracy-Midland	17% West Tracy-Midland
	11% Greenville	13% Greenville
	10% Midway-Black Butte	
Southern Forebay South	36% Mt. Diablo	32% Mt. Diablo
	20% West Tracy-Midland	18% West Tracy-Midland
	13% Midway-Black Butte	14% Greenville
	12% Greenville	13% Midway-Black Butte

Source: Lettis Consultants International, Inc. 2021:Table 3.

Note: Intake A was not evaluated in the Seismic Hazard Analyses Report and Development Conceptual Seismic Design Ground Motions for the Delta Conveyance (Lettis Consultants International, Inc. 2021).

CRSB = Coast Range-Sierran Block zone (encompasses the West Tracy and Midland Faults); PGA = peak ground acceleration.

Site Soil Amplifications

Thick deposits of peaty and soft soil tend to de-amplify short-period earthquake ground motions and amplify long-period ground motions. The earthquake ground motions (expressed in fractions of g (i.e., the standard acceleration due to Earth's gravity) developed for the Delta as part of the seismic study are applicable for a stiff soil site condition. Therefore, these motions are expected to change as they propagate upward through the peaty and soft soil from the stiffer alluvium underlying the Delta.

Table 10-12 (based on the *Conceptual Design Phase Seismic Site Response Analysis (Final Draft)* (Delta Conveyance Design and Construction Authority 2022g:28) presents the ranges of PGA values at 16 conveyance facility sites. The range of input PGAs shown in the table reflects the ground motions calculated on the stiffer alluvium underlying the Delta at each conveyance facility site. The range of calculated ground-surface PGAs refers to the PGA values calculated at the ground surface above the peaty and soft soils. The ratio between the ground surface PGA and the corresponding stiffer soil PGA (or input PGA) is defined as the *site amplification factor*. The table shows that the strongest shaking potential is on the Byron Tract (PGA 0.59–0.67 g), and the weakest shaking potential is at Intake B (PGA 0.19–0.24 g).

Table 10-12. Input and Calculated Ground Surface PGAs at Each Facility

Facility	Peak Ground Accelerations (g)	
	Range of Input PGAs	Range of Calculated Ground Surface PGAs
Bacon Island	0.63–0.86	0.29–0.35
Banks Connection	0.52–0.65	0.25–0.33
Bethany Reservoir Pumping Plant	0.37–0.49	0.29–0.33
Bouldin Island	0.53–0.64	0.30–0.34
Byron Tract	0.69–0.93	0.59–0.67
Canal Ranch Tract	0.28–0.36	0.31–0.35
Discharge Structure ^a	N/A	N/A
Intake B	0.26–0.40	0.19–0.24
Intake C	0.32–0.40	0.27–0.37
King Island	0.34–0.49	0.25–0.36
Lower Roberts Island	0.36–0.57	0.2–0.24
New Hope Tract	0.32–0.51	0.23–0.33
Southern Forebay–North	0.55–0.67	0.53–0.58
Southern Forebay–South	0.79–1.11	0.32–0.42
Twin Cities Road	0.25–0.44	0.28–0.41
Union Island	0.69–0.92	0.24–0.32

Source: Delta Conveyance Design and Construction Authority 2022g:28.

Note: Intake A was not evaluated in the Conceptual Design Phase Seismic Site Response Analysis (Delta Conveyance Design and Construction Authority 2022g:28).

g = acceleration due to gravity (32.2 square feet per second).

^a Bethany Reservoir Discharge Structure was not analyzed because the facility overlies rock; no liquefaction is anticipated.

Liquefaction

Liquefaction is a process whereby strong ground shaking causes loose and saturated soil to lose strength and to behave as a viscous fluid. This process can cause partial or total loss of soil's shear strength and temporary loss of soil-bearing capacity, resulting in excessive ground deformations, foundation instability, embankment failures, and damage to structures and levees. Many factors could influence the severity of these consequences, including site topography, subsurface soil heterogeneity, horizontal and vertical extents of potentially liquefiable soils, and effects of foundations.

Factors that control liquefaction-induced ground failure are the extent, depth, density, and thickness of liquefiable materials; depth to groundwater; rate of drainage; slope gradient; proximity to free faces; and intensity and duration of ground shaking. Ground failures can take the form of lateral spreading, excessive differential or total compaction or settlement, and slope failure.

Liquefaction can also increase the potential for buoyancy to buried structures, such as buried pipes, tunnels, and other structures, causing them to float toward the ground surface.

The Delta is underlain at shallow depths by various channel deposits and recent silty and sandy alluvium. Some of the existing levee materials also consist of loose, silty, and sandy soil. Where saturated, the soil of the levee embankment and the soil of the levee foundations locally may be susceptible to liquefaction during earthquakes.

Soil liquefaction is also a function of ground motion intensity and shaking duration. Longer ground shaking, even at a lower intensity, may cause liquefaction as the soil is subject to more repeated cycles of loading. Longer duration shaking is typically associated with larger magnitude earthquakes, such as earthquakes that occur on the San Andreas, Hayward, and Calaveras Faults.

Historical Occurrences of Liquefaction

Ground manifestation associated with possible liquefaction during the 1906 San Francisco earthquake was reported in two locations within and in the vicinity of the study area. Youd and Hoose (1978:122) reported settlements of several inches at the Southern Pacific Bridge Crossing over the San Joaquin River in Stockton and settlement of 3 feet at a bridge crossing over Middle River, approximately 10 miles west of Stockton. The specific mechanism for the settlements (e.g., liquefaction, consolidation) were not identified.

Holzer (1998:B1) reports that the greatest distance from the epicenter of the more recent 1989 Loma Prieta earthquake was 76 miles, in the Bolinas Lagoon tidal flats. The southern end of the Delta is 52 miles from the epicenter, but Holzer (1998) does not mention liquefaction occurring in the Delta.

Liquefaction Susceptibility and Potential Mapping

Part of the study area falls within an area that the California Geological Survey (2021a) has evaluated for a type of Seismic Hazard Zone referred to as *Earthquake Zones of Required Investigation*. The general approach and recommended methods of the required investigations are presented in the CGS Special Publication 117A—Guidelines for Evaluating and Mitigating Seismic Hazards in California (California Geological Survey 2008:35–42), including requirements for screening investigations for liquefaction potential and quantitative evaluation of liquefaction resistance. The identification of a Seismic Hazard Zone for liquefaction is intended to prompt more detailed, site-specific geotechnical investigations, as required by the Seismic Hazards Mapping Act (Section 10.2, *Relevant Laws, Regulations, and Programs*). As such, these maps identify areas where the potential for liquefaction is relatively high. They do not predict the amount or direction of liquefaction-related ground displacements or the amount of damage to facilities that may result from liquefaction.

Areas identified as Liquefaction Zones in the mapping of Earthquake Zones of Required Investigation by the California Geological Survey (2018b:13, 14; 2018c:13, 14; 2021c:25, 26) have been mapped for those parts of the study area west of Old River and south of the San Joaquin River corresponding to parts of the USGS 7.5-minute Woodward Island quadrangle, the area surrounding

the Clifton Court Forebay on the Clifton Court Forebay USGS 7.5-minute quadrangle, and the Bouldin Island 7.5-minute quadrangle, where Alternative 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5 facilities would be located.⁸ The mapped areas (Figure 10-6) (which included the Rail Depot area, RTM area and associated facilities, and the Byron Tract Working Shaft) extend from approximately Isleton to the north and southerly to the northern part of the proposed Southern Complex. The mapping shows that the area surrounding Clifton Court Forebay is subject to liquefaction hazard, with a pseudo-peak ground acceleration (g) of 0.23 to 0.32 g with a 10% probability in 50 years (California Geological Survey 2021c:11-13, plate 2.2). The mapping shows that the Byron Tract Working Shaft site is subject to liquefaction hazard, with a pseudo-peak ground acceleration (g) of 0.26 to 0.27 g with a 10% probability in 50 years (California Geological Survey 2018c:11-13, plate 3.2). The Rail Depot area and RTM area and associated facilities are subject to liquefaction hazard, with a pseudo-peak ground acceleration of 0.26 to 0.28 g.

The remaining parts of the study area have not been evaluated for liquefaction hazard zonation by the California Geological Survey (2018b:13, 14; 2018c:13, 14; 2021c:plate 1.1).

The Association of Bay Area Governments (ABAG) (2021) Metropolitan Transportation Commission (MTC)/ABAG Hazard Viewer Map shows liquefaction susceptibility for the part of the USGS 7.5-minute Clifton Court Forebay quadrangle (i.e., the quadrangle immediately south of the Woodward Island quadrangle) that is within Contra Costa and Alameda Counties. Within the study area, the ABAG mapping covers the entire perimeter of the Clifton Court Forebay (including the Southern Complex) as well as the Bethany Complex area (Figure 10-6). The susceptibility rating scale is from very low to very high. With respect to Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c, the mapping shows a high rating in the area of the Southern Complex launch shaft and Southern Forebay and a low rating in the remainder of the Southern Complex. With respect to Alternative 5, the mapping shows very high liquefaction susceptibility to the east and southeast sides of Clifton Court Forebay, intersecting the Bethany Reservoir alignment tunnel. South of Clifton Court Forebay, the Bethany Reservoir alignment tunnel and the Bethany Complex are in an area of moderate and low liquefaction susceptibility.

For Delta Conveyance Project-specific analyses, the Liquefaction and Ground Improvement Analysis Technical Memorandum in *Volume 1: Delta Conveyance Final Draft Engineering Project Report, Central and Eastern Options* (Delta Conveyance Design and Construction Authority 2022c) describes the results of a conceptual-level evaluation of the liquefaction potential of the foundation soils at the following locations.

- Three potential intake sites
- Southern Forebay Inlet Structure and South Delta Pumping Plant
- Southern Forebay Outlet Structure
- South Delta Outlet and Control Structure
- Tunnel shaft sites along the central and eastern alignments

The evaluation determined that all the evaluated sites are subject to liquefaction, with the exception of the facilities near Twin Cities Road and the South Delta Outlet and Control Structure.

⁸ Within the study area, areas north of the San Joaquin River and east of Old River have not been evaluated by the California Geological Survey for liquefaction hazard.

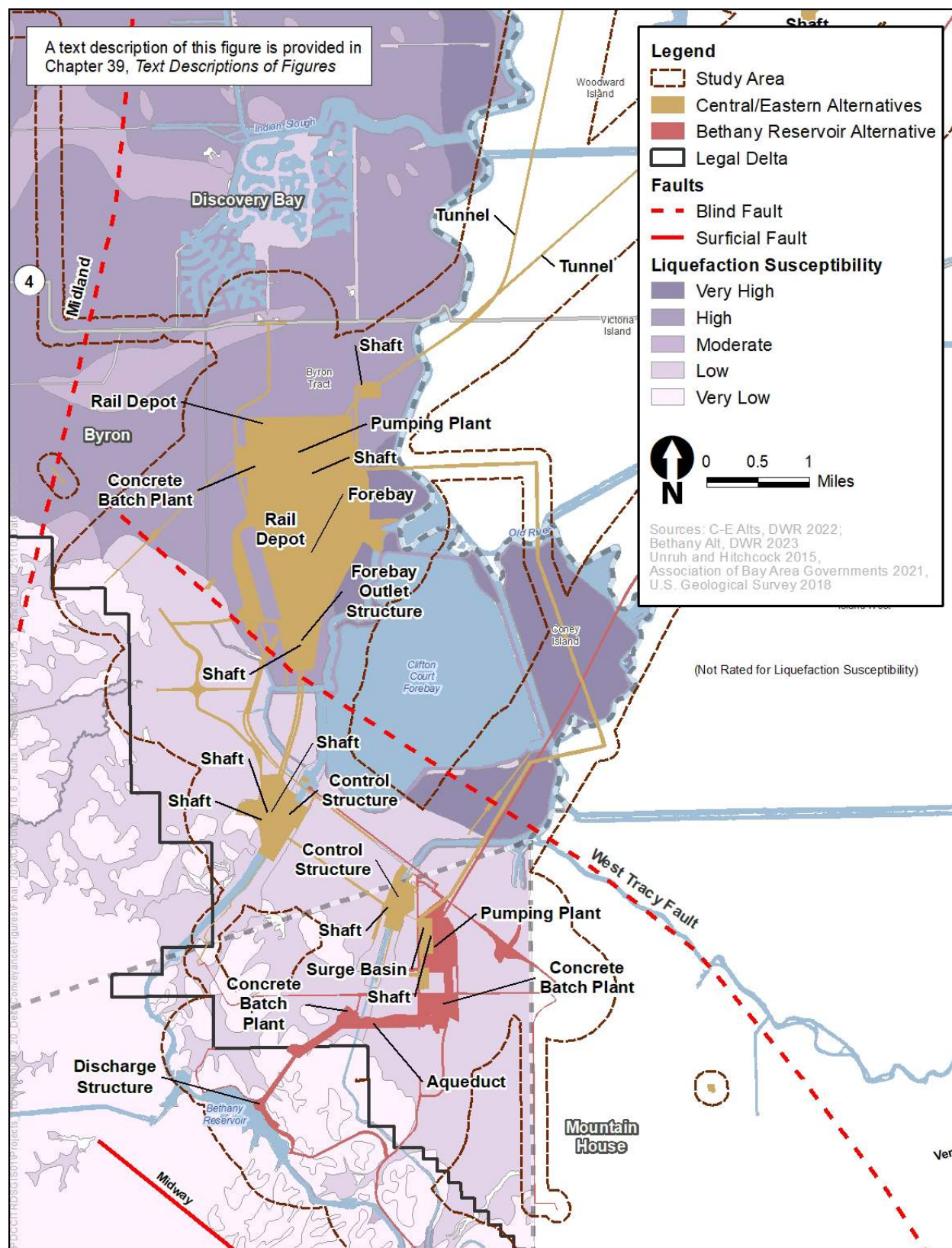


Figure 10-6. Faults and Liquefaction Susceptibility in Vicinity of Southern Complex and Bethany Complex

The Liquefaction and Ground Improvement Analysis for Bethany Reservoir Alternative Technical Memorandum (Delta Conveyance Design and Construction Authority 2022f) describes the results of a conceptual-level evaluation of the liquefaction potential of the foundation soils at the following locations that are in addition to the three intakes and tunnel shaft sites described above for the central and eastern alignments.

- Union Island Tunnel Maintenance Shaft
- Bethany Reservoir Pumping Plant and Surge Basin
- Bethany Reservoir Discharge Structure

The evaluation determined that a significant liquefaction potential exists at the Union Island tunnel maintenance shaft site. However, at the Bethany Reservoir Pumping Plant and Surge Basin, the evaluation determined that the soil characteristics are clayey and that the Bethany Reservoir Discharge Structure is underlain by soft rock, such that there is no significant liquefaction potential at these sites.

Conditions Associated with Landslides/Slope Instability

A landslide (more broadly referred to as mass movements and slope failures) is a mass of rock, soil, or debris that has been displaced downslope by sliding, flowing, or falling. Landslides may also occur as a result of liquefaction, which reduces soil shear strength to a low residual value, causing the soil to move. Landslides include cohesive block slides and disrupted slumps that have formed by the translation or rotation of slope materials along one or more planar or curve-planar surfaces. Soil creep is the slow, imperceptible downslope movement of weak soil and soft rock under the force of gravity.

Landslides occur when shear stresses within a soil or rock mass exceed the available shear strength of the mass. Failure may occur when stresses that act on a slope increase, internal strength of a slope decreases, or a combination of both. Increased stresses can be caused by an increase in weight of the overlying slope materials (by saturation), addition of material (surcharge) to the slope, application of external loads (foundation loads, for example), or seismic loading (application of an earthquake-generated agitation to a structure).

Slope soil shear strength (the internal resistance of a soil to shear stress) can be reduced through erosion or undercutting or removal of supporting materials at the slope toe as a result of scouring (concentrated erosion by streamflow), increased pore water pressure within the slope, and weathering or decomposition of supporting soil. Zones of low shear strength within the slope are generally associated with the presence of certain clay, bedding, or fracture surfaces.

Strong earthquake ground shaking often causes landslides, particularly in areas already susceptible to landslides because of other non-seismic factors, including the presence of existing landslide deposits and water-saturated slope materials. Failure of steep slopes, collapse of natural streambanks, and reactivation of existing landslides may occur extensively during a major earthquake.

Historical Occurrences of Landslides in the Study Area

Existing landslides have been mapped for all of Alameda County (Roberts et al. 1999). Within the study area, the map shows one relatively small landslide (i.e., less than one acre) located approximately 2,800 feet southeast of the Bethany Reservoir.

Historical Occurrences of Levee Failure in the Study Area

During the last century through 2015, more than 160 levee failures or breaches have been reported in the Delta islands and tracts (California Department of Water Resources 2015:1).

Areas Susceptible to Landslides and Debris Flows in the Study Area

Because the topography of the Delta has little relief, the potential for mass failure of natural slopes, including landslides and debris flows in nearly all the study area is considered very low. However, certain streambanks may be subject to undercutting and resultant failure, although there are no known maps of channel banks that are prone to failure.

The MTC/ABAG Hazard Viewer Map (Association of Bay Area Governments 2021), which covers only the Alameda and Contra Costa Counties parts of the study area, rates the areas to the east and west of the Bethany Reservoir within the study area as being subject to “few landslides.”

Areas Susceptible to Levee Failure in the Study Area

Levee damage or mass failure can occur as a result of hydrologic and hydraulic conditions and from seismic loading. Site-specific conditions that can contribute to a levee’s vulnerability for failure when subjected to seismic loading include poor/weak embankment or foundation soils, insufficient levee geometry (i.e., height, width, and slope inclination), and damaging animal activity or vegetation growth. Liquefaction of levee materials and levee foundation soils is also known to cause levee failure in the Delta.

There are no known maps of levees in the study area that are particularly subject to failure from mass movement alone. Studies of levees in the Delta tend to be directed to evaluating the overall vulnerability of a levee to failure as a result of levee geometry, soil foundation conditions, floodwater levels and wave runup, sea level rise, and seismic loading, which could contribute to mass failure of a levee. Relative levee vulnerability in the Delta was evaluated in the Levee Vulnerability Assessment Technical Memorandum (Delta Conveyance Design and Construction Authority 2022h). The assessment assigned Delta levees at approximately 5,000 cross-sections according to one of four relative vulnerability ratings (high, medium, low, and very low). Approximately $\frac{1}{4}$ of the cross-sections received a high vulnerability rating and half of the cross-sections received scores were Low or very low vulnerability. Levees with a High rating most frequently are mapped in the central parts of the eastern and central alignments. Levees with the very low rating most frequently are mapped in the northern and southern parts of the eastern and central alignments.

Despite extensive geological and geotechnical explorations and multiple analyses by seismic experts, there remains uncertainty regarding the effects of potential seismic events on Delta levee integrity.

Earthquake hazards to Delta levees in particular were reviewed in a workshop organized by the Delta Independent Science Board in July 2016. Earthquake hazards in the Delta were described in terms of ground motions from Bay Area earthquakes, infrequent earthquake recurrence on faults beneath the Delta, and levee fills prone to earthquake-induced liquefaction. Large uncertainties are associated with all of these seismic contributions to the hazard of levee failure. Those uncertainties, according to presentations in the workshop, include whether the Delta ground motions previously computed for Bay Area earthquakes were overestimated (Delta Independent Science Board 2016:3). According to the Delta Independent Science Board, Bay Area faults pose an overall greater risk to Delta levee failure in the Delta than faults located beneath the Delta itself (Delta Independent

Science Board 2016:3) because earthquakes in the Bay Area occur more frequently than Delta earthquakes. However, faults beneath the Delta are capable of producing stronger ground shaking because they are located in the Delta itself. The degree to which a Bay Area earthquake affects the Delta, however, depends on attenuation (i.e., how abruptly the ground motions diminish as the seismic waves advance eastward from the Bay Area into the Delta).

Earthquake-Induced Landslide Potential Maps

California Geological Survey Seismic Hazard Zones for earthquake-induced landslides are delineated using criteria adopted by the California State Mining and Geology Board. Under these criteria, these zones are defined as areas that meet one or both of the following conditions.

1. Areas that have been identified as having experienced landslide movement in the past, including all mappable landslide deposits and source areas, as well as any landslide that is known to have been triggered by historic earthquake activity.
2. Areas where the geologic and geotechnical data and analyses indicate that the earth materials may be susceptible to earthquake-induced slope failure (California Geological Survey 2021c:31).

The only official Seismic Hazard Zone mapping for earthquake-induced landslide hazard potential in the study area is an area corresponding to the northwestern part of the Clifton Court Forebay USGS 7.5-minute quadrangle (California Geological Survey 2021c), and only the Contra Costa County part of the quadrangle was evaluated for earthquake-induced landslide hazard potential. Within the study area, the resultant mapping (California Geological Survey 2021a) shows small areas located on the side slopes of areas mapped as artificial fill around both sides of the California Aqueduct/Banks Pumping Plant Inlet channel (Figure 10-6), as having the potential for an earthquake-induced landslide.

Ground Failure and Seismic-Induced Soil Instability

Compaction and Settlement

Earthquake ground motions can cause compaction and settlement of soil deposits because of rearrangement of soil particles during shaking. The amount of settlement depends on ground motion intensity and duration and degree of soil compaction; looser soil subjected to higher ground shaking will settle more. Empirical relationships are commonly used to provide estimates of seismic-induced settlement. In these relationships, ground shaking can be represented by PGA and magnitude, and soil compaction is typically measured by a Standard Penetration Test (SPT) (i.e., an *in situ* dynamic penetration test that measures the density of granular soil) blow-counts or N-values. Excessive total and differential settlements can cause damage to buried structures, including utilities, which in turn may initiate larger failure of levees and other aboveground facilities.

Loss of Bearing Capacity

Liquefaction can also result in temporary loss of bearing capacity in foundation soil, which has the potential to cause foundation, pipeline, and tunnel failures during and immediately after an earthquake event.

Lateral Spreading

Soil lateral spreading, or horizontal movement, can be initiated during an earthquake event. Liquefaction-induced lateral spreading could occur even on gently sloping grounds or flat ground

with a nearby free face (e.g., a steep stream bank or other slope) when the underlying soil liquefies. The amount of horizontal movement depends on ground motion intensity, the ground's slope, soil properties, and conditions of lateral constraint (free-face or non-free-face condition).

Increased Lateral Pressures

Liquefaction can increase lateral earth pressures on walls and buried structures. As soil liquefies, earth lateral pressure will approach that of a fluid-like material.

Buoyancy

Liquefaction can cause buried pipes, tunnels, and structures to become buoyant. The potential for buoyancy caused by liquefaction is typically determined using site-specific data at the planned locations of buried structures.

Tsunami and Seiche

Tsunamis, which typically consist of multiple waves that rush ashore, range in size from micro-tsunamis detectable only by sensitive instruments to waves tens of feet high. They may be triggered by earthquakes, volcanic eruptions, submarine landslides, and by onshore landslides. The California Governor's Office of Emergency Services (2021) MyHazards website⁹ shows that there is no potential hazard of a tsunami in the study area nor in the Delta in general. The website shows that the tsunami inundation hazard area nearest to the study area is on the north shore of the Sacramento River, extending approximately 1 mile upstream (i.e., east) of the Benicia Bridge. The inundation area extends over mud flats and tidal marshes, which are presumed to have an elevation at or within approximately 3 feet above sea level. Because the inundation zone is close to sea level, it appears that substantial tsunami effects extending into the Delta are mostly attenuated in the San Francisco Bay. Any tsunami effects significantly to the east of the Benicia Bridge are presumed to be further attenuated in Suisun and Grizzly Bays.

Historic records of the Bay Area indicate that 19 tsunamis were recorded in San Francisco Bay during the period of 1868 to 1968. The maximum wave height recorded at the Golden Gate tide gage was 7.4 feet (Ritter and Dupre 1972:Plate 1).

Based on available data, the Safety Element of the 2005–2020 Contra Costa County General Plan reports that there is a systematic diminishment of wave height from the Golden Gate to about half that height on the shoreline near Richmond. The wave height would be negligible upon reaching the Carquinez Strait (County of Contra Costa 2005:10-30).

Based on the above information, the effects of a tsunami in the study area are expected to be minimal.

A seismically induced seiche is a rhythmic standing wave in a partly or fully enclosed body of water caused by seismic waves generated by a landslide, earthquake-induced ground acceleration, or ground offset. Elongate and deep (relative to width) bodies of water seem most likely to be subject to seiches, and earthquake wave orientation may also play a role in seiche formation. The "sloshing" waves generated can reach tens of feet high and have devastating effects on people and property. Seiches can temporarily flood a shoreline in a manner similar to tsunami; however, their destructive capacity is not as great. Seiches may cause overtopping of impoundments such as dams, particularly

⁹ Available at: myhazards.caloes.ca.gov.

when the impoundment is in a near-filled condition, releasing flow downstream. Earthquakes occurring miles away can produce seiches in local bodies of water that could overtop and damage levees and dams and cause water to inundate surroundings. In 1868, an earthquake along the Hayward Fault in the Bay Area generated a seiche along the Sacramento River (AECOM 2013:3.7).

With the exception of the Clifton Court Forebay, the hazard of a seiche occurring in the study area is expected to be low because of the lack of existing deep, narrow, and enclosed waterbodies and distance from seismic sources capable of generating strong ground motions.

As a point of reference, Fugro Consultants (2011:14) identified the potential for strong ground motions along the West Tracy Fault to cause a seiche of an unspecified wave height to occur in the Clifton Court Forebay, assuming that this fault is potentially active.

10.2 Applicable Laws, Regulations, and Programs

The applicable laws, regulations, and programs considered in the assessment of project impacts on geology and seismicity are indicated in this section, in Section 10.3.1, *Methods for Analysis*, or the impact analysis, as appropriate. Applicable laws, regulations and programs associated with state and federal agencies that have a review or potential approval responsibility have also been considered in the development of CEQA impact thresholds or are otherwise considered in the assessment of environmental impacts. A listing of some of the agencies and their respective potential review and approval responsibilities, in addition to those under CEQA, is provided in Chapter 1, Table 1-1. A listing of some of the federal agencies and their respective potential review, approval, and other responsibilities, in addition to those under NEPA, is provided in Chapter 1, Table 1-2. DWR would follow the applicable standards, guidelines, and codes (or the most current applicable version at the time of implementation), which establish minimum design criteria and construction requirements for project facilities, levees, pipelines, excavations and shoring, pumping stations, grading, and foundations, bridges, access roads, structures, and other facilities, where applicable, in the design of project facilities and would include each as minimum standards in the construction specifications. The following list provides examples of the standards, guidelines, and code requirements that are legally mandated.

- **Liquefaction and Landslide Hazard Maps (Seismic Hazards Mapping Act):** The act (Pub. Resources Code §§ 2690–2699.6) directs the California Geological Survey to identify and map areas prone to earthquake-induced liquefaction, landslides, and amplified ground shaking, and requires site-specific geotechnical investigations for seismic hazard and mitigation measure identification prior to permitting most developments designed for human occupancy. Seismic hazard guidance and maps prepared by the California Geological Survey under this act are used in the seismic hazard analyses presented in this chapter.
- **Alquist–Priolo Earthquake Fault Zones:** Pub. Resources Code Section 2621 *et seq.* directs the California Geological Survey to identify and map known active faults to prevent building construction for human occupancy on a fault surface trace. The Alquist–Priolo Earthquake Fault Zone establishes a 200- to 500-foot zone on each side of the mapped fault trace to account for potential branches of active faults. California Geological Survey Special Publication 42 shows mapped faults capable of surface fault rupture. Maps and data prepared by the California Geological Survey that identify active faults are used in the seismic hazard analyses presented in this chapter.

- **Regulatory Design Codes and Standards for Project Structures:** Numerous state, federal and professional association design codes and standards regulate and guide structure construction. These codes and structures establish minimum design and construction requirements including for concrete and steel structures, levees, tunnels, pipelines, canals, buildings, bridges, and pumping stations. Project-specific design criteria and guidelines will be developed as part of future design activities either to meet or exceed the requirements of the design standards. DWR would also follow any other applicable standards, guidelines, and code requirements that are promulgated during the detailed design and construction phases and during operation of the water conveyance facilities. Additionally, during construction, the California Occupational Safety and Health Act of 1973, as administered by California Division of Occupational Safety and Health Administration (Cal/OSHA), would be followed as a minimum standard to protect workers. The requirements established by these design codes and standards are considered in the analysis of impacts in this chapter.

10.3 Environmental Impacts

This section describes the direct and cumulative environmental impacts associated with geology and seismicity that would result from project construction and operations and maintenance. It describes the methods used to determine the impacts of the project and lists the thresholds they used to conclude whether an impact would be significant. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts are provided. Indirect impacts are discussed in Chapter 31, *Growth Inducement*.

10.3.1 Methods for Analysis

This section describes the methods used to evaluate the potential for geologic and seismic hazards to affect the constructed and operational elements of the alternatives and the potential for the elements of the alternatives to increase risk to loss of life or loss of property or other associated risks. Other than seismic sources that exist outside the study area, lands outside of the study area are not considered because there are no structures or other facilities being proposed there and because project alternative operations within the water user service areas would not increase geologic or seismic hazards in those areas. There would be no Delta Conveyance Project structures in areas upstream of the intakes and Delta in general, nor would there be any changes as a result of the project in those areas. Both quantitative and qualitative methods were used to evaluate these effects, depending on the type and availability of data.

10.3.1.1 Process and Methods of Review for Geology and Seismicity

The DCA has developed geologic and geotechnical information for all of the conveyance facility alternatives. This information has been developed under the supervision of professional engineers and geologists and documented in the technical memoranda DCA prepared for the project. These documents show project and alternative feasibility by identifying site geotechnical conditions and associated site constraints. The methods used by the DCA to prepare the technical memoranda are specific to the objectives of a given memorandum, but typically preparation of each memorandum involved review of existing literature and data, analyses of new mapping and data (some of which was generated by the DCA), statement of design parameters, development of conceptual design and construction measures, and recommendations for future studies and design work.

Other study results and applicable maps and information published by various regulatory agencies, researchers, and consultants were also used in the EIR analysis (e.g., California Geological Survey 2021a, 2021b; California Governor’s Office of Emergency Services 2021; Knudsen et al. 2000; Unruh and Hitchcock 2014; U.S. Geological Survey 2016; Working Group on Northern California Earthquake Potential 2012; Wong et al. 2021).

The geology and seismicity analyses conducted to prepare this chapter were based on critical review and use of the DCA Engineering Project Reports (EPRs) narrative reports and those associated technical memoranda that are relevant to geologic and seismic conditions and hazards. Information in the EPR narratives and technical memoranda and other existing reports and data were used to determine whether significant risks might occur from constructing and operating the project. The impact analysis for geology and seismicity was performed primarily using information on geologic substrate composition, topography, and potential fault rupture and earthquake hazards, largely derived from the EPR narrative reports and technical memoranda, as listed below.

- *Volume 1: Delta Conveyance Final Draft Engineering Project Report—Central and Eastern Options*
- *Volume 1: Delta Conveyance Draft Engineering Project Report—Bethany Reservoir Alternative*
- *Potential Future Field Investigations—Central and Eastern Corridor Options (Final Draft)*
- *Potential Future Field Investigations—Bethany Reservoir Alternative (Final Draft)*
- Conceptual Design Phase Seismic Site Response Analysis (Final Draft) Technical Memorandum, Version 1
- *Conceptual-Level Seismic Design and Geohazard Evaluation Criteria (Final Draft)*
- Liquefaction and Ground Improvement Analysis for Bethany Reservoir Alternative (Final Draft) Technical Memorandum
- Liquefaction and Ground Improvement Analysis (Final Draft) Technical Memorandum
- West Tracy Fault Preliminary Displacement Hazard Analysis (Final Draft) Technical Memorandum, Central and Eastern Options
- Supplementary Tunnel Information Technical Memorandum for the Bethany Reservoir Alternative
- Dewatering Estimates for Intake Facilities and Southern Forebay Emergency Spillway (Final Draft) Technical Memorandum

During the conceptual design process, the geological and geotechnical information within the EPR was used to understand subsurface conditions that vary within large construction sites, between construction sites, and along the proposed tunnel alignment. The information was used to understand subsurface geology and groundwater conditions related to preliminary design criteria and the need for specific construction methods, such as:

- Tunnel boring methods, tunnel liner segment design criteria, and tunneling production rates based upon soil pressures, soil abrasivity, and groundwater presence.
- Development of tunneling criteria for structure protection assessments, such as levees, road crossings, rail crossings, pipeline crossings, and nearby structures.
- Design of levee improvements around large construction sites at the tunnel launch shaft sites and height of all tunnel shafts based upon levee vulnerability evaluations.

- 1 • Use of drainage, subsurface cutoff walls, and ground improvement to improve geotechnical
- 2 stability, minimize surface settlements, and minimize changes to adjacent groundwater
- 3 conditions.
- 4 • Groundwater dewatering methods within the cutoff walls to minimize changes to adjacent
- 5 groundwater conditions.
- 6 • Removal and containment of peat soils that could compromise stability of constructed features.
- 7 • Design criteria to protect constructed features related to site-specific seismic conditions.
- 8 • Ability to reuse soil (including Reusable Tunnel Material) both on-site and at other construction
- 9 sites to reduce the need to haul soil or use soil material from offsite quarries.
- 10 • Use and depths of piles and types of installation methods (pile driving, vibrations, cast-in-place,
- 11 or other means).

12 The DCA reviewed and considered the available geological and geotechnical information for
 13 comparison of potential construction sites for intakes, tunnel shafts, Southern Complex, and Bethany
 14 Complex in the EPR screening analyses and for preparation of the conceptual engineering designs.
 15 However, most of the potential construction sites are located within agricultural areas that have not
 16 needed previous geotechnical investigations at targeted depths except near larger structures, such
 17 as bridges or levees. There were very few geotechnical investigations near the potential intake
 18 locations and along the tunnel alignments, especially for the eastern alignment alternatives and the
 19 Bethany Reservoir Alternative. Without the site-specific geotechnical information, available
 20 geological and geotechnical conditions were extrapolated for the project features in the EPRs.

21 As described in Chapter 3, Section 3.15, *Field Investigations*, geotechnical investigations would occur.
 22 During preparation of the EPRs and EIR, DWR and DCA initiated geotechnical investigations under
 23 the Soils Investigations for Data Collection in the Delta Project,¹⁰ which provided additional
 24 information. The geological and geotechnical investigations included soil borings on land and over
 25 water, cone penetration tests (CPTs) and geophysical surveys. The geophysical surveys included use
 26 of time domain electromagnetic equipment, cesium vapor total field magnetometer, electrical
 27 resistivity tomography equipment, and seismic refraction-reflection equipment. The results from
 28 more than 170 investigations were consistent with assumptions used in the EIR and EPR. These
 29 conditions result in more competent soils near Interstate (I-) 5 along the eastern alignment
 30 alternatives and Bethany Reservoir alternative tunnel alignments as compared to closer to the
 31 Sacramento River near the central alignment alternatives tunnel alignment. This information was
 32 also used to further validate the geotechnical assumptions and construction methods that were used
 33 for the conceptual designs of each facility in the EPRs. Results from these investigations are
 34 summarized below.

- 35 • **Intakes** – Soil investigations at the intakes confirmed the assumptions that the alluvium below
- 36 the SR 160 levee embankment is primarily composed of sand and silt and interbedded with
- 37 layers of clay and gravel.
- 38 • **Twin Cities Complex Tunnel Launch Shaft** – Soil investigations at the Twin Cities Complex site
- 39 confirmed the assumptions that the soils at depths of approximately 200 feet below ground

¹⁰ Soil Investigations for Data Collection in the Delta Project Final Initial Study and Mitigated Negative Declaration was adopted on July 9, 2020. Addenda to this document were adopted on February 19, 2021; June 30, 2022; and January 9, 2023.

surface are primarily composed of interlayers of sand, silt, and clay. The tunnel launch shafts at the Twin Cities Complex would extend to the depths investigated.

- **Lower Roberts Island Shaft** – In the area of Lower Roberts Island tunnel launch shaft site, the soil investigations confirmed the assumptions that the soils at depths of approximately 240 feet below ground surface are primarily composed of interlayers of sand, silt, and clay. The tunnel launch shafts on Lower Roberts Island would extend to the depths investigated.
- **Bethany Reservoir Pumping Plant** – In the area of Bethany Reservoir Pumping Plant, the soil investigations confirmed the assumptions that the soils are primarily clays with interbedded layers of sand.
- **Southern Complex near the Byron Tract Shaft** – In the area of the tunnel launch shaft on Byron Tract for the Southern Complex, the soils investigations confirmed the assumptions that the soils are primarily composed of interlayers of sand, silt, and clay.

The emphasis of the impact analysis was on identifying where the existing data suggest that geologic or seismic conditions pose a potentially serious threat to loss of life and loss of property, including the structural integrity of the conveyance facilities and related improvements. The analysis determines whether these conditions and associated risk can be reduced to a less-than-significant level by conformance with existing codes and standards and the application of accepted, proven design and construction engineering practices.

The methods used in this chapter to evaluate some of the geologic and seismic hazards are similar for both construction and operations and maintenance impacts; those impacts that are unique to one or the other are discussed under their respective sections.

As described in Chapter 3, Section 3.15, additional geological and geotechnical investigations would be conducted during the design phase of the project to further develop design criteria, provide geotechnical design parameters for proposed facilities structural foundations and subsurface structural elements such as shafts and tunnels. The field investigations would also include geotechnical pilot studies to further understand potential for settlement, need for ground improvement, pile installation methods, groundwater testing and monitoring, and West Tracy Fault studies.

10.3.1.2 Evaluation of Construction Activities

Geologic and seismic hazards were evaluated by analyzing the presence or creation of conditions that could jeopardize project worker safety and nearby properties. Specifically, potential impacts would occur if construction resulted in one of the following conditions.

- Unstable soil in tunnel bores, excavations, cut slopes, fill slopes, or areas of native soil material that is naturally subject to instability (e.g., landslide, debris flow).
- The presence of soil and groundwater conditions within the conveyance facility footprints and the conveyance alternatives and their construction conditions that could be subject to construction-induced liquefaction, such as that generated from impact pile driving and heavy construction vehicle vibrations.

In general, geologic methods and sequences were identified and were used to evaluate potential construction impacts related to geology and seismicity at the project level.

Tunnel-Bore Ground Settlement

The hazard of ground settlement above the tunnel during boring was assessed based on a review of relevant discussions in the EPR narrative reports for the central and eastern alignments and the Bethany Reservoir alignment and the Supplementary Tunnel Information Technical Memorandum in the EPR for the Bethany Reservoir alignment (Delta Conveyance Design and Construction Authority 2022i).

Excavation Failure

The likelihood that excavations such as shafts could collapse during construction was assessed based on a qualitative review of geotechnical boring logs and the discussions in the EPR narrative reports for the central and eastern alignments and the Bethany Reservoir alignment and the ground improvement technical memoranda for the central and eastern alignments and the Bethany Reservoir alignment.

Slope Instability

The potential for failure of new cut or fill slopes under construction was evaluated qualitatively based on slope inclination, slope height, and soil characteristics.

Soil Instability from Construction Vibrations

The potential for soil and levee instability (e.g., settlement) caused by ground vibrations generated by geotechnical investigations, pile driving, heavy equipment operations, and tunnel boring was evaluated based on the type, duration, and amplitude of the vibrations; soil characteristics; and distance of the potential failure areas from project workers.

Construction-related Liquefaction

The potential for construction activities such as impact pile driving, use of heavy equipment and heavy vehicle traffic, and geotechnical investigations to trigger liquefaction was evaluated based on the types of construction activities that could trigger ground motions, the soil characteristics, and the depth to groundwater.

10.3.1.3 Evaluation of Operations and Maintenance

To evaluate geologic and seismic impacts during operations and maintenance at a project level, geologic substrate/soil characteristics, fault rupture, liquefaction, and other hazards present within the conveyance facility footprints (both surface and at depth) were identified. Earthquake-induced seismic shaking hazards generated from both within the study area and in the greater San Francisco Bay Area, as well as the potential for operation of the proposed facilities to increase risks associated with geologic hazards, were identified based on quantitative information.

Fault Rupture

Two (or three) types of (surface) fault rupture (sudden, offset and slow-offset) were identified as having the potential to occur in the study area and vicinity. Additionally, there are blind thrust faults known to occur within the study area and vicinity; however, these are not anticipated to result in near-surface ground rupture.

The methodology for assessing the potential for fault rupture was based primarily on the available Alquist–Priolo Fault Zone maps. Additional information provided in the West Tracy Fault Preliminary Displacement Hazard Analysis (Final Draft) Technical Memorandum (Delta Conveyance Design and Construction Authority 2022d) and unpublished information pertaining to the West Tracy Fault was also used. Areas within the footprints of each alternative located within the Alquist–Priolo Fault Zones or having the potential of experiencing fault ruptures during future earthquakes were identified. Regarding potential rupture of the West Tracy Fault, the probabilistic and deterministic fault offsets during earthquakes were determined using the West Tracy Fault Preliminary Displacement Hazard Analysis (Final Draft) Technical Memorandum (Delta Conveyance Design and Construction Authority 2022d:8, 9).

The long-term offset attributable to fault creep was also estimated using fault slip rate and time frame considered.

Earthquake Ground Shaking

The potential exposure to ground shaking during future earthquakes and the effects on facilities within all project alternative footprints were evaluated using acceleration response spectral value at period of zero seconds, which is also widely used to characterize the level of ground motion. The DRMS Phase 1 Technical Memorandum for seismology (California Department of Water Resources 2007b), the DRMS *Risk Analysis Report* (California Department of Water Resources 2008), the Seismic Hazard Analyses and Development of Conceptual Seismic Design Ground Motions for the Delta Conveyance (Lettis Consultants International, Inc. 2021) served as the primary sources for the analysis.

Liquefaction and Lateral Spreading

The assessment of the hazard of liquefaction and differential settlement to occur at the conveyance facility locations was based on California Geological Survey Seismic Hazard Zone reports for liquefaction susceptibility for the Southern Complex vicinity and the results of the EPR Liquefaction and Ground Improvement technical memoranda for the central and eastern alignments and the Bethany Reservoir alignment(Alternative 5) (Delta Conveyance Design and Construction Authority 2022c, 2022f). The seismic vulnerability (including liquefaction potential) of existing levees in the Delta was based on two DRMS reports (California Department of Water Resources 2007a, 2007b).

The assessment of the hazard of lateral spreading triggered by liquefaction was based on the liquefaction hazard determined above and on a review of the presence of any open-face topographic features in the vicinity of each conveyance facility.

Buoyancy of Below-Ground Structures

The evaluation of the potential for below-ground or buried structures to become buoyant (i.e., become subject to “flotation”) and possibly fail was based on a review of the Conceptual Tunnel Lining Evaluation Technical Memorandum (Final Draft) (Delta Conveyance Design and Construction Authority 2022j:10, 11) for the central and eastern alignments and the Bethany Reservoir alignment.

1 Slope Instability

2 The potential for failure of new cut or fill slopes was assessed based on slope inclination, slope
 3 height, and soil characteristics, and approaches to constructing these slopes was assessed
 4 qualitatively based on the Soil Balance (Final Draft) Technical Memorandum (Delta Conveyance
 5 Design and Construction Authority 2022k) and Post-Construction Land Reclamation Technical
 6 Memorandum for the central and eastern alignments (Delta Conveyance Design and Construction
 7 Authority 2022l:5, 8) and the *Soil Balance and Reusable Tunnel Material Supplement—Bethany
 8 Reservoir Alternative (Final Draft)* (Delta Conveyance Design and Construction Authority 2022m:6)
 9 and *Post-Construction Land Reclamation Supplement—Bethany Reservoir Alternative* (Delta
 10 Conveyance Design and Construction Authority 2022n:5–9).

11 Seiche and Tsunami

12 The evaluation of the hazard for the impact of tsunami was based on review of online geographic
 13 information system data for tsunami-related wave runup in the Sacramento and San Joaquin Rivers.

14 The evaluation for the impact of a seiche was based on review of expected earthquake-induced
 15 ground motions, presence of any landslide-prone areas adjacent to the conveyance facilities, and the
 16 height of the freeboard incorporated into the design of facilities that would impound water.

17 10.3.2 Thresholds of Significance

18 This impacts analysis assumes that a project alternative would have a significant impact under CEQA
 19 if implementation would result in one of the following conditions.

- 20 • Directly or indirectly cause potentially substantial impacts, including the risk of loss, injury, or
 21 death involving:
 - 22 ○ Rupture of a known earthquake fault, as delineated on the most recent Alquist–Priolo
 23 Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other
 24 substantial evidence of a known fault. Refer to Division of Mines and Geology Special
 25 Publication 42.
 - 26 ○ Strong seismic ground shaking.
 - 27 ○ Landslides.
- 28 • Be located on a geologic unit or soil that is unstable or that would become unstable as a result of
 29 the project and potentially result in on- or off-site landslide, lateral spreading, settlement,
 30 liquefaction, or collapse.
- 31 • Be subject to inundation by seiche or tsunami.

32 10.3.2.1 Evaluation of Mitigation Impacts

33 CEQA also requires an evaluation of potential impacts caused by the implementation of mitigation
 34 measures. Following the CEQA conclusion for each impact, the chapter analyzes potential impacts
 35 associated with implementing both the Compensatory Mitigation Plan (CMP) and the other
 36 mitigation measures required to address with potential impacts caused by the project. Mitigation
 37 impacts are considered in combination with project impacts in determining the overall significance
 38 of the project. Additional information regarding the analysis of mitigation measure impacts is
 39 provided in Chapter 4, *Framework for the Environmental Analysis*.

10.3.3 Impacts and Mitigation Approaches

10.3.3.1 No Project Alternative

As described in Chapter 3, *Description of the Proposed Project and Alternatives*, CEQA Guidelines Section 15126.6 directs that an EIR evaluate a specific alternative of “no project” along with its impact. The No Project Alternative in this Final EIR represents the circumstances under which the project (or project alternative) does not proceed and considers predictable actions, such as projects, plans, and programs, that would be predicted to occur in the foreseeable future if the Delta Conveyance Project is not constructed and operated, which are identified in Appendix 3C, *Defining Existing Conditions, No Project Alternative, and Cumulative Impact Conditions*, Section 3C.3.2, *No Project Alternative Conditions*, including Table 3C-2. This description of the environmental conditions under the No Project Alternative first considers how geology and seismicity could change over time and then discusses how other predictable actions described in Appendix 3C, Section 3C.3.2.5, *No Project Alternative Assumptions for Water Agency Actions*, could affect geology and seismicity.

Future Geology and Seismicity Conditions

For geology and seismicity, most future conditions are not anticipated to substantially change compared to existing conditions because climate change, sea level rise, and other variables are not expected to affect the incidence of fault rupture and incidence or strength of earthquake ground shaking if the project (or project alternative) does not proceed. However, sea level rise could cause an indirect impact on the potential for liquefaction and its secondary effects by raising the water table underlying Delta islands. Sea level rise could also make Delta levees more vulnerable to liquefaction of their foundations and to mass failure of their waterside slopes as a result of increased soil pore water pressure at a higher elevation of the levee. Levee failure caused by liquefaction of levee foundations and mass failure of levee slopes could cause inundation of Delta islands.

In the event of large-scale, seismically induced levee failures, DWR, in cooperation with the Metropolitan Water District and other federal and state agencies, would develop an Emergency Freshwater Pathway. The purpose of the freshwater pathway is to move fresh water from north to south through the Delta to the existing pumping facilities of the State Water Project and Central Valley Project (Wong et al. 2021).

Predictable Actions by Others

A list and description of actions included as part of the No Project Alternative are provided in Appendix 3C, Section 3C.3.2.5. As described in Chapter 4 and Appendix 3C, the No Project Alternative analyses focus on identifying the additional water-supply-related actions public water agencies may opt to follow if the Delta Conveyance Project does not occur.

Public water agencies participating in the Delta Conveyance Project have been grouped into four geographic regions. The water agencies within each geographic region would likely pursue a similar suite of water supply projects under the No Project Alternative (Appendix 3C, Section 3C.3.2.5). Construction of water supply reliability projects would result in various construction types that would each be designed to address the site-specific geologic conditions, as well as the impacts that the geologic environment would have on the facility.

Desalination projects would most likely be pursued in the northern and southern coastal regions. The southern coastal regions would likely require larger and more desalination projects than the northern coastal region to replace the water yield that otherwise would have been received through Delta Conveyance. These projects would be sited near the coast. Groundwater recovery (brackish water desalination) would involve similar facilities, but could occur across the northern inland, southern coastal, southern inland regions and in both coastal and inland areas, such as the San Joaquin Valley. Facility location and design would address avoidance of Alquist–Priolo Fault Zones, unstable ground (e.g., liquefaction, lateral spreading, slope failure), the potential for tsunami or seiche, and withstanding anticipated seismic shaking. Design parameters would vary according to underlying geologic materials such as competent bedrock or less competent and loose sedimentary (e.g., alluvial) deposits.

The northern and southern coastal regions are also most likely to explore constructing groundwater management projects. The southern coastal region would require more projects than the northern coastal region under the No Project Alternative. Groundwater management projects would occur in association with an underlying aquifer, but could occur in a variety of locations. Since these projects require an underlying aquifer, they would generally be in areas with deep sedimentary (e.g., alluvial) deposits. Construction activities for each project could require excavation for the construction of the recharge basins, conveyance canals, and pipelines and drilling for the construction of recovery wells (with completion intervals between approximately 200 and 900 feet below ground surface). Construction activities would include site clearing; excavation and backfill; and construction of basins, pipelines, and pump stations. Earthwork activities associated with the construction of recharge basins would involve earthmoving, excavation, and grading. Pipelines would likely be constructed using typical open trench construction methods. In some cases where siphons would be installed, jack and bore methods could be used to tunnel under and avoid disruption of surface features. Buildings required for these projects would generally be small, e.g., housing pumps or electrical equipment.

Water recycling projects could be pursued in all four regions. The northern inland region would require the fewest number of wastewater treatment/water reclamation plants, followed by the northern coastal region, followed by the southern coastal region. The southern inland region would require the greatest number of water recycling projects to replace the anticipated water yield that it would receive through Delta Conveyance. These projects would be located near water treatment facilities and could entail large buildings and potentially expanded outdoor treatment ponds. Building size and associated infrastructure for water recycling projects would vary depending on the type of project (e.g., for landscape irrigation, groundwater recharge, dust control, industrial processes), but could require earth moving activities, grading, excavation, and trenching. Design and construction of all project components would address site geologic and seismic conditions. In the southern inland region where a greater number of projects would be needed as a substitute for Delta Conveyance, the potential for an impact would also be increased, although appropriate design and construction measures would minimize potential impacts.

Water efficiency projects could be pursued in all four regions and involve a wide variety of project types, such as flow measurement or automation in a local water delivery system, lining of canals, use of buried perforated pipes to water fields, and additional detection and repair of commercial and residential leaking pipes. These projects could occur anywhere in the regions and most would involve only small buildings to house equipment or electrical facilities. Little ground disturbance or would occur in previously disturbed areas.

As detailed above, all project types across all regions would involve relatively typical construction techniques and would be required to conform to seismic standards other requirements which take into consideration the geologic conditions of the sites in which these facilities may be located. These requirements would be commensurate with the type of water supply action being implemented. As an example, desalination plants or large-scale water recycling projects would be required to meet seismic standards and a wide range of building code requirements, whereas water conservation actions such as retrofits would have little or no need to comply with seismic or other standards.

10.3.3.2 Impacts of the Project Alternatives on Geology and Seismicity

Impact GEO-1: Loss of Property, Personal Injury, or Death from Structural Failure Resulting from Rupture of a Known Earthquake Fault or Based on Other Substantial Evidence of a Known Fault

All Project Alternatives

Project Construction

Project construction activities would not increase the potential for loss of property, personal injury, or death from structural failure resulting from rupture of a known earthquake fault under any of the alternatives. A surface rupture of the West Tracy Fault (if field investigations determine surface rupture to be a hazard) during construction of certain Southern Complex or Bethany Complex water conveyance facilities would not pose a threat to workers at the construction sites as the suspected fault alignment does not cross any proposed aboveground structures. However, workers could be at risk from the effects of ground deformation along the West Tracy Fault alignment even in the absence of surface rupture.

The field investigations would include geotechnical investigations, including excavation of five 1,000-foot-long test trenches along the projected alignment of the West Tracy Fault between Byron and the Clifton Court Forebay, which cover the alignments for Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5. Because of the depth of the fault, neither the trench excavations nor the other geotechnical investigations are likely to increase the potential for fault rupture. Similarly, the chances of personnel conducting the West Tracy Fault trench study, geotechnical borings and geophysical surveys being present at the time that fault rupture (if this is indeed a possibility) occurs are remote.

Operations and Maintenance

Strict regulations apply to faults for development in Alquist–Priolo Earthquake Fault Zones (California Geological Survey 2008). There are no faults in or near the project area designated as an Alquist–Priolo Earthquake Fault Zone (California Geological Survey 2021a).

However, the C-E EPR and other sources (Delta Conveyance Design and Construction Authority 2022d:9; Unruh and Hitchcock 2014:14) report that the West Tracy Fault may have the potential for surface rupture along the western portion of its alignment. The West Tracy Fault near the Southern Complex may have experienced movement within the past 35,000 years and, therefore, is potentially active. It is currently unknown whether the West Tracy Fault is capable of rupturing to the ground surface to the south of the proposed Southern Forebay area in a large earthquake, but the principal fault displacement hazard at the proposed dual southern tunnels (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c) is low to very low. Based on available information, the width of the permanent deformation of soils in the shallow subsurface that a rupture on the West Tracy Fault

may cause during a large earthquake is uncertain (Delta Conveyance Design and Construction Authority 2022d:8, 9). Broad folding and tilting, where differential vertical displacement may be distributed over hundreds of feet, may result if the West Tracy Fault is locally blind (i.e., the top of the fault is hundreds to thousands of feet below the ground surface). If the West Tracy Fault extends to the shallow subsurface (to within a hundred feet to tens of feet below ground), the width of deformation in the shallow subsurface may be about 30 feet or less. Additionally, work by DCA determined that there could be significant fault offset over a short distance, essentially confirming a narrow width of predicted rupture (Delta Conveyance Design and Construction Authority 2022d:10). The precise location of the West Tracy Fault is poorly understood. Unruh and Hitchcock (2014:44) have mapped the fault beneath the southwestern part of the Clifton Court Forebay and approximately 1,800 feet south of what would be the southern tip of the Southern Forebay (Figure 10-6). For central and eastern alignments, the fault alignment would intersect the dual southern tunnels between the Southern Forebay Outlet Structure double launch shaft and the South Delta Outlet and Control Structure. For the Bethany Reservoir alignment, the fault alignment would intersect the tunnel segment between the Union Island maintenance shaft and the surge basin reception shaft/Bethany Reservoir Pumping Plant.

To further investigate the geometry and location of the West Tracy Fault between the town of Byron and the area southeast of the Clifton Court Forebay, during the design phase, five test trenches (up to approximately 1,000 feet long and 20 feet deep) would be excavated along a line running from the southeast of Byron to the southeast of Clifton Court Forebay, along the suspected alignment of the fault. Additionally, two arrays of surface geophysical surveys (1,000 feet long and 3 feet wide), conducted as part of the field investigations, would be completed and up to 15 CPTs and six soil borings would be completed to a depth of 150 feet. Selected soil samples from the test borings would be subjected to age-dating laboratory testing. The Conceptual-Level Seismic Design and Geohazard Evaluation Criteria (Final Draft) Technical Memorandum (Delta Conveyance Design and Construction Authority 2022o) describes guidelines for assessing the permanent ground displacement (PGD) hazard from fault rupture from a major seismic event at the conveyance facilities. A PGD from fault rupture or from fault-related geologic folding without fault rupture could be a significant hazard for critical infrastructure that intersects or is adjacent to active faults. The following key parameters would be considered as part of the engineering evaluation and design for PGDs due to fault rupture.

- The fault location and the level of uncertainty for the determination.
- An estimate of the expected co-seismic rupture and the level of uncertainty for the determination.
- The style of faulting, such as direction of displacement and horizontal and vertical components of fault slip.
- The distribution of fault displacement, such as folding, knife-edge dislocation, or distributed shear across a zone.

Unlike oil and gas well drilling and hydraulic fracturing (also referred to as fracking), which has been known to stimulate seismic activity, geotechnical exploration drilling does not introduce very high - pressure fluids into the ground. During geotechnical drilling, the downhole drilling fluid pressures are limited to those required to balance the soil and water pressures at depths less than 200 feet, typically less than 150 pounds per square inch. In contrast, downhole drilling fluid pressures used to stimulate oil and gas production often exceed 9,000 pounds per square inch. Consequently, the

1 likelihood of the geotechnical investigations to trigger an earthquake on the West Tracy Fault or
2 other faults in the region is low.

3 The final design of the conveyance facilities, which would be based on the results of the geological
4 and geotechnical investigations described above and the results of the fault rupture displacement
5 hazard assessment, would meet USACE, DWR, American Society of Civil Engineers, and other
6 industry standards to prevent failure of the conveyance facilities as a result of fault rupture or fault-
7 related geologic folding.

8 ***CEQA Conclusion—All Project Alternatives***

9 Although both the central and eastern alignments pass through the Thornton Arch, based on
10 available information, it does not present a hazard of surface rupture because it is a blind thrust
11 fault (California Department of Water Resources 2007b:8, 12), and there would be no increased
12 likelihood of loss of property, personal injury, or death associated with the Thornton Arch. The
13 impact would be less than significant for a possible surface rupture of the Thornton Arch; therefore,
14 no mitigation is required.

15 A rupture of the West Tracy Fault (if field investigations determine surface rupture to be a hazard)
16 during construction of certain Southern Complex or Bethany Complex water conveyance facilities
17 would not pose a threat to workers at the construction sites, as the suspected fault alignment does
18 not cross any proposed aboveground structures. However, workers in the tunnel boring machine
19 (TBM) could be at risk from a rupture on the fault, but the risk of such a rupture occurring during
20 construction is low. The impact would be less than significant for a possible surface rupture of the
21 West Tracy Fault. No mitigation is required.

22 Other than the West Tracy Fault, there are no known active faults capable of surface rupture in the
23 project area. The field investigations would include trench explorations and geophysical surveys
24 along the possible surface trace of the West Tracy Fault. The investigations may determine that fault
25 is capable of rupture. Additionally, as described in the West Tracy Fault Preliminary Displacement
26 Hazard Analysis (Final Draft) (Delta Conveyance Design and Construction Authority 2022d:2),
27 possible ground deformation (e.g., uplift) from fault movement along the fault could occur without
28 rupture in the vicinity of the Southern Complex or Bethany Complex (Figure 10-6). Depending on
29 the precise alignment of the fault relative to the conveyance facilities, surface rupture and ground
30 deformation could damage the southern tip of the Southern Forebay and Bethany Reservoir
31 alignment aqueduct pipelines, and in extreme cases, the damage to the facilities could disrupt the
32 water supply through the conveyance system or could cause an uncontrolled release of water from
33 tunnels, the Southern Complex, or the Bethany Complex facilities, resulting in uncontrolled flooding.
34 However, DWR would conduct field investigations prior to construction to determine the potential
35 for fault rupture, slip rate of fault displacement, and PGA generated by movement on the West Tracy
36 Faults. The results of the investigations would be used to inform the detailed design of the
37 conveyance facilities. The detailed design would be consistent with applicable design standards and
38 building codes, which require that all facilities and active construction sites be designed and
39 managed to meet Cal/OSHA and safety-and-collapse-prevention requirements for the anticipated
40 seismic loads, such as by implementing shoring, bracing, lighting, excavation depth restrictions,
41 required slope angles, and other measures, to protect worker safety.

42 Because the geotechnical investigations would not introduce high pressure fluids into the ground
43 (which are associated with causing seismic activity), the likelihood of the investigations to trigger an

1 earthquake on the West Tracy Fault or other faults in the region is low. The impact would be less
2 than significant. No mitigation is required.

3 Additionally, based on the field investigations and the PGD, a California-licensed geotechnical
4 engineer or engineering geologist would ensure that the final design conforms to applicable design
5 specifications and standards. When applied to project design, the standards set by USACE, DWR,
6 American Society of Civil Engineers, and other entities have been proven to enable facilities to
7 withstand fault rupture or fault displacement such that the Delta Conveyance Project facilities would
8 be able to withstand the design ground movements or deformations. Accordingly, operation of the
9 facilities would not increase the likelihood of loss of property, personal injury, or death of
10 individuals in the event of fault rupture or ground deformation at the Southern Complex or Bethany
11 Complex. The impact would be less than significant. No mitigation is required.

12 ***Mitigation Impacts***

13 *Compensatory Mitigation*

14 Although the CMP described in Appendix 3F, *Compensatory Mitigation Plan for Special-Status Species*
15 *and Aquatic Resources*, does not act as mitigation for impacts on this resource from project
16 construction or operations and maintenance, its implementation could result in impacts on this
17 resource. CEQA requires analysis of the impacts of mitigation; therefore, this discussion is included
18 here.

19 Compensatory mitigation, as described in Appendix 3F would be implemented on Bouldin Island
20 and the I-5 ponds, where there are no known or suspected earthquake faults capable of rupture in
21 the mitigation areas, nor are the mitigation areas within the Thornton Arch zone, such that the
22 hazard of loss of property, personal injury, or death from structural failure caused by fault rupture is
23 low. Therefore, the project alternatives combined with compensatory mitigation implemented at
24 Bouldin Island and the I-5 ponds would not change the overall impact conclusion of less than
25 significant.

26 As described in Appendix 3F, compensatory mitigation would also involve construction of setback
27 levees at undetermined tidal wetland or channel margin restoration sites within the North Delta Arc.
28 However, it is unknown at this time if any of the levees would cross any known earthquake faults
29 because the West Tracy Fault is the only fault that has the potential for surface rupture in the Delta,
30 and because its trace appears to not cross any tidal channels, it is unlikely that any of the levees at
31 the undetermined tidal wetland or channel margin restoration sites would be subject to fault
32 rupture. Therefore, the project alternatives combined with compensatory mitigation would not
33 change the overall impact conclusion of less than significant.

34 *Other Mitigation Measures*

35 The other mitigation measures would not involve activities that could trigger an earthquake on the
36 West Tracy Fault or other faults in the region, and there would be no increased likelihood of loss of
37 property, personal injury, or death associated with surface fault rupture. In addition, it is unlikely
38 that any of the other mitigation measures would involve construction of structures or pipelines that
39 would cross the West Tracy Fault or other faults in the region; nor would they be within the
40 Thornton Arch zone. Therefore, the hazard of loss of property, personal injury, or death from
41 structural failure caused by fault rupture as a result of implementing the compensatory mitigation
42 and the other mitigation measures, combined with project alternatives, remains low. The overall

1 impact of implementing the compensatory mitigation and other mitigation measures, combined
2 with the project alternatives, would not change the impact conclusion of less than significant.

3 **Impact GEO-2: Loss of Property, Personal Injury, or Death from Strong Earthquake-Induced** 4 **Ground Shaking**

5 ***All Project Alternatives***

6 *Project Construction*

7 Project construction activities would not increase the potential for earthquake shaking to occur in
8 the project area. However, earthquakes could be generated from local seismic sources during
9 construction of the water conveyance facilities (Table 10-11) and pose threats to workers,
10 particularly those working in shafts and tunnels, behind vulnerable levees and cofferdams, and in
11 similar situations. For example, workers could be at risk from flooding caused by seismically
12 induced levee failure on Bouldin Island, Lower Roberts Island, and other islands. Ground shaking
13 could cause injury or death of workers at the construction sites as a result of facilities collapse,
14 especially those conveyance facilities located closer to regional and local active faults, such as the
15 facilities that make up the Southern Complex or Bethany Complex and the southern tunnel segments
16 and tunnel shafts. (See related Impact FP-2 in Chapter 7, *Flood Protection*, for additional discussion
17 of worker safety as affected by flooding as a result of failure of levees and other facilities during
18 construction.)

19 The field investigations would include geotechnical investigations where the investigators would be
20 in areas subject to ground shaking. However, because the investigators would not be working in
21 structures, the likelihood of an injury caused by strong earthquake event occurring while the
22 investigations are being conducted is low, and the investigation activities would not trigger an
23 earthquake, the investigations are unlikely to cause a loss of property, personal injury, or death from
24 strong earthquake-induced ground shaking.

25 *Operations and Maintenance*

26 Earthquakes may occur along Delta-area and regional faults during operation and maintenance of
27 the water conveyance facilities. Unless properly engineered, ground shaking in the project area
28 could damage the intakes, tunnels, and tunnel shafts, Southern Complex or Bethany Complex
29 facilities, and other facilities, disrupting the water supply through the conveyance system. During an
30 extreme event of seismic shaking, the uncontrolled release of water from the damaged tunnels,
31 Southern Forebay, and other facilities could cause flooding, disruption of water supplies to the
32 south, and inundation of structures, potentially resulting in loss of property, personal injury, or
33 death.

34 ***CEQA Conclusion—All Project Alternatives***

35 Seismically induced ground shaking that may occur could cause damage, collapse, or other failure of
36 project facilities while under construction and during operations and maintenance. The damage to
37 the facilities could disrupt the water supply through the conveyance system or could cause an
38 uncontrolled release of water from the damaged tunnels, Southern Complex, or Bethany Complex
39 facilities, resulting in flooding or collapse of facilities like bridges. The ground shaking could also
40 cause loss of property, personal injury, or death as a result of damage or failure of the conveyance
41 facilities, both during construction and operations and maintenance. Prior to construction, DWR

would conduct additional field investigations, which include geotechnical studies, to inform the detailed design of the conveyance facilities. The detailed design would be consistent with applicable design standards and building codes, which require that all facilities and active construction sites be designed and managed to meet Cal/OSHA and safety-and-collapse-prevention requirements for the anticipated seismic loads, such as by implementing shoring, bracing, lighting, excavation depth restrictions, required slope angles, and other measures, to avoid potential release of water from the facilities and flood the surrounding area and to protect worker safety. The project's seismic guidelines discuss a minimum level of ground shaking (currently set at ground shaking with a 200-year return period or a 5% chance of being exceeded in 10 years) that would be used to assess the safety of temporary works during construction (Delta Conveyance Design and Construction Authority 2022g:4–6). Additionally, the facilities have been designed with safety precautions/system redundancy in the event of an extreme case where facilities are damaged. The detailed design would also conform to other standards and codes by applying accepted, proven construction engineering practices to reduce any potential risk such that construction of the facilities would not create an increased likelihood of loss of property, personal injury, or death of individuals as a result of seismic shaking. Because the project would conform to relevant design standards and building codes and would apply proven engineering practices, the impact would be less than significant.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on this resource from project construction or operations and maintenance, its implementation could result in impacts on this resource. CEQA requires analysis of the impacts of mitigation; therefore, this discussion is included here.

As described in Appendix 3F, compensatory mitigation would also involve construction of setback levees at undetermined tidal wetland or channel margin restoration sites within the North Delta Arc. Moderate earthquake-induced ground shaking could damage the levees, and strong earthquakes could cause the levees to fail, resulting in an uncontrolled release of water and potentially flooding, loss of property, personal injury, or death. However, since the setback levees would be engineered in the same manner as those on Boulton Island and consistent with applicable design standards and building codes, the hazard of ground shaking on the stability of the levees would be reduced to an acceptable level. The impact would not change the impact conclusion of less than significant after implementation of the CMP. Therefore, the project alternatives combined with compensatory mitigation would not change the overall impact conclusion of less than significant.

Other Mitigation Measures

The other mitigation measures could involve construction of structures that would be affected by seismically induced ground shaking. However, these structures and any visual or noise barriers (which could include chain link fencing, a wood or concrete barrier, or other similar barrier a minimum of 6 feet tall) would be constructed to be consistent with applicable design standards and building codes such that there would be no increased likelihood of loss of property, personal injury, or death associated with strong ground shaking. Therefore, the hazard of loss of property, personal injury, or death from structural failure caused by strong ground shaking as a result of implementing compensatory mitigation and other mitigation measures, combined with project alternatives,

remains low. The overall impact of implementing the compensatory mitigation and the other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant.

Impact GEO-3: Loss of Property, Personal Injury, or Death from Earthquake-Induced Ground Failure, including Liquefaction and Related Ground Effects

All Project Alternatives

Project Construction

Project construction activities would not increase the potential for loss of property, personal injury, or death from structural failure resulting from earthquake-induced ground failure, including liquefaction under any of the alternatives, because the ground vibrations generated by the activities would not create sufficient ground motions to trigger liquefaction.

However, an earthquake of sufficient magnitude and duration of shaking along local or regional faults could result in ground failure, including liquefaction during construction, and could cause injury or death of workers as a result of collapse of the conveyance facilities. Refer to the discussion below, under *Operations and Maintenance*, for detail on the specific facility construction sites where a hazard for liquefaction could occur.

Given the infrequency of strong ground shaking in the project area, the likelihood that earthquake-induced liquefaction would occur at the time the personnel are conducting field investigations is low. Further, the personnel would not be in any structures during the investigations; therefore, they would not be subject to liquefaction-induced structural hazards and damage should a strong earthquake occur.

Operations and Maintenance

The Liquefaction and Ground Improvement Analysis Technical Memorandum for the central and eastern alignments (Delta Conveyance Design and Construction Authority 2022c) describes the results of a conceptual-level evaluation of the liquefaction potential of the foundation soils for all the facility sites. The evaluation determined that the three intakes and the Southern Forebay Inlet Structure and tunnel launch shaft sites are subject to liquefaction.

The available data acquired to date in support of the project design indicate the main tunnel would be bored through consolidated soil materials, which would have a low potential for liquefaction. However, because the data are limited, it is possible that the liquefaction potential may be determined to be greater as more data become available in the future.

The aqueduct pipelines as part of Alternative 5 would be constructed at a depth in which groundwater is likely to be encountered. However, the substrate underlying the pipelines consists of clayey soil and is not liquefiable. Therefore, there is no hazard for liquefaction to occur in the material surrounding the aqueduct pipelines.

The Liquefaction and Ground Improvement Analysis for Bethany Reservoir Alternative Technical Memorandum (Delta Conveyance Design and Construction Authority 2022f) describes the results of a conceptual-level liquefaction potential evaluation for the Union Island tunnel maintenance shaft, the Bethany Reservoir Pumping Plant and Surge Basin, and the Bethany Reservoir Discharge Structure. The evaluation determined that a significant liquefaction potential exists at the Union

1 Island tunnel maintenance shaft site. The evaluation determined that the soil characteristics are
2 clayey at the Bethany Reservoir Pumping Plant and Surge Basin and Bethany Reservoir Discharge
3 Structure, such that there is no significant liquefaction potential at these sites. Similar to the
4 potential effect during project construction, an earthquake of sufficient magnitude along local or
5 regional faults could result in ground failure, including liquefaction during operations and
6 maintenance, and could damage the affected conveyance facilities.

7 ***CEQA Conclusion—All Project Alternatives***

8 During construction, seismically induced ground shaking could cause liquefaction and related
9 ground effects at certain conveyance facilities. The ground effects could cause temporary structural
10 features (e.g., scaffolding) to collapse and could cause injury or death of the workers. However,
11 adherence to standard Cal-OSHA health and safety regulations would ensure the safety of the
12 construction workers during an earthquake event. The impact would be less than significant.

13 Seismically induced liquefaction could occur at the locations where the field investigations are being
14 conducted. However, in most cases since the investigators would not be working in or around
15 structures, the impact would be less than significant.

16 The safety of investigators working in fault trenches for the West Tracy Fault investigation could be
17 jeopardized in the event of liquefaction for those trenches that are located in a liquefaction hazard
18 zone. However, adherence to standard Cal-OSHA health and safety regulations require shoring of
19 trenches deeper than 5 feet and emergency trench egress measures would ensure the safety of the
20 workers during an earthquake event. The impact would be less than significant.

21 During operation and maintenance, seismically induced ground shaking could cause liquefaction
22 and related ground effects at certain conveyance facilities. The consequences of liquefaction could
23 be manifested by soil compaction or settlement, loss of soil-bearing capacity, lateral spreading,
24 increased lateral soil pressure, and buoyancy within the zones of liquefaction. Failure of the tunnels,
25 certain tunnel shafts, intakes, facilities at the Southern Complex or Bethany Complex facilities
26 including the aqueduct pipelines, bridges, and other structures and facilities could result in injury or
27 loss of life and uncontrolled releases of water, flooding, and disruption of water supply deliveries
28 through the conveyance system. Prior to construction, DWR would conduct the field investigations,
29 which include advancing soil borings and conducting standard penetration tests to characterize
30 subsurface conditions and installing groundwater test wells to determine the depth to groundwater
31 at various facility locations. Combined with historic boring logs and studies done in support of the
32 liquefaction and ground improvement analyses conducted for central and eastern alignments and
33 the Bethany Reservoir alignment, the results of these investigations would be used to inform the
34 detailed design of the conveyance facilities. The design, which would include measures for ground
35 improvement such as deep mechanical mixing to form a soil-cement grid at those facility locations
36 determined to be subject to liquefaction, would be consistent with applicable design standards and
37 building codes. Seismic design criteria of all project facilities are in general conformance with those
38 recommended in the Conceptual-Level Seismic Design and Geohazard Evaluation Criteria (Final
39 Draft) Technical Memorandum (Delta Conveyance Design and Construction Authority 2022o), by
40 DWR for the State Water Project in the Seismic Loading Criteria Report (California Department of
41 Water Resources 2012a) with some modifications to incorporate specific requirements of agencies
42 including DWR's Division of Safety of Dams, USACE, California Department of Transportation, and
43 other agencies. The detailed design would also conform to other standards and codes by applying
44 accepted, proven construction engineering practices to reduce the risk that the facilities could fail or

that there would be an increased hazard of loss of property, personal injury, or death of individuals as a result of liquefaction and related ground effects. The impact would be less than significant.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on this resource from project construction or operations and maintenance, its implementation could result in impacts on this resource. CEQA requires analysis of the impacts of mitigation, and therefore, this discussion is included here.

The potential for liquefaction at the Bouldin Island compensatory mitigation area has not been formally evaluated. However, the Delta island immediately southwest of Bouldin Island (i.e., the Webb Tract) has been determined to be in a liquefaction zone by the California Geological Survey (2021b). Given that Bouldin Island and the Webb Tract are underlain by the same geologic unit (Pleistocene eolian deposits) (Figure 10-3), are underlain by similar surface soils (generally the organic Rindge series), and have a shallow water table, it is possible that the Bouldin Island compensatory mitigation area may be subject to liquefaction.

The potential for liquefaction at the I-5 ponds compensatory mitigation area has not been formally evaluated. However, the mitigation proposed at this mitigation area would involve only excavation and minor recontouring with no construction of levees or other similar earthworks or structures. Consequently, the mitigation construction activities would not increase the potential for liquefaction to occur and would not have any features that could be affected by liquefaction to the point that there would be no loss of property, personal injury, or death from earthquake-induced ground failure.

CMP project design would require that any new setback levee be designed and constructed according to applicable design standards and building codes. The detailed design would also conform to other standards and codes by applying accepted, proven construction engineering practices to reduce the risk that the facilities could fail or that there would be an increased hazard of loss of property, personal injury, or death of individuals as a result of liquefaction and related ground effects. Therefore, the project alternatives combined with compensatory mitigation implemented at Bouldin Island and the I-5 ponds would not change the overall impact conclusion of less than significant.

As described in Appendix 3F, compensatory mitigation would also involve construction of setback levees at undetermined tidal wetland or channel margin restoration sites within the North Delta Arc. Earthquake-induced ground shaking could cause liquefaction of the levee foundations, potentially causing the levees to fail and result in an uncontrolled release of water and potentially flooding, loss of property, personal injury, or death. However, the project alternatives would be engineered consistent with applicable design standards and building codes. Therefore, the project alternatives combined with compensatory mitigation would not change the overall impact conclusion of less than significant.

Other Mitigation Measures

The other mitigation measures could involve construction of structures that would be affected by liquefaction to the point that there could be a loss of property, personal injury, or death from

1 earthquake-induced ground failure, such as liquefaction. The hazard of loss of property, personal
2 injury, or death from structural failure caused by earthquake-induced ground failure as a result of
3 implementing the compensatory mitigation and the other mitigation measures, combined with
4 project alternatives, remains low. However, any visual or noise barriers (which could include chain
5 link fencing, a wood or concrete barrier, or other similar barrier a minimum of 6 feet high) would be
6 constructed to be consistent with applicable design standards and building codes such that the
7 overall impact after implementing the compensatory mitigation and the other mitigation measures,
8 combined with project alternatives, would not change the impact conclusion of less than significant.

9 **Impact GEO-4: Loss of Property, Personal Injury, or Death from Ground Settlement, Slope** 10 **Instability, or Other Ground Failure**

11 This impact discussion addresses the hazards of ground settlement associated with tunnel boring
12 during and after boring; ground settlement caused by construction of project facilities at the surface;
13 failure of cut slopes, fill slopes, embankments, stockpile slopes, and excavations (including those
14 resulting from construction dewatering); and landsliding on natural slopes.

15 ***All Project Alternatives***

16 *Project Construction*

17 For all project alternatives, field investigations prior to the start of construction would involve a
18 variety of ground-disturbing activities. With the exception of the trenching that would be conducted
19 to enable the West Tracy Fault investigation, none of these activities are likely to cause an increase
20 in the hazard settlement or slope failure. The trenching would involve excavation of five 1,000-foot-
21 long, 20-foot-deep test trenches along the suspected alignment of the West Tracy Fault. Additionally,
22 at all conveyance facility sites, test trenches (approximately 30 feet long and 10 feet deep) would be
23 excavated to characterize the near-surface soils. Where unstable soils are present, the trench walls
24 could fail or collapse, threatening worker safety. DWR would conform to Cal/OSHA and other state
25 code requirements, such as by implementing shoring, bracing, excavation depth restrictions, and
26 required slope angles to protect worker safety. Shoring of trenches deeper than a 5-foot depth and
27 emergency trench egress measures would ensure the safety of the workers during the investigation.
28 The trenches would be immediately backfilled following observations of the soil conditions
29 encountered in the trench. The impact would be less than significant.

30 **Tunneling-Induced Ground Settlement.** Both the central and eastern tunnel alignments would
31 cross under levees, railroads, highways, and the East Bay Municipal Utility District Mokelumne
32 Aqueducts. The top of the tunnel structure would cross under these surface features at depths of
33 approximately 100 feet under the ground surface and in some areas approximately 80 feet under
34 the ground surface (e.g., Bouldin Island for central alignment and near the Southern Forebay Outlet
35 Structure). The tunnel and shafts would be excavated in saturated soft ground conditions. At the
36 tunnel depth, the soils are expected to consist of clays, silts, silty and clayey sands, and clean sands,
37 which are below the depth of the near-surface peat layers.

38 As tunnel boring proceeds, settlement of the soil above the tunnel could potentially occur as a result
39 of uncontrollable ground loss. In extreme circumstances, the settlement effects could translate to the
40 ground surface. Tunneling at a greater depth below ground level induces less ground surface
41 settlement because a greater volume of soil material is available above the tunnel to fill any void
42 space.

1 During tunnel boring, the main tunnels would be lined with precast, 18-inch-thick concrete
2 segmental liners. This liner thickness is based on a tunnel inside diameter of 36 feet and experience
3 with other tunnel projects having similar ground conditions. The voids between the liners and
4 excavated soil would be continuously pressure-grouted simultaneous with the installation of new
5 liner segments. The tunnel liner would provide support against static and dynamic external and
6 internal pressures. External pressures would include TBM construction forces, earth weight,
7 groundwater pressure, and earthquake loads.

8 The main tunnel would be constructed within the Alluvial Fans from Glaciated Basins geologic unit
9 (Figure 10-3), not the Alluvium unit. The older Alluvial Fans from Glaciated Basins (Modesto and
10 Riverbank formations) unit is older and partially cemented compared to the younger and less
11 consolidated Alluvium unit. Therefore, the Alluvial Fans unit is much harder and stiffer than the
12 recent, looser sediment that forms the Alluvium unit, which is more prone to settlement.

13 The Tunneling Effects Assessment Technical Memorandum (Delta Conveyance Design and
14 Construction Authority 2022q:5, 11–18) describes the results of a preliminary analysis of tunneling-
15 induced ground settlement. Based on the data previously collected within the potential main tunnel
16 alignments and the anticipated depth of the tunnels for the California WaterFix project conceptual
17 engineering report, it is expected the soil deposits around the tunnel would consist of clays, silts,
18 silty and clayey sands, and clean sands. The tunnel alignment would not cross beneath nearby
19 communities. For example, at a location along State Route 4 near Discovery Bay, which is the closest
20 community to the alignment, the maximum ground settlement was computed to be 0.22 inch. This
21 amount of settlement is not likely to result in any effects on Discovery Bay. The central alignment
22 tunnel would pass under the Mokelumne Aqueducts. At that point, the aqueducts are located
23 aboveground and rest on pipe saddles that are supported on piles. Two of the aqueduct piles at this
24 location have a minimum tip elevation of approximately -50 feet NGVD. The third aqueduct is
25 underground at this location as it approaches the Old River crossing. At the approximate central
26 alignment tunnel crossing location, the invert of the third aqueduct is approximately at elevation -30
27 feet NGVD. The central alignment tunnel excavation crown (i.e., the top of the tunnel) near this point
28 would be approximately at elevation -120 feet NGVD. This would result in approximately 70 feet of
29 soil cover between the tunnel springline (i.e., the widest point of the tunnel, and generally, the mid-
30 point of the tunnel diameter) and the bottom of the Mokelumne Aqueduct piles. The Tunneling
31 Effects Assessment Technical Memorandum (Delta Conveyance Design and Construction Authority
32 2022q:12) determined that the maximum settlement beneath the tip (i.e., bottom) of the
33 Mokelumne Aqueduct piles where the central alignment tunnel would pass under the Mokelumne
34 Aqueducts would range from 0.18 to 0.43 inch, depending on the radius of the tunnel that is bored.
35 Such settlement is not likely to result in substantial changes to the aqueducts.

36 At the point where the eastern alignment tunnel would cross under the Mokelumne Aqueducts, all
37 three aqueducts are above the ground surface and sit on pipe saddles that are supported on piles.
38 The piles at this location have a tip elevation of approximately -60 feet NGVD. The tunnel excavation
39 crown at this location would be approximately at elevation -120 feet NGVD. This would result in
40 approximately 60 feet of soil cover between the pile tips and the tunnel springline. The Tunneling
41 Effects Assessment Technical Memorandum (Delta Conveyance Design and Construction Authority
42 2022q:15) determined that the maximum surface settlement where the eastern alignment tunnel
43 would pass under the Mokelumne Aqueducts would range from 0.20 to 0.48 inch depending on the
44 radius of the tunnel that is bored. Such settlement is not likely to result in substantial changes to the
45 aqueducts.

1 **Surface Structure-Related Ground Settlement.** For all project alternatives, some of the project
2 facilities would be constructed in areas where the surface soils and substrates are subject to
3 settlement when the load, such as an embankment, levee, RTM stockpile, shaft pad, and bridge
4 abutments, is applied to them.

5 Damage to certain conveyance facilities, such as pumping plants, control structures, and forebay
6 embankments, caused by ground settlement under the facilities and consequent damage to or failure
7 of the facility, could occur. Facility damage or failure could cause a release of water to the
8 surrounding area, resulting in flooding, thereby endangering people and property in the vicinity.

9 Based on site-specific geotechnical investigations, feasible ground improvement measures would be
10 designed for each facility site in which the soils are subject to excessive settlement, depending on
11 the nature of the facility. Embankment foundation improvements would be implemented where
12 needed (i.e., cutoff walls for seepage, or ground improvement for embankment stability). The
13 ground improvement measures for a given facility may include various combinations of removal of
14 peat soils, installation of vertical wick drains, and preloading of soils to promote soil consolidation
15 prior to construction, installation of seepage cutoff walls, and *in situ* soil treatments for improving
16 foundation strength, such as deep mechanical mixing or jet grouting approaches.

17 For the Southern Forebay, shaft pad fills, ring levees, and the intakes, design considerations to avoid
18 excessive settlement would include flood management, soil stability and seismic considerations,
19 embankment and foundation stability, and seepage cutoff wall placement. Embankment foundation
20 improvements would be implemented where needed (i.e., cutoff walls for seepage, or ground
21 improvement for embankment stability) because of potentially poorly consolidated or weak
22 foundation soils. A 15-foot-wide access road and groundwater monitoring network would be
23 installed along the perimeter of the outboard toe of the embankment (exterior slope). Ground
24 improvement would be implemented under portions of the embankment to minimize risk of
25 excessive settlement. Ground improvement would include excavation and replacement of at least 6
26 feet of the upper Southern Forebay embankment foundation and would be performed for the entire
27 embankment perimeter. The excavation and replacement, and ground improvement if required,
28 would create a consistent embankment foundation and remove variations in foundation soil
29 characteristics. Deeper excavation and replacement could be performed, if practical, to remove
30 unsuitable foundation materials, such as peat and highly organic mineral soils.

31 In addition to excavation and replacement of the upper foundation soils, three additional methods of
32 ground improvement would be used at the Southern Forebay for improving foundation strength,
33 including a deep mechanical mixing cutoff wall, surcharging, and wick drains.

34 **Slope Failure.** Slope failures, as discussed here, includes failure of cut slopes, fill slopes,
35 embankments, stockpile slopes, and excavations.

36 Permanent embankments, such as those to construct the Southern Forebay, would be graded to
37 stable slopes ranging from 3:1 (horizontal/vertical) to 6:1 (horizontal/vertical), depending on soil
38 conditions.

39 Excavations into native soils for borrow material at the intakes and at the Southern Forebay could
40 result in failure of the cut slopes, potentially causing injury of workers at the construction sites. Soil
41 and sediment, especially those consisting of loose alluvium and soft peat or mud, particularly would
42 be prone to failure and movement. Additionally, groundwater is expected to be within a few feet of
43 the ground surface in some of these areas, which may make excavations more prone to failure.

1 Soil excavation in areas with shallow or perched groundwater levels would require the pumping of
2 groundwater from excavations to allow for construction of facilities. Based on the Dewatering
3 Estimates for Intake Facilities and Southern Forebay Emergency Spillway (Final Draft) Technical
4 Memorandum (Delta Conveyance Design and Construction Authority 2022r:1) and the EPR
5 narrative reports for the central and eastern alignments and Bethany Reservoir alignment (Delta
6 Conveyance Design and Construction Authority 2022a:12, 100, 102; 2022b:37, 66), dewatering is
7 primarily anticipated to be conducted at the intakes, sedimentation basins, Bethany Reservoir
8 Discharge Structure, and the Southern Forebay emergency spillway, with more site-specific
9 dewatering conducted at the planned bridge replacements and at miscellaneous site improvement
10 locations, such as for installation of underground utilities. Dewatering can stimulate soil settlement
11 in excavations and could cause the slopes or sidewalls of the excavations to fail. However,
12 dewatering typically would be performed in conjunction with subsurface isolation measures, such
13 as cutoff walls and sheet piles that would be designed to withstand the external loads once the water
14 is removed through dewatering. This also would reduce the amount of dewatering required to lower
15 the groundwater table in the construction area and would decrease the local effects of dewatering
16 outside of the cutoff walls.

17 Because of high groundwater levels, the tunnel shafts would be constructed in saturated soil
18 conditions. Water at the bottom of the tunnel shafts would be pumped after a 5-foot-thick slurry
19 wall and a 3-foot-thick shaft secondary lining are installed, which would resist external earth,
20 seismic and hydrostatic pressures. The tunnel shaft would then be excavated, followed by placement
21 of an approximate 30-foot-thick concrete base slab. Following installation of the concrete plug at the
22 base of the tunnel shaft, the shaft would be dewatered. The interior shaft concrete lining would then
23 be placed from the top of the base slab. The tunnel liner and the 30-foot-thick concrete base slab
24 would resist uplift pressures from groundwater and separate the tunnel from the surrounding
25 groundwater. This approach to constructing the shafts would avoid failure of the walls of the shaft.

26 New and repaired levees would have 2:1 (horizontal to vertical) or shallower interior (land side)
27 slopes and have 3:1 (horizontal to vertical) or shallower exterior (water side) slopes.

28 Operations and Maintenance

29 The hazard of systematic settlement during operations and maintenance is similar to that described
30 above under *Project Construction*.

31 The hazard of fill slope, embankment, and stockpile slopes during operations and maintenance
32 would be similar to that as described above, under *Project Construction*.

33 With respect to tunnel flotation, the possibility of main tunnel flotation (buoyancy) exists when
34 tunnels are constructed in areas with high groundwater (i.e., where a tunnel is bored at a depth
35 where groundwater is present). Flotation could cause the tunnel to weaken and fail, causing release
36 of water from the tunnel and erosion of the sediments surrounding the failure location (refer to
37 Section 7.3.1.1, *Process and Method of Review for Impeding or Redirecting Localized Flood Flow*, in
38 Chapter 7 for additional discussion). The highest groundwater table along the alignment would be
39 approximately 10 feet below ground surface. The buoyancy of the tunnel depends on the weight of
40 water for the volume displaced and is resisted by the weight of the precast segmental lining and the
41 weight of the ground above the tunnel. The flotation analysis described in the Conceptual Tunnel
42 Lining Evaluation Technical Memorandum (Final Draft) (Delta Conveyance Design and Construction
43 Authority 2022j:10, 11) was conducted using a conservative approach, in which the tunnel was
44 assumed to be empty and not in use. A minimum ground cover of 98 feet over the tunnel was

1 assumed; however, as constructed, the thickness of the ground cover would range from
2 approximately 98 to 119 feet along the entire tunnel alignment. The analysis as conducted using
3 project design capacity scenarios of 3,000 cubic feet per second (cfs). 4,500 cfs, 6,000 cfs, and 7,500
4 cfs and for all scenarios determined that there would be adequate forces from the ground cover
5 above the tunnel to withstand flotation pressure, such that flotation would not occur.

6 With respect to landsliding of natural slopes, only one existing landslide has been mapped in the
7 study area (Roberts et al. 1999:1). The area, less than 1 acre, is approximately 2,800 feet southeast
8 of the Bethany Reservoir. The slide is in the area covered by the MTC/ABAG Hazard Viewer Map
9 (Association of Bay Area Governments 2021), which covers only the Alameda and Contra Costa
10 County parts of the project area. It rates the areas east and west of the Bethany Reservoir within the
11 project area as being subject to “few landslides.” Consequently, because of the overwhelmingly
12 shallow slopes in the project area and low hazard for landslides, the potential for construction
13 activities to create a condition that could initiate a landslide on a natural or constructed slope during
14 operations and maintenance is low.

15 ***CEQA Conclusion—All Project Alternatives***

16 Ground settlement, slope instability, and other ground failure impacts during operation and
17 maintenance would be similar to those that could occur during construction. Therefore,
18 construction and operation and maintenance impacts are combined in the discussion below.

19 Many of the project construction sites would be located near existing levees, and both the central
20 and eastern tunnel alignments would cross under levees, railroads, highways, and the East Bay
21 Municipal Utility District Mokelumne Aqueducts. The top of the tunnel structure would cross under
22 these surface features at depths of approximately 100 feet below under the ground surface, with
23 some areas (e.g., Bouldin Island for central alignment and near the Southern Forebay Outlet
24 Structure) approximately 80 feet below the ground surface. The nearest tunnel alignment (i.e.,
25 central alignment) to homes in Discovery Bay would be approximately 4,000 feet from the nearest
26 home.

27 Ground settlement above the tunnel could result in loss of property or personal injury during
28 construction. In extreme circumstances, large settlement above the tunnel, caused by voids and/or
29 sinkholes above the tunnel during boring, could translate to the ground surface, potentially causing
30 loss of property or personal injury above the tunnel construction area. Collapse of the tunnel during
31 boring could also translate to the ground surface and result in a greater depth of ground surface
32 settlement than large settlement. However, as described above, based on the results of the
33 Tunneling Effects Assessment Technical Memorandum (Delta Conveyance Design and Construction
34 Authority 2022q:14, 15) the amount of surface settlement above the main tunnel where it would
35 pass near Discovery Bay and pass under the Mokelumne Aqueducts is expected be negligible to less
36 than ½ inch and therefore the impact would be less than significant.

37 Excavation of borrow material could result in failure of oversteepened cut slopes, potentially
38 causing injury of workers at the construction sites.

39 Soil excavations in areas with shallow or perched groundwater levels, such as the intake structure,
40 sedimentation basins and drying lagoons at the intake facilities; Bethany Aqueduct tunnel shaft;
41 Bethany Reservoir Discharge Structure; Southern Forebay emergency spillway and certain
42 structures are the pumping plants would require construction dewatering. Dewatering could
43 stimulate soil settlement in the excavations and could cause the slopes or sidewalls of the

excavations to fail, endangering workers in the excavations themselves and workers at ground level near the edge of the excavation. The potential impact from ground settlement during tunnel construction; from excavation at borrow sites, cut slopes, and spoils and RTM storage sites; and from dewatering of excavations could be significant. Complying with applicable design standards and building codes would avoid a loss of property, personal injury, or death from slope instability or other ground failures, during both construction and operation and maintenance. A California-registered civil engineer or California-certified engineering geologist would recommend measures to address the hazards of slope instability and ground failure, such as specifying the type of TBM to be used in a given tunnel segment. The results of the site-specific evaluation and the engineer's recommendations would be documented in a detailed geotechnical report, which would contain site-specific evaluations of the settlement hazard associated with the site-specific soil conditions overlying the tunnel throughout the alignment. During tunnel construction, DWR would evaluate and refine the tunneling equipment and drilling methods to account for sudden changes in ground conditions; these actions would be implemented to minimize or avoid settlement over the tunnel to minimize the likelihood of loss of property or personal injury from ground settlement above the tunnel during and after construction.

The new and repaired levees also would be constructed according to relevant design standards and specifications, and DWR would conform to Cal/OSHA, USACE, and other design requirements to protect worker safety at borrow sites, cut slopes and other excavations, and fill slopes and embankments (e.g., levees), both during construction and operation and maintenance.

As described in the Potential Future Field Investigations Technical Memorandum for the central and eastern alignments (Delta Conveyance Design and Construction Authority 2022e:24), equipment for monitoring movement and settlement during levee repairs and new levee construction would be installed during construction. Specifically, inclinometers and extensometers would be installed in vertical borings along levees at the intakes, Bouldin Island, Lower Roberts Island, and Byron Tract and along levees near bridge improvements along Hood-Franklin Road over Snodgrass Slough, State Route 12 over Little Potato Slough, the access road to Mandeville Island over Connection Slough, the access road to Lower Roberts Island over Burns Cut and Turner Cut; and the bridge across the California Aqueduct near Byron Highway. Inclinometers and extensometers are also planned at the Southern Complex and along the tunnel alignment and at tunnel shafts. The average installation depth is estimated to be 150 feet. Inclinometers are planned to be installed on 1,000-foot centers along areas of levee improvements. Additionally, tilt meters, settlement plates, and survey monuments would be installed at all construction sites and approximately every mile along the tunnel alignment. Periodic monitoring of this instrumentation would be conducted by security and on-site personnel.

As described in the Potential Future Field Investigations Technical Memorandum for the Bethany Reservoir alignment (Delta Conveyance Design and Construction Authority 2022p:24), inclinometers and extensometers would be installed in vertical borings along levees at the intakes, King Island, Lower Roberts Island, Upper Jones Tract, Victoria Island, Union Island, and Coney Island and along levees near bridge improvements along Hood-Franklin Road over Snodgrass Slough and the access road to Lower Roberts Island over Burns Cut and Turner Cut. Inclinometers and extensometers would also be installed at the Bethany Complex. The average installation depth is estimated to be 150 feet. Inclinometers are planned at 1,000-foot centers along areas of levee improvements. Additionally, tilt meters, settlement plates, and survey monuments would be installed at all construction sites and approximately every mile along the tunnel alignment. Periodic monitoring of this instrumentation would be conducted by security and on-site personnel.

1 The detailed design would also conform to other standards and codes by applying accepted, proven
2 construction engineering practices to reduce the risk that the facilities could fail or that there would
3 be an increased hazard of loss of property, personal injury, or death of individuals as a result of
4 slope instability and ground failure. Consequently, the likelihood of a failure of a levee slope,
5 whether as a result of earthquake ground shaking or other type of failure mechanism (e.g.,
6 construction of an oversteepened slope, excess loading of a foundation), is judged to be low because
7 slope designs would conform to applicable design standards. The impact would be less than
8 significant.

9 ***Mitigation Impacts***

10 *Compensatory Mitigation*

11 Although the CMP described in Appendix 3F does not act as mitigation for impacts on this resource
12 from project construction, operations, and maintenance, its implementation could result in impacts
13 on this resource. CEQA requires analysis of the impacts of mitigation, and therefore, this discussion
14 is included here.

15 As described in Appendix 3F, compensatory mitigation would also involve construction of setback
16 levees at undetermined tidal wetland or channel margin restoration sites within the North Delta Arc.
17 Unless properly engineered, the levees could be subject to mass failure as a result of high soil pore
18 water pressure, causing inundation of the area behind the levee. However, levee designs would need
19 to conform to standards and codes by applying accepted, proven construction engineering practices
20 to reduce the risk of loss of property, personal injury, or death of individuals as a result of slope
21 instability. Design and construction of the levees would adhere to relevant design standards and
22 specifications such that they would be constructed with slopes and would not be subject to mass
23 failure. Therefore, the project alternatives combined with compensatory mitigation would not
24 change the overall impact conclusion of less than significant.

25 *Other Mitigation Measures*

26 The other mitigation measures could involve construction of structures or infrastructure that could
27 be affected by ground settlement, slope instability, or other ground failure, such that there could be
28 no increased likelihood of loss of property, personal injury, or death associated with these types of
29 ground failures. However, any visual or noise barriers (which could include chain link fencing, a
30 wood or concrete barrier, or other similar barrier a minimum of 6 feet high) would be constructed
31 to be consistent with applicable design standards and building codes such that they would not be
32 subject to mass failure. Therefore, the hazard of loss of property, personal injury, or death from
33 structural failure caused by ground failure as a result of implementing compensatory mitigation and
34 other mitigation measures, combined with project alternatives, remains low. The overall impact
35 after implementing the compensatory mitigation and the other mitigation measures, combined with
36 project alternatives, would remain less than significant.

Impact GEO-5: Loss of Property, Personal Injury, or Death from Structural Failure Resulting from Project-Related Ground Motions

All Project Alternatives

Project Construction

Pile Driving Effects. Impact pile driving during construction could cause vibrations that may initiate liquefaction and associated ground movements in places where soil and groundwater conditions are present to allow liquefaction to occur. The consequences of liquefaction could be manifested in terms of compaction or settlement, loss of bearing capacity, lateral spreading (i.e., horizontal soil movement), increased lateral soil pressure, and buoyancy within the zones of liquefaction. These consequences could cause personal injury or death and could damage nearby structures and levees. The lateral extent (i.e., influenced distance) of potential ground effects caused by pile driving depends on soil characteristics, groundwater conditions, the piling hammer used, frequency of pile driving, and the vibration tolerance of structures and levees.

The ground vibrations from impact pile driving during construction could also cause soil compaction and resultant ground settlement/failure, even in the absence of liquefaction. These effects on soil movements and ground elevation could cause personal injury or death and could damage nearby structures and levees.

Impact pile driving would be conducted only at the intakes and the modified bridges. At the intakes, sheet-pile walls are expected to be installed using both the vibratory approach (which would tend not to cause seismic motions) and impact driving. Because of the characteristics of the soils at these sites, it is anticipated that up to the last 10 feet of the sheet-pile installation would require impact driving. Because liquefaction caused by impact pile driving is rare and very localized, and because most of the piles would be installed using non-impact driving techniques, it is unlikely that pile driving-induced liquefaction would occur or cause any distress at ground surface related to pile driving-induced liquefaction.

If liquefaction due to pile driving is encountered, it is typically extremely restricted to a zone immediately surrounding the pile and can actually facilitate the pile driving, reducing the number of required pile strikes to advance to the pile tip depth. Increased soil pore water pressures due to pile driving dissipate quickly in liquefaction-prone soils, allowing a gain in soil strength and an increased resistance to future liquefaction. Evaluation of pile-driving-induced liquefaction would be completed at sites where seismic liquefaction potential was identified during final design activities and would be rechecked prior to construction using the characteristics of the specific hammer to be used by the contractor.

Heavy Equipment Effects. In addition to impact pile-driving activities, construction of the water conveyance facilities would involve use of heavy equipment (e.g., bulldozers, motor scrapers) and heavy trucks to load and transport RTM and topsoil to stockpiles and use locations. Gravel, aggregate base material, concrete, and asphalt would be imported to some construction sites from outside the project area.

Some construction sites and access roads where heavy equipment and trucks would be used have subsurface soil layers with potential for liquefaction. Although the heavy equipment and trucks could generate vibrations in levees, the severity of the vibrations would not be capable of initiating sufficient ground motion to cause soil liquefaction. However, the vibrations could cause soil

1 compaction and resultant settlement in the absence of liquefaction. These effects on the soil and
2 ground elevation could cause personal injury or death and could damage nearby structures and
3 levees.

4 Some existing public roads would be used as haul routes for the construction of conveyance
5 facilities. Use of the state highway system as haul routes would be used, where feasible, because
6 these roadways are rated for truck traffic and would generally provide the most direct and easily
7 maneuverable routes for large loads. Construction traffic may need to access levee roads at various
8 points along state highways, as shown in Figure 10-7, as well as on access roads and levee access
9 roads shown in Figure 10-8.

10 Except at the intakes, levee modifications, and bridges, all construction would be set back by at least
11 300 feet from existing levees to reduce the potential to affect the levees. Construction traffic would
12 be prohibited from using levee roads except along State Routes 4 and 12 during construction and
13 State Route 160 to repave the road areas moved during construction of the intakes. Field
14 investigation results would be used to further analyze soil stability responses and develop
15 appropriate construction methods to protect existing levees, utilities, structures, and adjacent lands.

16 **Tunneling Effects.** The Tunneling Effects Assessment Technical Memorandum (Delta Conveyance
17 Design and Construction Authority 2022q:20, 21) describes the results of a preliminary analysis of
18 TBM vibrations that can be expected to occur along the main tunnel alignments. The analysis of
19 potential TBM vibrations was based on attenuation curves developed for a variety of types of
20 construction equipment. Based on the current tunnel depth profiles, a minimum ground cover of
21 110 feet can be expected along the main tunnel alignment for the central and eastern alternatives.
22 Based on this minimum ground cover, a peak particle velocity of 0.003 inch per second can be
23 expected. Assuming that humans can detect vibrations equal to or greater than 0.01 inch per second,
24 it appears unlikely there would be noticeable vibrations generated along the main tunnel alignment.

25 The technical memorandum states vibrations generated by TBM excavation are typically extremely
26 low and rarely cause damage to surface structures.

27 During project design, site-specific geotechnical and groundwater investigations would be
28 conducted to build upon existing data to identify and characterize the vertical (depth) and
29 horizontal (spatial) variability in soil-bearing capacity and extent of liquefiable soil. During final
30 design, the facility-specific potential for construction-induced liquefaction would be investigated by
31 a geotechnical engineer. The potential effects of construction vibrations on nearby structures,
32 levees, and utilities would be evaluated using specific piling information (e.g., pile type, length,
33 spacing, pile-driving hammer to be used). In areas determined to have a potential for liquefaction,
34 the engineer would develop design measures and construction methods to minimize the potential
35 for liquefaction caused by pile driving, heavy equipment operations, and heavy truck traffic, thereby
36 protecting the safety of workers at the site and avoiding property damage.

37 Field investigations would involve conducting geotechnical investigations at the intakes, tunnel
38 shafts, Southern Complex facilities, or Bethany Complex facilities, and along the tunnel alignment.
39 The investigations would involve one or more of the following methods at a given facility site: fault
40 trenching, soil borings, CPTs, groundwater well-installation testing and monitoring, geophysical
41 surveys, utility potholing and test pile driving. The soil borings would be drilled to create a 4-inch to
42 8-inch-diameter hole from which soil samples would be recovered. The CPTs would involve
43 hydraulically pressing a 1-inch to 2-inch-diameter cone-tipped rod into the ground. The
44 groundwater test wells would involve installing a 12-inch-diameter steel casing within a 24-inch-

1 diameter borehole to conduct pump tests. The groundwater monitoring wells are likely to entail
2 installing a 4-inch-diameter groundwater monitoring well within the soil bore holes. A test pile
3 driving program would be conducted only at the intakes. Based on DWR's 30 years of well drilling
4 and deep-soil investigations in the Delta, none of the investigations are likely to cause a ground
5 vibration sufficiently strong to initiate liquefaction or ground settlement.

6 Operations and Maintenance

7 Impact pile driving would be conducted only during construction; therefore, there would be no
8 hazard of pile driving-induced liquefaction or ground settlement during operations and
9 maintenance.

10 Heavy equipment use at RTM stockpiles and heavy truck traffic on access roads and state highways
11 could continue at times during operations and maintenance. The RTM stockpiles and access roads
12 are in areas that may be subject to vibration-induced liquefaction. However, the strength of the
13 vibrations caused by heavy equipment at construction sites and on haul routes would not be
14 sufficient to initiate liquefaction and associated ground failures.

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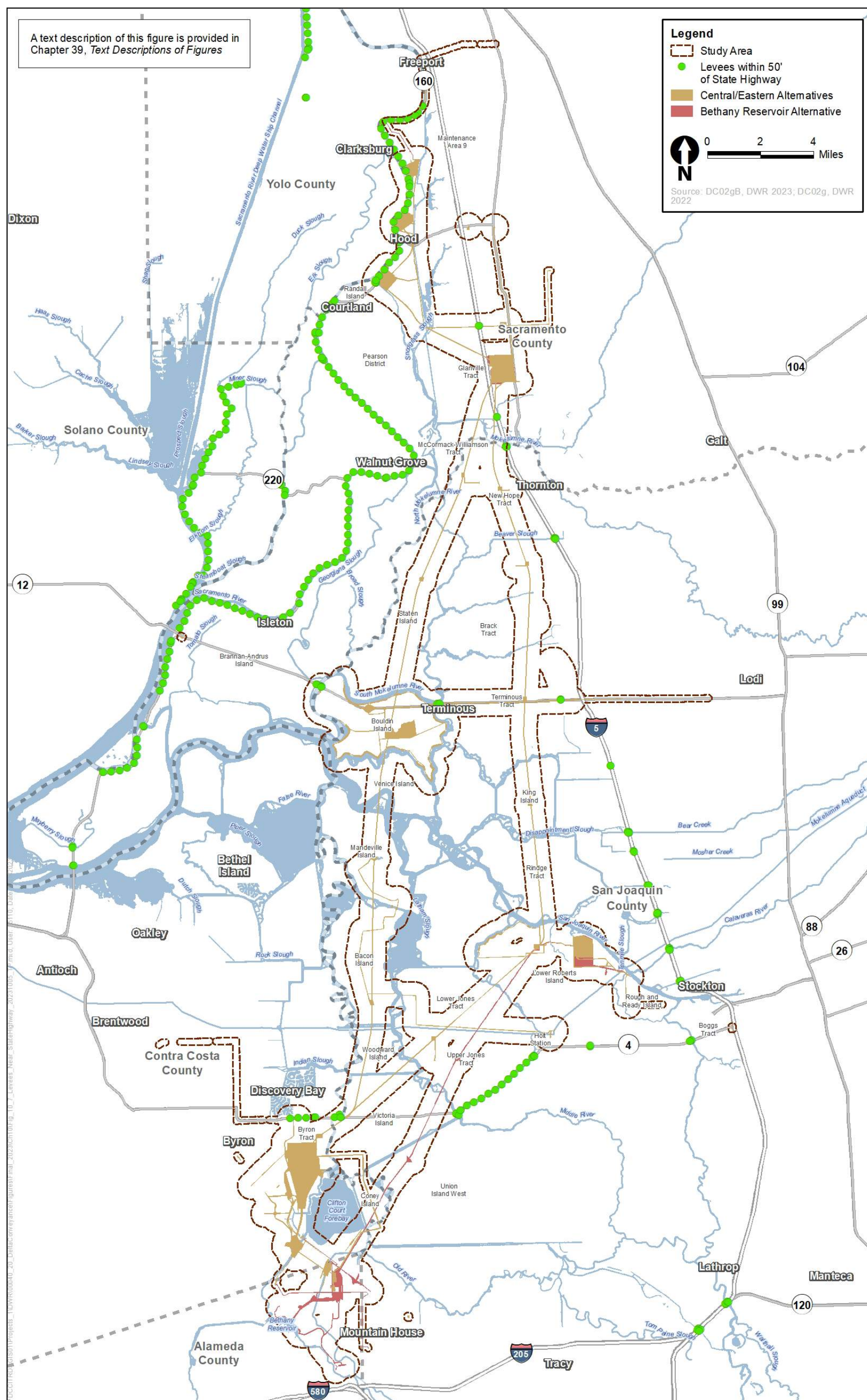


Figure 10-7. Levees Near State Highways

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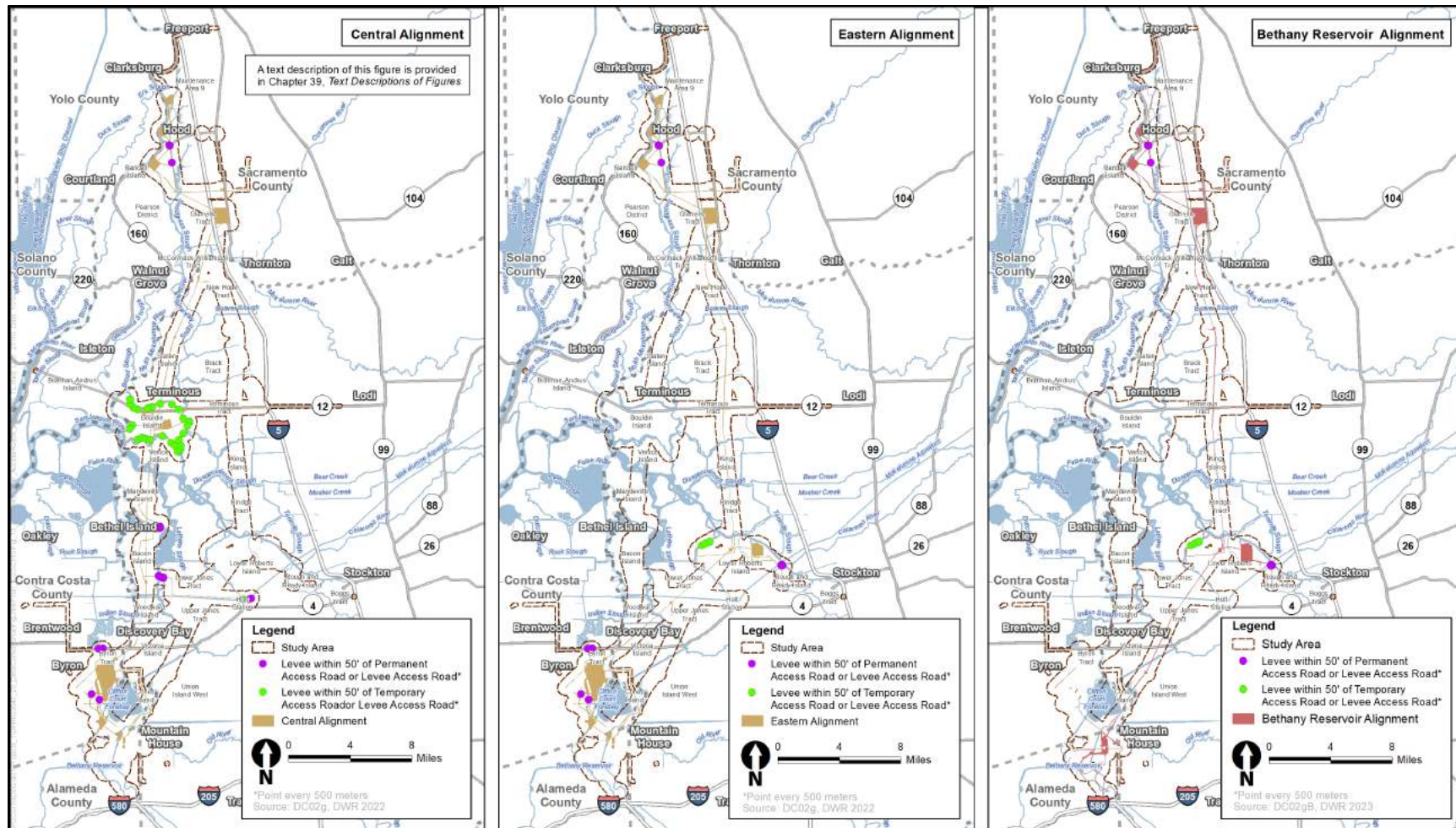


Figure 10-8. Levees Near Access Roads and Levee Access Roads

CEQA Conclusion—All Project Alternatives

Construction-related ground motions from impact pile driving could initiate liquefaction, which could cause failure of temporary works and structures during construction and result in injury of workers at the construction sites. However, impact pile driving at the intakes would be conducted approximately 200 or more feet from active levees, and nearby levees would be constructed by the project with ground improvement measures before pile driving. Such conditions would minimize potential impact pile driving-induced liquefaction or ground settlement effects on levees. Additionally, heavy equipment and truck traffic could result in soil compaction and resultant ground settlement without liquefaction occurring, which could cause failure of temporary works and structures during construction and result in injury of workers at the construction sites.

With very few exceptions, the conceptual project design avoids the use of existing levees as haul routes. Where levees are used for haul routes, potential effects on levees that could occur during the construction may include rutting, settlement, and slope movement. Heavy equipment could also cause ground vibrations during operations and maintenance. However, the strength of the vibrations caused by heavy equipment at construction sites and on haul routes would not be capable of initiating liquefaction. Conformance with applicable design standards and building codes would avoid a loss of property, personal injury, or death from project-related ground motions during both construction and operations and maintenance. The impact would be less than significant.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on this resource from project construction, operations, and maintenance, its implementation could result in impacts on this resource. CEQA requires analysis of the impacts of mitigation, and therefore, this discussion is included here.

The compensatory mitigation on Bouldin Island and the I-5 ponds site would involve use of heavy grading equipment and possibly heavy truck traffic at the mitigation areas and possibly along nearby access roads. Similar to the conveyance facilities, the heavy equipment and truck traffic could be in areas that may be subject to liquefaction. Although the heavy equipment and trucks could generate vibrations in levees, the strength of the vibrations is not expected to be sufficient to initiate liquefaction and ground settlement. As with the project, compensatory mitigation would conform with applicable design standards and building codes. The project and compensatory mitigation would conform with applicable design standards, which would avoid a loss of property, personal injury, or death from project-related ground motions.

As described in Appendix 3F, compensatory mitigation would also involve construction of setback levees at undetermined tidal wetland or channel margin restoration sites within the North Delta Arc. Unless properly engineered, the levees could be subject to similar ground vibrations and effects as described for the Bouldin Island and I-5 ponds sites. However, levee designs would need to conform to standards and codes by applying accepted, proven construction engineering practices to reduce the risk of loss of property, personal injury, or death of individuals as a result of slope instability. Design and construction of the levees would adhere to relevant design standards and specifications such that they would be constructed with slopes and would not be subject to vibration-induced

liquefaction and ground settlement. Therefore, the project alternatives combined with compensatory mitigation would not change the overall impact conclusion of less than significant.

Other Mitigation Measures

Some of the other mitigation measures would involve the use of heavy equipment such as graders, excavators, dozers, and haul trucks that would have the potential to result in ground motions underlying existing structures. Similar to the conveyance facilities, the heavy equipment and truck traffic could be in areas that may be subject to liquefaction. Although the heavy equipment and trucks could generate vibrations, the strength of the vibrations is not expected to be sufficient to initiate liquefaction and ground settlement under existing structures. Therefore, the hazard of loss of property, personal injury, or death caused by project-related ground motions as a result of constructing the project alternatives and implementing the compensatory mitigation and the other mitigation measures, remains low. Therefore, the impact of loss of property, personal injury, or death from structural failure caused by ground failure as a result of vehicle and equipment vibrations during implementation of the compensatory mitigation and other mitigation measures, combined with project alternatives, would remain less than significant.

Impact GEO-6: Loss of Property, Personal Injury, or Death from Seiche or Tsunami

Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c

Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c, described in Chapter 3, *Description of the Alternatives*, have similar impact levels and are discussed together.

Project Construction

Project construction activities would not increase the potential for a seiche or tsunami to occur at the conveyance facilities under Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c. A seiche during construction of the Southern Forebay would be unlikely to occur since the forebay would not be filled until near project completion and following major construction activities. Once filled, the conceptual design of the Southern Forebay includes 10.5 feet of total freeboard between the Maximum Normal Operating Water Level and the perimeter embankment crest, which greatly reduces the potential for embankment overtopping. The potential for an earthquake-induced seiche to occur in the Southern Forebay would also be addressed through site-specific fault studies of fault offset to be completed as part of the field investigations. The freeboard requirements would be confirmed or modified following completion of additional site-specific geotechnical and seismic studies that would evaluate the potential for seiche and the resulting wave height and associated freeboard criteria to avoid overtopping.

Construction activities at the Southern Forebay generally would be several hundred feet from the Clifton Court Forebay embankments, which greatly reduces the potential for project construction activities to initiate a seiche in Clifton Court Forebay. The effects of project construction activities would be confirmed during design following completion of site-specific geotechnical studies.

The field investigations would involve conducting geotechnical investigations at the intakes, tunnel shafts, Southern Complex facilities, and along the tunnel alignment. The investigations would involve one or more of the following methods at a given facility site: fault trenching, soil borings, CPTs, groundwater well-installation testing and monitoring, geophysical surveys, utility potholing and test pile driving at the intakes. The soil borings would be accomplished by advancing an

1 approximate 4-inch to 8-inch-diameter sampler using a drill bit; impact driving of the sampler
2 would be used only if the drill bit does not penetrate smoothly through the soil column. The CPTs
3 would involve hydraulically pushing a 1-inch to 2-inch-diameter cone-tipped rod into the ground.
4 The groundwater test wells would involve installing 12-inch-diameter steel casing within a 24-inch-
5 diameter borehole to conduct pump tests. The groundwater monitoring wells are likely to entail
6 installing a 4-inch-diameter groundwater monitoring well within the soil bore holes.

7 The conceptual design of the Southern Forebay includes 10.5 feet of total freeboard between the
8 Maximum Normal Operating Water Level and the perimeter embankment crest, which greatly
9 reduces the potential for embankment overtopping. Although there are no known reports that well
10 drilling on any of the Delta islands has triggered a seiche, the freeboard requirements for the
11 Southern Forebay would be confirmed following completion of additional site-specific geotechnical
12 and seismic studies to evaluate the potential for seiche and the resulting wave height.

13 The field investigations would not increase the hazard of a tsunami to occur in the area because the
14 locations of the investigations are beyond the reach of tsunami waves.

15 Operations and Maintenance

16 Apart from the Southern Forebay, the potential for a substantial earthquake-induced seiche to occur
17 at the conveyance facilities that could cause loss of property or personal injury is considered low
18 because the seismic hazard and the geometry (e.g., width and depth) of the waterbodies (e.g.,
19 sedimentation basins, sediment drying lagoons, drying lagoon outlet structures) are not favorable
20 for a seiche to occur.

21 However, Fugro Consultants (2011:14) identified the potential for ground motions along the West
22 Tracy Fault to cause a seiche of an unspecified wave height to occur in the Clifton Court Forebay,
23 assuming that this fault is potentially active. Because the Southern Forebay effectively would be a
24 similar distance from the West Tracy Fault as the Clifton Court Forebay,¹¹ there is a potential for a
25 seiche to occur in the Southern Forebay, assuming that the geometry of the Southern Forebay is
26 conducive to the occurrence of a seiche. It is conceivable that a seiche could also occur in the
27 Southern Forebay from seismic shaking generated along a more distant fault, such as a fault in the
28 San Francisco Bay Area. If a seiche occurred in the Southern Forebay and the embankment was not
29 properly designed, multiple seiche waves could overtop the embankment, erode it, and cause
30 localized flooding.

31 The conceptual design of the Southern Forebay includes 10.5 feet of total freeboard between the
32 Maximum Normal Operating Water Level and the perimeter embankment crest, which greatly
33 reduces the potential for embankment overtopping. The potential for an earthquake-induced seiche
34 to occur in the Southern Forebay would also be addressed through site-specific studies ground
35 shaking in the vicinity. The freeboard requirements would be confirmed following completion of
36 additional site-specific geotechnical and seismic studies evaluating the potential for seiche and the
37 resulting wave height.

38 Seiches can also occur as a result of a movement of an underwater landslide within a waterbody or
39 one generated upslope and entering a waterbody. The likelihood of a landslide-induced seiche
40 occurring at the Southern Forebay is judged to be low because the forebay would have a level

¹¹ The West Tracy Fault crosses the southwestern part of the Clifton Court Forebay and would intersect the southern tip of the Southern Forebay.

bottom, the forebay embankments would have a stable 4:1 (horizontal/vertical) slope, and there would be no landslide-prone areas near the perimeter of the forebay.

At the other conveyance facilities consisting of some form of waterbody (e.g., sedimentation basins, sediment drying lagoons, drying lagoon outlet structures), the potential for a seiche to occur is judged to be low, either because the earthquake- or landslide-induced hazard is low, because the geometry of the waterbody (i.e., wide and shallow) is not favorable for a seiche to occur, or because of a combination of the two factors.

Based on the California Governor's Office of Emergency Services (2021) MyHazards website, the tsunami inundation hazard area nearest to the project area is on the north shore of the Sacramento River, extending approximately to 1 mile upstream (i.e., east) of the Benicia Bridge. The inundation areas extend over mud flats and tidal marshes, which are presumed to have an elevation at or within approximately 3 feet above sea level. The low height of a tsunami wave in the vicinity of the Benicia Bridge, combined with the attenuating effect of the Suisun Bay and the northwestern part of the Delta, indicates that the potential hazard of loss of property or personal injury as a result of a tsunami on the water conveyance facilities is low.

For the Southern Forebay, the field investigations and design-level studies conducted by a California-licensed civil engineer or certified engineering geologist would consider the PGA caused by movement of the West Tracy Fault and regional faults along with the geometry of the forebay in determining the maximum probable seiche wave height that could be generated by ground shaking. The civil engineer or certified engineering geologist would recommend any design measures, such as increasing the freeboard to address any seiche hazard and conform to applicable design codes, guidelines, and standards, as described in Appendix 3B, *Environmental Commitments and Best Management Practices*. Conformance with the following codes and standards would reduce the potential risk for increased likelihood of loss of property or personal injury from tsunami or seiche.

- DWR Division of Flood Management *FloodSAFE Urban Levee Design Criteria* (California Department of Water Resources 2012b)
- USACE Engineering Report 1110-2-1806, *Earthquake Design and Evaluation for Civil Works Projects* (U.S. Army Corps of Engineers 2016)

DWR would require that the geotechnical design recommendations be included in the design of project facilities and construction specifications to minimize the potential effects from any seismic events and consequent seiche waves. DWR would also require that the design specifications be properly executed during construction. Conformance with these codes and standards is an environmental commitment by DWR to require that any potential significant impacts of a seiche are reduced to an acceptable level while the forebay facility is operated.

The worker safety codes and standards specify protective measures that must be taken at workplaces to minimize the risk of injury or death from structural or earth failure (e.g., utilizing personal protective equipment). The relevant codes and standards represent performance standards that must be met by employers and these measures are subject to monitoring by state and local agencies. Cal/OSHA requires a workplace Injury and Illness Prevention Program, the terms of which would be used as the principal measures enforced at the facility sites to protect worker safety during operations and maintenance.

Conformance to these and other applicable design specifications and standards would require that the Southern Forebay embankment would be designed and constructed to contain and withstand

the anticipated maximum seiche wave height and would not create an increased likelihood of loss of property, personal injury, or death of individuals at the forebay during operation and maintenance of the water conveyance features.

Alternative 5

Project Construction

Project construction activities would not increase the potential for a seiche or tsunami to occur at the conveyance facilities under Alternative 5 because the ground vibrations generated by the activities would not be sufficient to generate seiche waves. Further, the construction activities would not increase the project area's exposure to a tsunami.

Field investigations would not increase the hazard of a seiche or tsunami to occur in the project area under Alternative 5 for the same reasons as described for Alternatives 1–4c.

Operations and Maintenance

The low likelihood for a seiche or tsunami to occur under Alternative 5 would be similar to that of Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c, except that Alternative 5 does not involve construction of a Southern Forebay. (The Bethany Reservoir Surge Basin is deemed to be too small [i.e., 815 by 815 feet] for a significant seiche wave to form during seismic ground shaking. Additionally, the surge basin would contain water only during an infrequent surge event from the pumping plant.) Therefore, Alternative 5 does not have any apparent potential for a seiche to occur at any of its facilities.

CEQA Conclusion—All Project Alternatives

As described above, the hazard of a substantial tsunami affecting the project area appears to be minor because of its distance from the Pacific Ocean and the attenuating effect of San Francisco and Suisun Bays.

None of the conveyance facilities proposed under Alternative 5 would be measurably affected by a seiche.

The Southern Complex components of Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c would be located near the Clifton Court Forebay, which may be subject to a seiche because of its proximity to sources of seismic shaking, including possibly the West Tracy Fault (Fugro Consultants 2011:14). A seiche in the Clifton Court Forebay could therefore affect the Southern Complex facilities as a result of water overtopping the Clifton Court Forebay embankment. Additionally, the Southern Forebay may be subject to a seiche because of its proximity to the same sources of seismic shaking. DCA has already designed the Southern Forebay to have sufficient freeboard to prevent wave-driven waves from overtopping the forebay embankment. During detailed design, DWR would assess whether there is a hazard of a seiche occurring in the forebay and would follow engineering requirements to require that the design allows for any coincident seiche wave height and wave-driven waves. This would ensure that the coincident waves do not exceed the embankment freeboard and overtop the embankment. A California-licensed geotechnical engineer would recommend any design measures to conform to applicable design codes, guidelines, and standards which would require that any seiche occurring in the Southern Forebay does not overtop the forebay embankment or otherwise risk the loss of property or personal injury from a seiche. The impact would be less than significant.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on this resource from project construction, operations, and maintenance, its implementation could result in impacts on this resource. CEQA requires analysis of the impacts of mitigation; therefore, this discussion is included here.

The compensatory mitigation would involve excavating areas to create open water channels and ponds. Because of their small size and geometry, these newly created channels are not likely to experience a seiche. Although the geometry of the I-5 ponds may be conducive to a seiche, they would be distant from sources of strong seismic shaking; therefore, they are unlikely to experience a significant seiche. Any seiche that would occur in the compensatory mitigation channels or ponds likely would not cause a loss of property, personal injury, or death. The compensatory mitigation would not increase the hazard of a tsunami to occur in the area and would be located beyond the influence of a tsunami. Therefore, the project alternatives combined with compensatory mitigation implemented at Bouldin Island and the I-5 ponds site would not change the overall impact conclusion of less than significant.

As described in Appendix 3F, compensatory mitigation would also involve excavation and other earthwork at undetermined tidal wetland or channel margin restoration sites within the North Delta Arc, although none of the restored open water components of the mitigation are expected to be sufficiently large or have geometry conducive to the formation of seiche waves. Additionally, the undetermined tidal wetland or channel margin restoration sites would not be located in an area subject to a tsunami. Therefore, the project alternatives combined with compensatory mitigation would not change the overall impact conclusion of less than significant.

Other Mitigation Measures

None of the other mitigation measures would involve construction of waterbodies, and the mitigation measures would not increase the hazard of a seiche or tsunami to occur in the project area. The project area is located beyond the influence of a tsunami. Therefore, the hazard of loss of property, personal injury, or death project-related caused by a seiche or tsunami as a result of implementing the other mitigation measures, combined with project alternatives, remains low. The overall impact after implementing the compensatory mitigation and the other mitigation measures, combined with project alternatives, would not change the conclusion of less than significant.

10.3.4 Cumulative Analysis

The geographic scope of the analysis for geology and seismicity is the project area as defined in Chapter 1 (Figure 1-4). This geographic limit encompasses the footprints of all construction and conservation-related ground-disturbing activity associated with the project.

The geographic scope of the geology and seismicity cumulative analysis is centered on large-scale ground-disturbing projects in the Delta region. The analysis focuses on large projects and programs within the project area and the broader Delta region that involve substantial excavation, filling, or construction (e.g., levees). The principal programs and projects considered in the analysis are listed in Table 10-13. A full list of projects and greater detail about each project shown in the table is provided in Appendix 3C.

1 **Table 10-13. Cumulative Impacts on Geology and Seismicity from Plans, Policies, and Programs**

Program/Project	Agency	Status	Description of Program/Project	Impacts on Geology and Seismicity
Delta Dredged Sediment Long-Term Management Strategy/Pinole Shoal Management Study	USACE	Ongoing	Maintaining and improving channel function, levee rehabilitation, and ecosystem restoration	No direct impact on increased risks at Delta Conveyance Project construction locations from earthquakes, ground shaking, liquefaction, slope instability, seiche, or tsunami.
Delta Dredged Sediment Long-Term Management Strategy	USACE	Ongoing	Maintaining and improving channel function, levee rehabilitation, and ecosystem restoration	No direct impact on increased risks at Delta Conveyance Project construction locations from earthquakes, ground shaking, liquefaction, slope instability, seiche, or tsunami.
2019 NMFS and USFWS BiOps	DWR	Ongoing	Restore 8,000 acres of tidal marsh	No direct impact on increased risks at Delta Conveyance Project construction locations from earthquakes, ground shaking, liquefaction, slope instability, seiche, or tsunami.
Lookout Slough Tidal Habitat Restoration and Flood Improvement Project (EcoRestore project)	DWR	Planning phase	Construction of approximately 2.9 miles of new setback levee to restore and enhance approximately 3,164 acres of upland, tidal, and floodplain habitat	No direct impact on increased risks at Delta Conveyance Project construction locations from fault rupture, earthquake ground shaking, liquefaction, slope instability, seiche, or tsunami.
Prospect Island Tidal Habitat Restoration Project (EcoRestore project)	DWR	Ongoing	Convert 1,253 acres of freshwater tidal marshes and associated aquatic habitat	No direct impact on increased risks at Delta Conveyance Project construction locations from earthquakes, ground shaking, liquefaction, slope instability, seiche, or tsunami.
Dutch Slough Tidal Marsh Restoration Project (EcoRestore project)	DWR	Planning phase	Wetland and upland habitat restoration in area used for agriculture	No direct impact on increased risks at Delta Conveyance Project construction locations from fault rupture, earthquake ground shaking, liquefaction, slope instability, seiche, or tsunami.
Alameda Watershed HCP	Alameda County	Planning phase	Habitat restoration and implementation of best management and maintenance practices for conservation sites	No direct impact on increased risks at Delta Conveyance Project construction locations from fault rupture, earthquake ground shaking, liquefaction, slope instability, seiche, or tsunami.

Program/Project	Agency	Status	Description of Program/Project	Impacts on Geology and Seismicity
Restoring Ecosystem Integrity in the Northwest Delta	CDFW	Completed	Management and restoration of up to 1,300 acres of perennial grassland/vernal pool complex in Solano County Island Corridor	No direct impact on increased risks at Delta Conveyance Project construction locations from fault rupture, earthquake ground shaking, liquefaction, slope instability, seiche, or tsunami.
CALFED Levee System Integrity Program	DWR, CDFW, USACE	Planning phase	Reuse of dredge material. Levee maintenance and levee improvement	No direct impact on increased risks at Delta Conveyance Project construction locations from fault rupture, earthquake ground shaking, liquefaction, slope instability, seiche, or tsunami.
Delta Flood Protection Fund	DWR	Ongoing	Maintenance and rehabilitation of non-project levees in the Delta	No direct impact on increased risks at Delta Conveyance Project construction locations from fault rupture, earthquake ground shaking, liquefaction, slope instability, seiche, or tsunami.
Mayberry Farms Subsidence Reversal and Carbon Sequestration Project	DWR	Completed (ongoing maintenance)	Wetland restoration and enhancement to reverse subsidence	No direct impact on increased risks at Delta Conveyance Project construction locations from fault rupture, earthquake ground shaking, liquefaction, slope instability, seiche, or tsunami.
Sherman Island Setback Levee-Mayberry Slough	DWR	Completed	Construction of four sections of setback levees to increase levee stability	No direct impact on increased risks at Delta Conveyance Project construction locations from fault rupture, earthquake ground shaking, liquefaction, slope instability, seiche, or tsunami.
Sherman Island – Whale’s Belly Wetlands	DWR	Ongoing	Wetland restoration and enhancement and levee construction to reverse subsidence provide 30,000 acres of habitat	No direct impact on increased risks at Delta Conveyance Project construction locations from fault rupture, earthquake ground shaking, liquefaction, slope instability, seiche, or tsunami.
Twitchell Island - San Joaquin River Setback Levee	DWR	Planning phase	Levee stabilization and habitat restoration	No direct impact on increased risks at Delta Conveyance Project construction locations from fault rupture, earthquake ground shaking, liquefaction, slope instability, seiche, or tsunami.

Program/Project	Agency	Status	Description of Program/Project	Impacts on Geology and Seismicity
Central Valley Joint Venture Program	Central Valley Joint Venture	Ongoing	Restoration of 19,170 acres of seasonal wetland, enhancement of 2,118 acres of seasonal wetland annually, restoration of 1,208 acres of semi-permanent wetland	No direct impact on increased risks at Delta Conveyance Project construction locations from fault rupture, earthquake ground shaking, liquefaction, slope instability, seiche, or tsunami.
Lower Putah Creek Realignment	CDFW	Planning phase	Restoration of 300–700 acres of tidal freshwater wetlands and creation of 5 miles of a new fish channel	No direct impact on increased risks at Delta Conveyance Project construction locations from fault rupture, earthquake ground shaking, liquefaction, slope instability, seiche, or tsunami.

BiOps = Biological Opinions; CDFW = California Department of Fish and Wildlife; DWR = California Department of Water Resources; EIR = Environmental Impact Report; EIS = environmental impact statement; USACE= U.S. Army Corps of Engineers.

10.3.4.1 Cumulative Impacts of the No Project Alternative

The ongoing projects and programs under the No Project Alternative in addition to the cumulative projects would require ground disturbance, construction of facilities, and habitat restoration activities. These activities could result in construction or operational activities in areas with geologic and seismic hazard concerns such as fault rupture, earthquake ground shaking, and liquefaction. However, these types of projects are required to be designed to meet geotechnical design standards. Thus, impacts of ongoing projects and programs within and outside of the Delta under the No Project Alternative related to geologic and seismic hazards are not anticipated to result in loss, injury, or death from geologic hazards.

10.3.4.2 Cumulative Impacts of the Project Alternatives

This cumulative impact analysis considers projects that could be constrained or affected by geologic and seismic hazards and, where relevant, in the same time frame as the project alternatives, resulting in a cumulative impact. Other than rise in sea level, which could increase groundwater levels such that there could be a modest increase in liquefaction hazard, the geologic and seismic environment is not expected to change as a result of past, present, and reasonably foreseeable future projects because projects in and near the study area would not change the underlying geologic conditions or seismic hazards and are required to be designed to meet geotechnical design standards. The project alternatives contribution would not be cumulatively considerable, and this cumulative impact is less than significant.

Hazards, Hazardous Materials, and Wildfire

This chapter describes the environmental setting and study area for hazards, hazardous materials, and wildfire; analyzes impacts that could result from construction, operation, and maintenance of the project; and provides mitigation measures to reduce the effects of potentially significant impacts. This chapter also analyzes the impacts that could result from compensatory mitigation required for the project and describes any additional mitigation necessary to reduce those impacts, and analyzes the impacts that could result from other mitigation measures associated with other resource chapters in this Final Environmental Impact Report (EIR).

25.0 Summary Comparison of Alternatives

Table 25-0 provides a summary comparison of important hazards, hazardous materials, and wildfire impacts by alternative. The table presents the CEQA findings after all mitigation is applied. Under all project alternatives, there is the potential to encounter hazardous materials through the handling of reusable tunnel material (RTM), excavation and tunneling near oil and natural gas production facilities, and while tunneling near gas fields.

Alternative 5 would have a greater potential to expose sensitive receptors at a school to hazardous materials, substances, or waste during construction because this alternative is the only one that has project facilities within 0.25 mile of a school.

Alternatives 3, 4a, 4b, and 4c would have the greatest potential to conflict with a known hazardous materials site and, as a result, create a potentially significant hazard to the public or environment because those alternatives would be constructed within 0.25 mile of two known hazardous materials sites. Conversely, Alternatives 1, 2a, 2b, 2c, and 5 would have the least potential to conflict with known hazardous sites because those alternatives would be constructed within 0.25 mile of only one known hazardous materials site.

The risk of wildfire is similar under all project alternatives. However, the magnitude of potential impacts during construction may be greater under Alternatives 2a, 3, 4a, 4b, 4c, and 5 because construction of these alternatives would take longer and thereby require the presence of personnel and equipment for a longer duration.

Table ES-2 in the Executive Summary provides a summary of all impacts disclosed in this chapter.

1 **Table 25-0. Comparison of Impacts on Hazards, Hazardous Materials, and Wildfire by Alternative**

Chapter 25 – Hazards, Hazardous Materials, and Wildfire	Alternative								
	1	2a	2b	2c	3	4a	4b	4c	5
Impact HAZ-1: Create a Substantial Hazard to the Public or the Environment through the Routine Transport, Use, or Disposal of Hazardous Materials	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS
Impact HAZ-2: Create a Significant Hazard to the Public or the Environment through Reasonably Foreseeable Upset and Accident Conditions Involving the Release of Hazardous Materials into the Environment	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS
Impact HAZ-3: Expose Sensitive Receptors at an Existing or Proposed School Located within 0.25 Mile of Project Facilities to Hazardous Materials, Substances, or Waste	NI	NI	NI	NI	NI	NI	NI	NI	LTS
Impact HAZ-4: Be Located on a Site That Is Included on a List of Hazardous Materials Sites Compiled Pursuant to Government Code Section 65962.5 and, as a Result, Create a Substantial Hazard to the Public or the Environment	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS
Impact HAZ-5: Result in a Safety Hazard Associated with an Airport or Private Airstrip	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS
Impact HAZ-6: Impair Implementation of or Physically Interfere with an Adopted Emergency Response Plan or Emergency Evacuation Plan	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS
Impact HAZ-7: Expose People or Structures, Either Directly or Indirectly, to a Substantial Risk of Loss, Injury, or Death Involving Wildland Fires	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS

2 NI = no impact; LTS = less than significant.

25.1 Environmental Setting

This section describes the environmental setting and affected environment for hazards, hazardous materials, and wildfire in the study area.

25.1.1 Study Area

This section discusses the hazards, hazardous materials, and wildfire study area (the area in which impacts may occur), which consists of the construction footprint (and 0.25-mile buffer) for all project alternatives. In the case of airports, the study area extends 2 miles from the construction footprint.

The Delta is characterized as a multi-use landscape, with agriculture accounting for approximately 75% of land use within the study area. Other land uses include industrial/manufacturing, transportation, recreation, habitat conservation, and residential, as described in Chapter 14, *Land Use*. The built environment of the study area contains a variety of roads, transportation facilities, waterways and canals, utilities, petroleum production and processing facilities, urban lands, and other structures. As described in Chapter 20, *Transportation*, the study area is home to several major transportation arteries, such as Interstate (I-) 5 and other highways in the region. Shipping centers include the Ports of Sacramento and Stockton, and several national and regional railroads operate within the study area.

A discussion of historical and existing land uses with the potential to result in hazardous conditions is provided in Section 25.1.2, *Potential Hazards and Hazardous Materials in the Study Area*.

25.1.2 Potential Hazards and Hazardous Materials in the Study Area

This section describes naturally occurring and anthropogenic hazards in the study area. Historic agricultural, industrial, and urban/recreational activities in the study area and, in some cases, upstream of it, have resulted in the presence of hazardous materials in soils, sediments, and groundwater in the study area. Additionally, current agricultural, industrial, urban, and recreational activities (e.g., boating) within the study area use and introduce hazardous materials (e.g., pesticides, fertilizers, industrial waste). Further, infrastructure, such as electrical transmission lines and crude oil and natural gas pipelines, is present throughout the study area. These materials have the potential to be released into the environment during construction of the project alternatives and during the project's operation. Specific types of hazards and hazardous materials are discussed in greater detail in the following sections.

25.1.2.1 Naturally Occurring Hazards

Historic geologic conditions in the study area have led to the formation of peat and other organic soils with thicknesses of up to approximately 55 feet on the western side of the Delta; peat deposits are not commonly found on the eastern side of the Delta. The thick organic soils and peat have the potential to generate flammable gases such as methane that can pose hazards to workers during deep excavations and tunneling. In addition, petroleum deposits underlying the study area could result in the migration of oil or natural gas from deep reservoirs into shallow strata that may be disturbed during construction. See Figure 25-1 for locations of oil and gas fields. Additional

information on organic soils in the study area is provided in Chapter 10, *Geology and Seismicity*, and Chapter 11, *Soils*.

Much of the study area consists of lowlands capable of supporting insects such as mosquitos, which can be vectors for infectious diseases. The potential hazards associated with vector-borne diseases are discussed in Chapter 26, *Public Health*.

The study area also contains water bodies with the potential to grow cyanobacteria harmful algal blooms (CHABs). The potential for CHABs to harm human health or aquatic ecosystems is also discussed in Chapter 26. The nutrient-associated water quality concerns of CHABs are discussed in Chapter 9, *Water Quality*.

Valley fever is a disease caused by inhaling *Coccidioides immitis* (*C. immitis*) fungus spores that are found in certain types of soil and become airborne when the soil is disturbed. Naturally occurring asbestos (NOA) is found in ultramafic rock that has undergone partial or complete alteration to serpentine rock and often contains chrysotile asbestos. The inhalation of asbestos fibers into the lungs can result in a variety of adverse health effects. Earthmoving activities during construction could release *C. immitis* spores and/or NOA if either are present in the soil. The potential for the project to expose people to increased risk of developing Valley fever and health effects from NOA are discussed in Chapter 23, *Air Quality and Greenhouse Gases*.

25.1.2.2 Hazards from Agricultural Practices

Agriculture has been the primary land use in the study area for more than a century. As described in Chapter 14, the majority of the 738,000 acres of the Delta area is used for agriculture.

A wide variety of pesticides, including insecticides, herbicides, and fungicides, have been used throughout the study area for decades and may be present in and near agricultural lands. Pesticides that have been widely and historically applied, but that are no longer in use, may also continue to persist within the soils (e.g., dibromochloropropane). Because of their relatively low water solubility, persistent pesticides and compounds generally accumulate in the environment in sediment and soil, as well as in the fatty tissue of terrestrial and aquatic animals and humans. Generally, human exposure to persistent pesticides is primarily through diet and the consumption of fatty animal-based foods, such as meat, fish, poultry, and dairy products. The effects of exposure to any hazardous substance depend on many variables, including the dose, duration, and route of exposure.

No comprehensive area-wide soil or sediment sampling program is known to have been conducted to evaluate pesticide residues from agricultural use. Further discussion of the fate, transport, and bioaccumulative properties of pyrethroid, organochlorine, and organophosphate pesticides that have been applied to study area crops is provided in Chapter 9.

Pesticide and fertilizer supply companies, including facilities that sell, store, concentrate, dilute, or distribute agricultural chemicals, are present in the study area. These supply facilities may be large-volume supply businesses that have tanks holding thousands of gallons of agricultural chemicals, which are sold to farmers or distributors for local use. Other pesticide and fertilizer facilities may be farm-level batch plants, which take the raw material from a supply yard or tanker and temporarily store the material prior to loading it into distribution equipment.

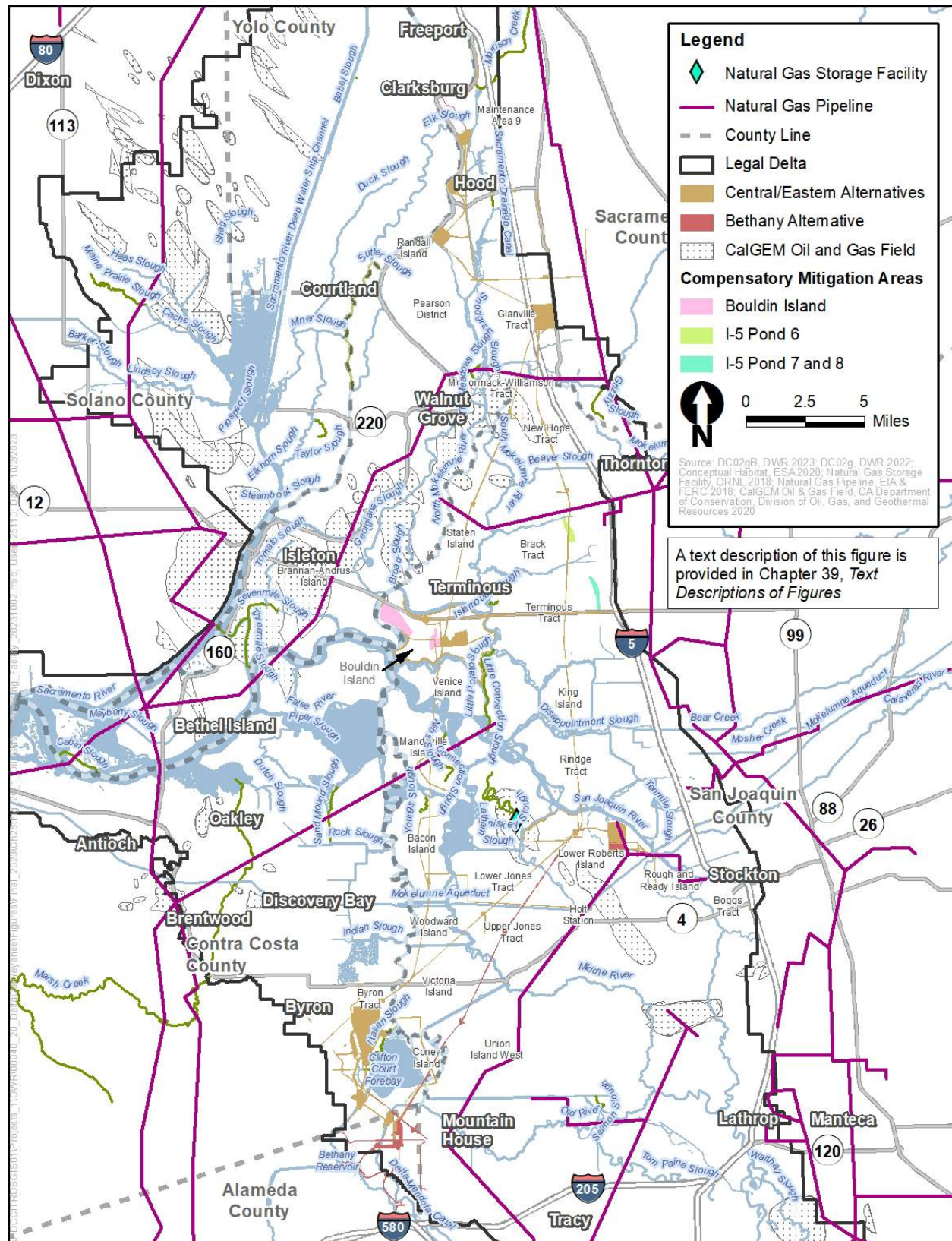


Figure 25-1. Oil and Gas Processing Facilities

In addition to agricultural pesticide and fertilizer use, other activities associated with farming can generate hazardous materials. Most farming properties have land that is not engaged directly in crop production (e.g., buildings used for equipment storage and maintenance). Aboveground and underground storage tanks (ASTs, USTs) potentially containing hazardous materials (e.g., fuel) used in farm operations may also be present. In addition to pesticides and fertilizers, storage of petrochemical products is prevalent. Farms also often have a waste disposal area where waste crop material may be stored for later offsite disposal, and composting storage areas may also contain drums of lubricants, agricultural chemicals, or other potentially hazardous materials (e.g., paint, solvents) temporarily stored before disposal.

The study area has a wide variety of processing facilities for the variety of crops grown (e.g., pears, asparagus). Contaminants of concern for these types of properties vary, but are primarily pesticides, fertilizers, and chemicals for maintaining farm equipment (e.g., solvents, grease, oil, gasoline). Waste disposal areas on farms may have petroleum products (e.g., waste materials from equipment maintenance) or agricultural chemicals (spillage from containers containing residual volumes of chemicals such as pesticides). Health studies of petroleum products have shown effects on lungs, the central nervous system, the immune system, reproduction, skin, and eyes (Agency for Toxic Substances and Disease Registry 2014a).

25.1.2.3 Hazards from Electrical Transmission Lines

Electricity within the study area is transmitted by power lines owned and maintained by the participants in the California-Oregon Transmission Project, which include Transmission Agency of Northern California (TANC), Western Area Power Administration (WAPA), Pacific Gas and Electric (PG&E), and Sacramento Municipal Utilities District (SMUD), and by the individual entities of WAPA, PG&E, and SMUD. The existing transmission lines are sized at 500 kilovolts (kV), 230 kV, 115 kV, 69 kV, or 60 kV. Distribution lines are lower voltage and therefore carry a smaller amount of power (e.g., 24 kV) and are generally owned by the utility companies that use them. When work is performed near transmission lines, electrical contact can occur even if direct physical contact with a line is not made because electricity can arc across an air gap. Accidental or inadvertent contact with energized 500-kV transmission lines and towers could result in public health and safety impacts including serious injury, electrocution, and in some instances, death. For a discussion regarding the project's potential to impact utility providers and utility infrastructure, see Chapter 21, *Public Services and Utilities*.

25.1.2.4 Hazards from Oil and Gas Production and Processing

Active oil and gas extraction fields are present throughout the study area. Petroleum production in the study area mainly consists of natural gas extraction, though minor quantities of crude oil and condensate are also produced.

Petroleum production has occurred in the study area at least since the discovery of the Rio Vista gas field in 1936. Numerous oil and gas wells have been drilled throughout the study area; many of these wells are present along the alignments under consideration for the project alternatives (Figure 25-2). Oil and natural gas production emits benzene, toluene, ethylbenzene, and xylenes (BTEX compounds) as well as n-hexane and other volatile organic compounds. Short-term exposure to these compounds can result in nose, throat, eye, skin, and gastric irritation; nausea; vomiting; and neurological effects. Chronic exposure can result in blood disorders, birth defects, developmental disorders, neurological effects, respiratory problems, and cancer (U.S. Environmental Protection

Agency 2016). The locations of active wells can be determined with relative ease; however, the locations of abandoned or plugged wells may be unknown due to inadequate or missing data or poor record keeping.

Active, abandoned, and idle oil and gas wells may be present in areas where excavation is planned. Improperly sealed natural gas wells have the potential to act as natural gas conduits from deep reservoirs to shallow strata where flammable gases may pose hazards to excavation or tunneling activities.

Chapter 27, *Mineral Resources*, provides a discussion of known oil and gas resources throughout the study area. Two active gas wells have been identified in the study area. The first is located near King Island just outside the eastern tunnel alignment. The second active gas well is located along the central tunnel alignment on Staten Island (Figure 25-2).

Previously active oil and natural gas well fields may have areas of contaminated soil and/or groundwater. In addition to production facilities, an active, producing well field may have areas used during exploration that may currently have soil or groundwater contamination. For example, during typical drilling activities, mud pits have served as surface impoundments for drilling fluids that can contain hazardous materials (e.g., cadmium, mercury, chromium, naphthalene, and fluorine), resulting in a potential source of contamination. Drilling fluids often contain petroleum compounds in both raw (crude) form and refined form (drilling enhancement additives). Generally, mud pits are a series of open tanks, usually made of steel plates, through which the drilling mud is cycled to allow sand and sediments to settle out. Former mud pits, although usually lined, may be a source of hydrocarbon contamination.

Other oil and gas exploration and production activities that can release hazardous materials into the environment, where they may be encountered during excavation or construction, include drilling, production, treatment and temporary storage areas, and storage and shipment to refineries and processing facilities. Oil and natural gas pipelines are also present throughout the study area and several pipelines are aligned west to east across the study area's southern half (Figure 25-1). A discussion of oil and natural gas resources in the study area is found in Chapter 27.

25.1.2.5 Hazards from Historical Mining

Mercury has been identified as a chemical of concern in Delta area sediments. Historically, mercury was used extensively upstream of the study area in mining to extract gold from ores and placer gravel deposits. Mercury released into the environment by historic gold mining practices has been flowing into the study area via water, primarily from the Sacramento River watershed, and sediments since the mid-1800s and is expected to continue to do so. An unknown amount of mercury, primarily as methylmercury, is present in sediments within the study area, but estimates of mercury flowing into the study area, mainly associated with suspended sediment, range from approximately 200 to 400 kilograms per year (Central Valley Regional Water Quality Control Board 2008:27–28). Discussions of mercury and other metals and their bioaccumulative properties are provided in Chapter 9 and Chapter 26.

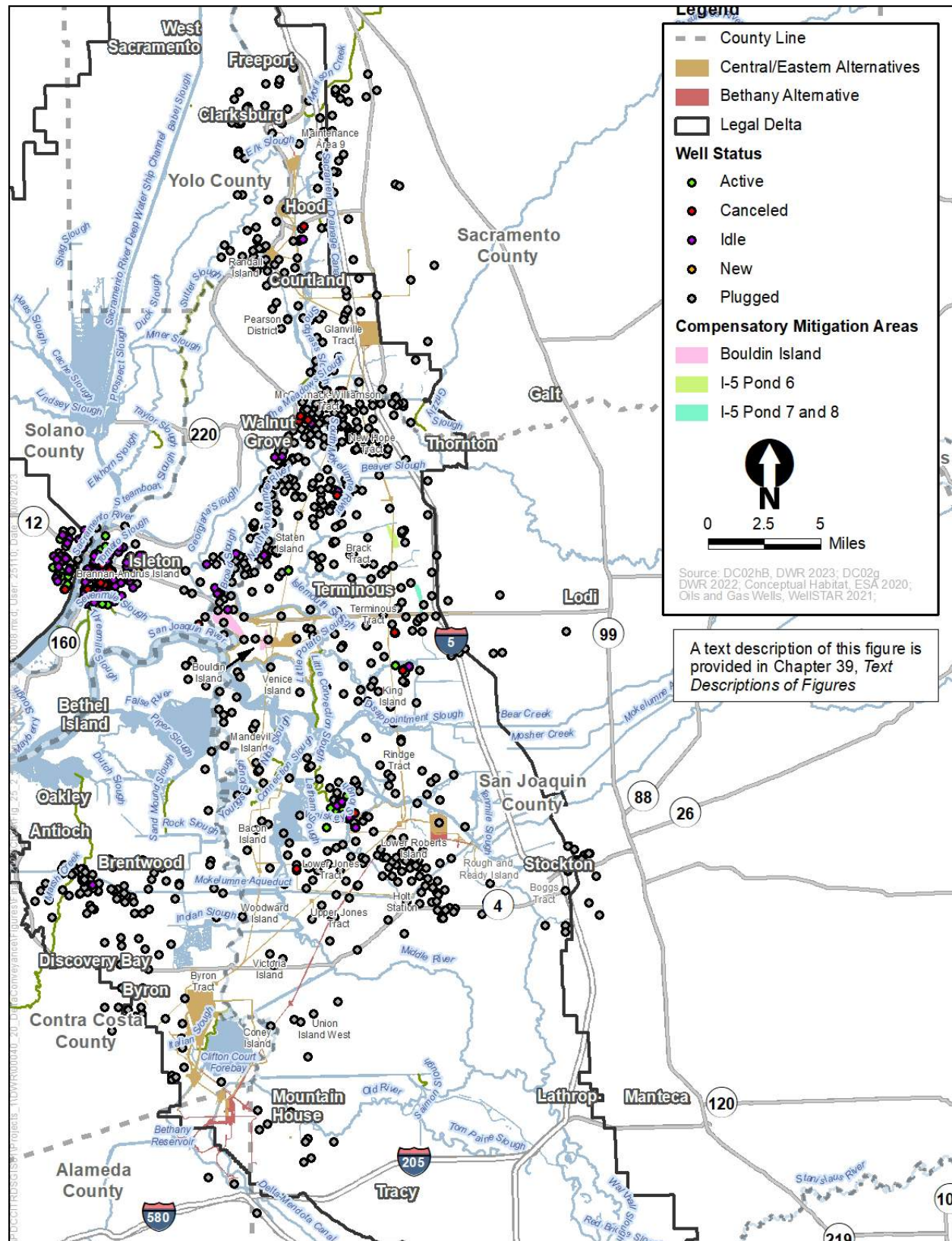


Figure 25-2. Oil and Gas Wells

25.1.2.6 Urban, Residential, and Recreational Land Use

In general, hazardous materials releases from cities and towns are associated with stormwater runoff and primarily affect water bodies. Urban stormwater discharges are generally characterized by varying levels of metals and hydrocarbons that can accumulate in river sediments over time. Historically, polychlorinated biphenyls (PCBs) have been associated with urban discharge, and these contaminants have been detected in fish tissues in San Francisco Bay.

Urban areas have many facilities that could have hazardous materials releases, including gas stations, dry cleaners, automotive repair facilities, and, in larger towns, manufacturing facilities. Stockton, for example, has large shipping and port facilities, as well as federal facilities with a history of hazardous materials use, storage, and releases. Possible contaminants of concern from urban land uses are extensive, but the most common contaminants in soil and groundwater are petroleum and associated compounds (typically from gasoline and diesel releases from USTs), chlorinated solvents and degreasers (from dry cleaning and vehicle repair facilities), and various heavy metals, such as arsenic and lead.

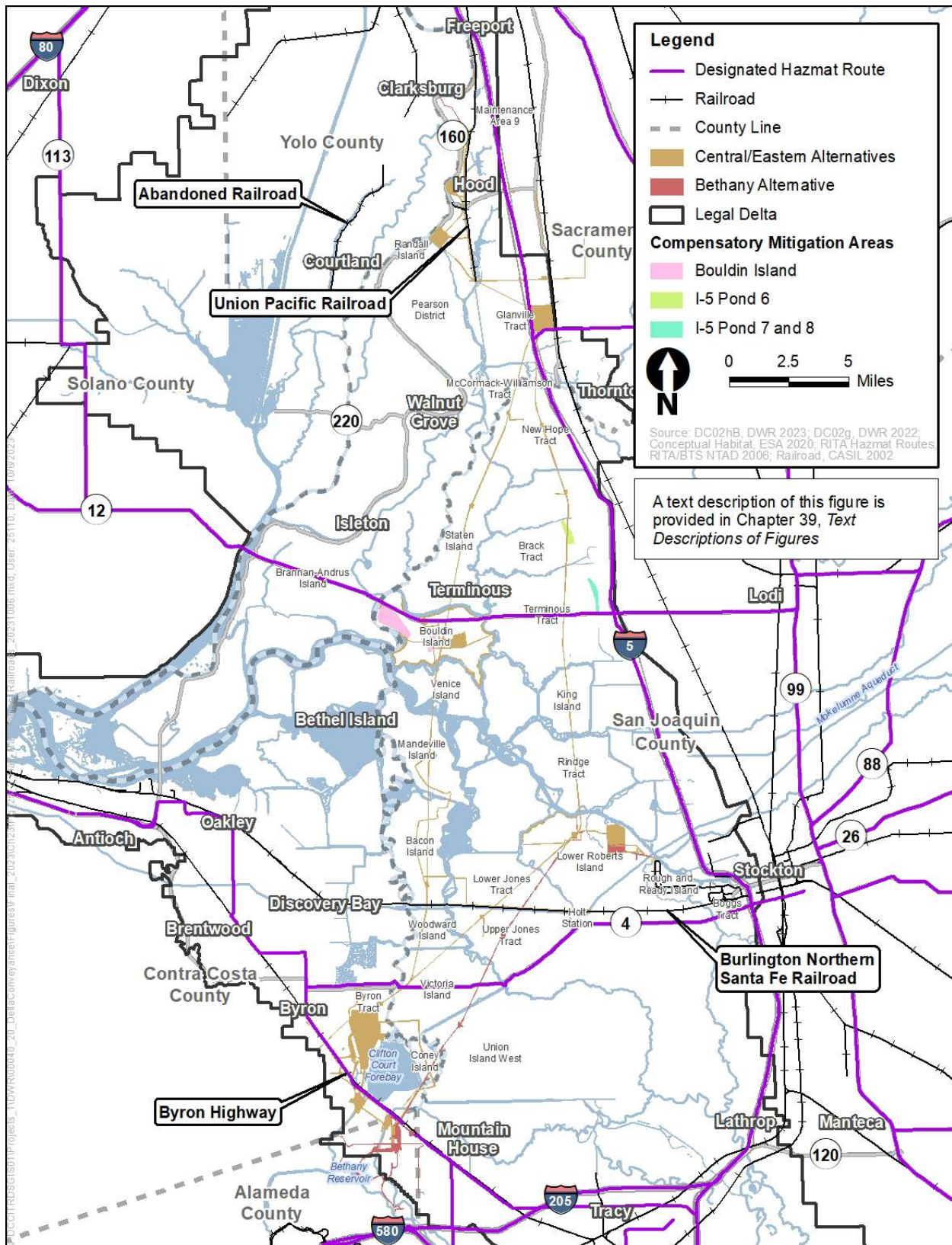
In addition, large marinas, service houseboats, pleasure craft, and commercial craft are present throughout the study area. Marinas typically have bulk fuel storage and overwater fueling facilities, various boat repair/maintenance facilities, stores, boat storage, and camping facilities. Typical chemicals associated with marinas include fuels, lubricants, cleaners, anti-fouling paints, and fiberglass components.

Wastewater discharges from treatment plants also are associated with urban and suburban land use. Given the small percentage of urban land in the study area, urban-related toxicants are of less concern than other potential sources of hazardous materials. A detailed discussion of water quality is provided in Chapter 9.

25.1.2.7 Hazardous Materials Transportation

The study area and surrounding region are home to urban centers, including the cities of Antioch, Stockton, Sacramento, and San Francisco. Major east-west surface transport routes and ship channels cross the Delta. These transportation corridors move a variety of products, including hazardous materials. Transportation of hazardous materials involves some risk of spillage and subsequent contamination of soil, water, or sediments.

Various hazardous materials are transported through the study area by water, pipeline, rail, and road. The hazardous materials shippers and transporters must comply with specific requirements of the Code of Federal Regulations (CFR), Title 49, Part 171 including proper classification, labeling, packaging, and handling. Figure 25-3 displays the locations of designated hazardous materials transportation routes, including rail, within the study area.



1
2 **Figure 25-3. Hazardous Materials Routes and Railroads**

Transported Commodities of Concern

The following commodities are known to be transported through the study area by one or more modes of transportation. Acute, short-term health effects of exposure to these chemicals (commodities) are briefly described below. The effects of exposure to any hazardous substance depend on many variables, including the dose, duration, and route of exposure.

- Anhydrous ammonia is commercially used directly or indirectly in the production of pharmaceuticals. Anhydrous ammonia is also used in the production of fertilizer. It is a caustic or corrosive, colorless gas. Ammonia is an irritant that is corrosive to the skin, eyes, respiratory tract, and mucous membranes. Exposure to liquid or rapidly expanding gases may cause severe chemical burns and frostbite to the eyes, lungs, and skin (Tanner Industries, Inc. 2011:1).
- Crude oil, or petroleum, is a naturally occurring, combustible liquid. It is the base product that is processed to produce other petroleum products.
- Diesel, or petro-diesel, is a product of crude oil used as fuel for vehicles, trucks, ships, and generators. It is a volatile, flammable liquid. Direct contact with diesel fuel causes severe skin irritation. Inhalation of diesel fuel can result in lung damage (California Office of Environmental Health Hazard Assessment 2021).
- Gasoline is a product of crude oil used primarily as engine fuel. It is a volatile, flammable liquid. Typical gasoline contains about 150 different chemicals, including BTEX compounds. Many adverse health effects of gasoline are due to individual chemicals in gasoline, mainly BTEX, that are present in small amounts. Inhalation of gasoline vapors can cause nose and throat irritation, headaches, dizziness, nausea, vomiting, confusion, and breathing difficulties. Skin contact with gasoline can result in rashes, redness, and swelling (Agency for Toxic Substances and Disease Registry 2014b).
- Natural gas consists primarily of methane and is a colorless, nearly odorless gas. Natural gas is volatile and flammable. Acute dizziness may result immediately or shortly after exposure to methane with oxygen levels of less than 15% in air; no long-term health effects are known to be associated with exposure to methane (Wisconsin Department of Health Services 2019).
- Propane is normally a colorless gas, but it can be compressed into a transportable liquid. Propane is volatile and flammable. Potential health effects associated with short-term exposure to propane include dizziness, disorientation, and excitation (i.e., hallucinations, euphoria); nausea and vomiting; unconsciousness; cardiac arrest; and frostbite (from contact with liquid) (U.S. Department of Health and Human Services 2017).
- Ethanol is a volatile, flammable, colorless liquid. It is a skin, eye, and lung irritant (Velocity EHS 2014).
- Coal fly ash is a fine particulate residue generated in the combustion of coal. The main components of coal fly ash are oxides of silicon, aluminum, iron, and calcium, with lesser amounts of magnesium, sulfur, sodium, and potassium. Other metals and metal-like elements are found in trace quantities, and can include arsenic, lead, cadmium, mercury, and other metals. Fly ash is a respiratory irritant, and some of the compounds found in fly ash can be toxic to the nervous system and cardiovascular system and can adversely affect the kidneys (U.S. Environmental Protection Agency 2019a).
- Radioactive material occurs in many forms. The type and severity of adverse health effects from radiation depend on the amount and duration of radiation exposure. Adverse health effects from

radiation exposure generally range from acute exposure effects such as skin burns, nausea, weakness, hair loss, or diminished organ function to DNA mutations and cancer (U.S. Environmental Protection Agency 2019b).

- Common acids and bases used in industry and research include sodium hydroxide, ammonium hydroxide, hydrochloric acid, and sulfuric acid. Strong acids and bases such as these are corrosive to skin as well as nasal and lung tissue (if inhaled).

Rail

Union Pacific Railroad (UPRR) and BNSF Railway (formerly Burlington Northern Santa Fe Railway) are the major railroads in the Delta. Two smaller railroads operate locally: Central California Traction Company (CCT) and Sierra Northern Railway. Both are short-line railroads at the Ports of Stockton and West Sacramento, respectively. These railroads provide service to UPRR and BNSF at the respective ports of their operations (Central California Traction Company n.d.; Sierra Northern Railway 2020). In addition to freight trains, Sierra Northern Railway also owns the Sacramento River Train, a passenger/tourist train that runs from West Sacramento to Woodland (Sierra Northern Railway 2020). For locations of railroads in the Delta and immediate vicinity, please refer to Figure 20-4 in Chapter 20, which provides additional information about rail transport in the study area.

On their national rail network, BNSF transports several types of fuel (e.g., liquefied petroleum gas, ethanol, coal) plastics, dry and liquid fertilizers, chemicals used in manufacturing, and other unspecified hazardous materials (BNSF Railway 2021a), as well as nonhazardous freight such as food and beverages (BNSF Railway 2021b). On its California routes, UPRR transports various chemicals, manufactured goods, agricultural products, industrial products, and energy products (Union Pacific Railroad 2019:26).

The exact types, quantities, or volumes of commodities transported through the study area by UPRR and BNSF Railway are not publicly available, presumably because of hazardous materials security plans required by U.S. Department of Transportation. Such non-disclosure is also consistent with definitions and regulations pertaining to protection of sensitive security information at 49 CFR Part 1520, Sections 1520.5(a)(3) and (8)(i) and 1520.9, applicable to maritime, rail, and aviation transportation. It is assumed that commodities carried on the short-line railroads would be transferred to the main railroad companies; however, this cannot be confirmed because of the safety and proprietary issues restricting access to commodity information from the ports and state and federal agencies.

Commodities transported by CCT, which operates freight service between Stockton and Lodi, include food, steel, lumber, and general commodities (Union Pacific Railroad n.d.). The short-line Sierra Northern Railway handles approximately 6,000 cars annually. Publicly available information indicates commodities carried by Sierra Northern Railway include unspecified chemicals, ethanol, and propane (Sierra Northern Railway 2020).

Federal, State, and County Roadways

Designated hazardous materials transportation routes avoid population centers, environmentally sensitive areas, narrow bridges, and tunnels. Designated routes are generally wider to provide easier access for first responders en route to an event (e.g., accident, release, or spill). Figure 25-3 shows the California designated routes for hazardous materials in the study area.

Designated hazardous materials routes in the study area are listed below.

- I-5, generally along the east side of the Delta boundary, and extending from Sacramento to south of Tracy.
- State Route (SR) 12, aligned from west to east across the central study area from Rio Vista to Lodi.
- SR 4, generally aligned from west to east across the southern portion of the study area from Pittsburg to Stockton.
- Byron Highway, a county road along the southwestern boundary of the study area; it intersects with SR 4 and trends southeasterly to the intersection with I-205.

Several alternative highway routes within and around the study area are available in the event of a hazardous materials accident and/or release. Refer to Chapter 20 for more detail about highways in the Delta.

Marine Transportation

Ships using ports in the study area transport hazardous materials by the Sacramento River, the San Joaquin River, the Sacramento River Deep Water Ship Channel, and the Stockton Deep Water Ship Channel. Ships enter the mainland at the Port of San Francisco and travel through San Pablo Bay, Suisun Bay, and Honker Bay before making their way to either the Sacramento River or the San Joaquin River, where they travel the Sacramento River Deep Water Ship Channel or the Stockton Deep Water Ship Channel to the port of choice.

The Port of West Sacramento is on the Sacramento River and the Sacramento River Deep Water Ship Channel. This port's location provides for immediate access to major highways and rail service. I-80 is approximately 0.25 mile from the front gate of the port. BNSF, UPRR, and Sierra Northern Railway provide rail service to the port. Intermodal services provided at the port are receiving from and loading out to ship, truck, or rail car. The port's primary cargoes are rice and cement (City of West Sacramento 2021:2), but also fertilizer, mineral/ore, and metals (SSA Marine 2022).

The Port of Stockton is on the Stockton Deep Water Ship Channel, approximately 1 mile from I-5 and other interconnecting major highway systems. It is centrally located, providing service for shipment and warehouse storage facilities for containerized and liquid bulk and dry bulk cargo. BNSF and UPRR serve these facilities. Commodities that are brought through the Port of Stockton include bulk materials, such as dry bulk (e.g., rice), cement, aggregate, steel products, coal, petroleum coke, slag, ores, clay, sulfur, liquid fertilizer, and anhydrous ammonia (Port of Stockton 2022).

25.1.2.8 Wildfire Hazards

In general, wildfire is a serious hazard in undeveloped areas with extensive areas of nonirrigated vegetation. Ninety-five percent of wildfires in California are caused by people, particularly where homes encroach on the wildland-urban interface (California State University n.d.). The typical "fire season" runs from June to October when vegetation is generally dry, but in recent history, the season is starting earlier and ending later each year. Climate change is considered a key driver of this trend—warmer spring and summer temperatures, reduced snowpack, and earlier snowmelt result in longer, more intense dry seasons (California Department of Forestry and Fire Protection 2019).

Fire hazard classification varies by areas in and around the study area. The California Department of Forestry and Fire Protection (CAL FIRE) has a legal responsibility to provide fire protection on all State Responsibility Area lands, which are defined based on land ownership, population density, and land use. For example, CAL FIRE does not have responsibility for densely populated areas, incorporated cities, agricultural lands, or lands administered by the federal government. The State Responsibility Area Fire Hazard Severity Zone maps show areas of legal responsibility for fire protection, including State Responsibility Areas, Federal Responsibility Areas, and Local Responsibility Areas. According to CAL FIRE's Natural Hazard Disclosure (Fire) maps, the majority of the study area is not in a fire hazard region, nor is it served by CAL FIRE under a State Responsibility Area or Local Responsibility Area (California Department of Forestry and Fire Protection 2007). The southwest portion of the project under all alternatives is within an area mapped as moderate for fire hazards and is served by CAL FIRE. Areas identified as Federal Responsibility Areas are in the Stone Lakes National Wildlife Refuge and just outside the study area in the Cosumnes River Preserve. Figure 25-4 shows CAL FIRE's fire hazard severity zones in relation to the study area. The types of fire hazards shown in Figure 25-4 are related to aboveground conditions and do not identify the potential for peat fires, discussed below.

Peat that has built up consists of decayed wetland vegetation (tule) and—when ignited—can cause fires that are particularly difficult to handle. Once ignited, peat's high carbon content and a propensity to burn at a lower temperature can smolder for very long periods of time (months or even years), slowly spreading underground. Peat fires are usually started by forest or grassland fires or—on rare occasions—lightning strikes. The thick organic soils and peat have the potential to generate flammable gases such as methane that can pose hazards to workers during deep excavations and tunneling. Figure 11-3 in Chapter 11 shows the thickness of organic soils of which peat is a major component in the study area.

25.1.3 Airports within 2 Miles of the Water Conveyance Project Footprints

Four public and seven private airports are within 2 miles of the study area. These airports are described briefly below (Figure 25-5).

25.1.3.1 Public Airports

Byron Airport. This airport is 2 miles south of Byron and is owned by Contra Costa County. Byron Airport has two runways and averages 227 operating aircraft per day, based on a 12-month period ending December 31, 2017 (AirNav, LLC 2020a). There is no control tower.

Franklin Field Airport. This airport is approximately 4 miles southeast of Franklin and is owned by the County of Sacramento. The Franklin Field Airport has two runways and averages approximately 89 operating aircraft per day, based on a 12-month period ending December 31, 2017 (AirNav, LLC 2020b). There is no control tower.

Lost Isle Seaplane Base. This airport is approximately 8 miles northwest of Stockton and is owned by the California State Lands Commission. The Lost Isle Seaplane Base has one runway and averages approximately 12 operating aircraft per year, based on a 12-month period ending October 10, 2018 (AirNav, LLC 2020c). There is no control tower.

- 1 **Kingdon Airpark.** This public-use airport is approximately 3 miles west of Lodi. The airport has
- 2 two lighted asphalt runways averaging 11 aircraft operations per day. There is no control tower
- 3 (AirNav, LLC 2021a).

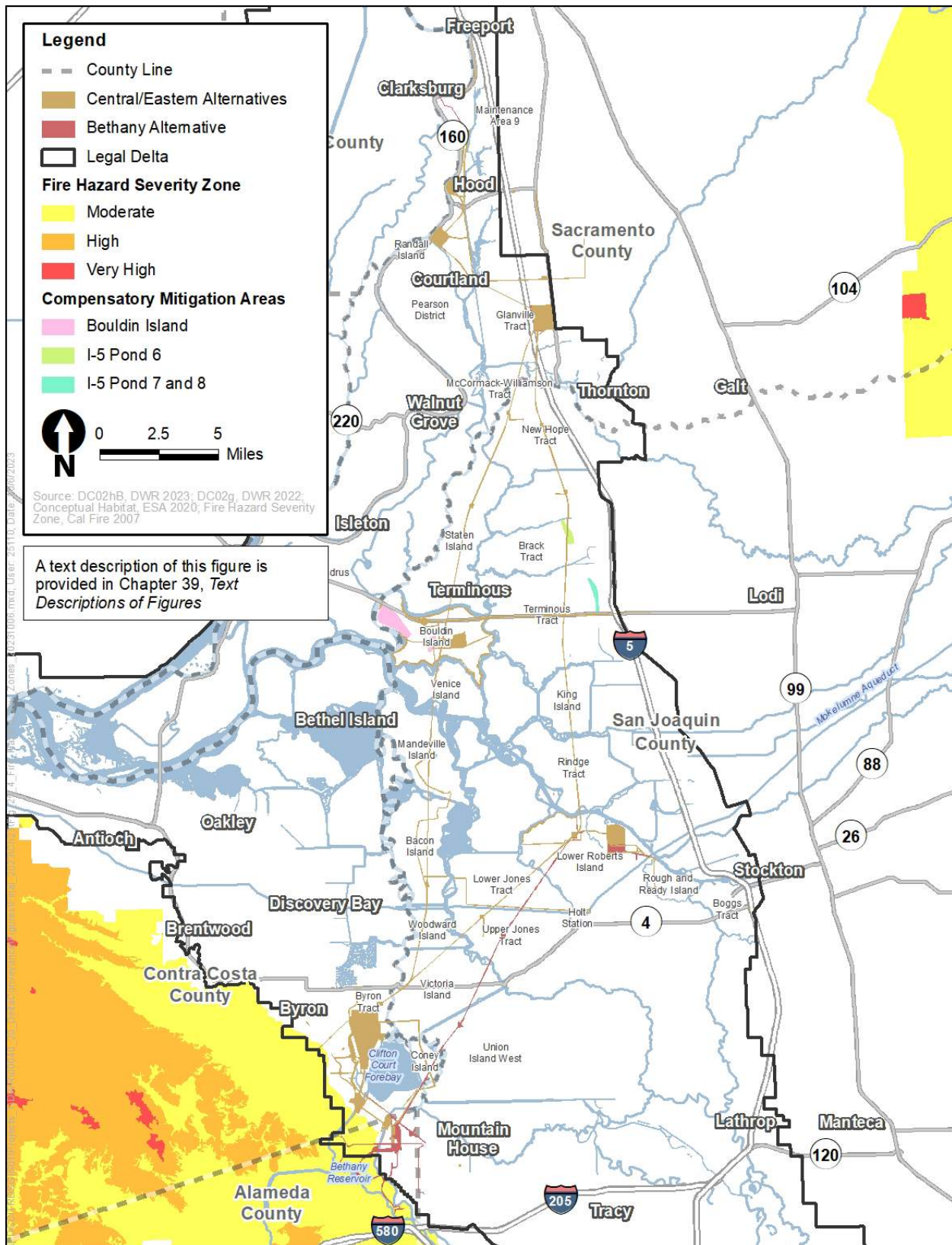


Figure 25-4. Fire Hazard Severity Zones

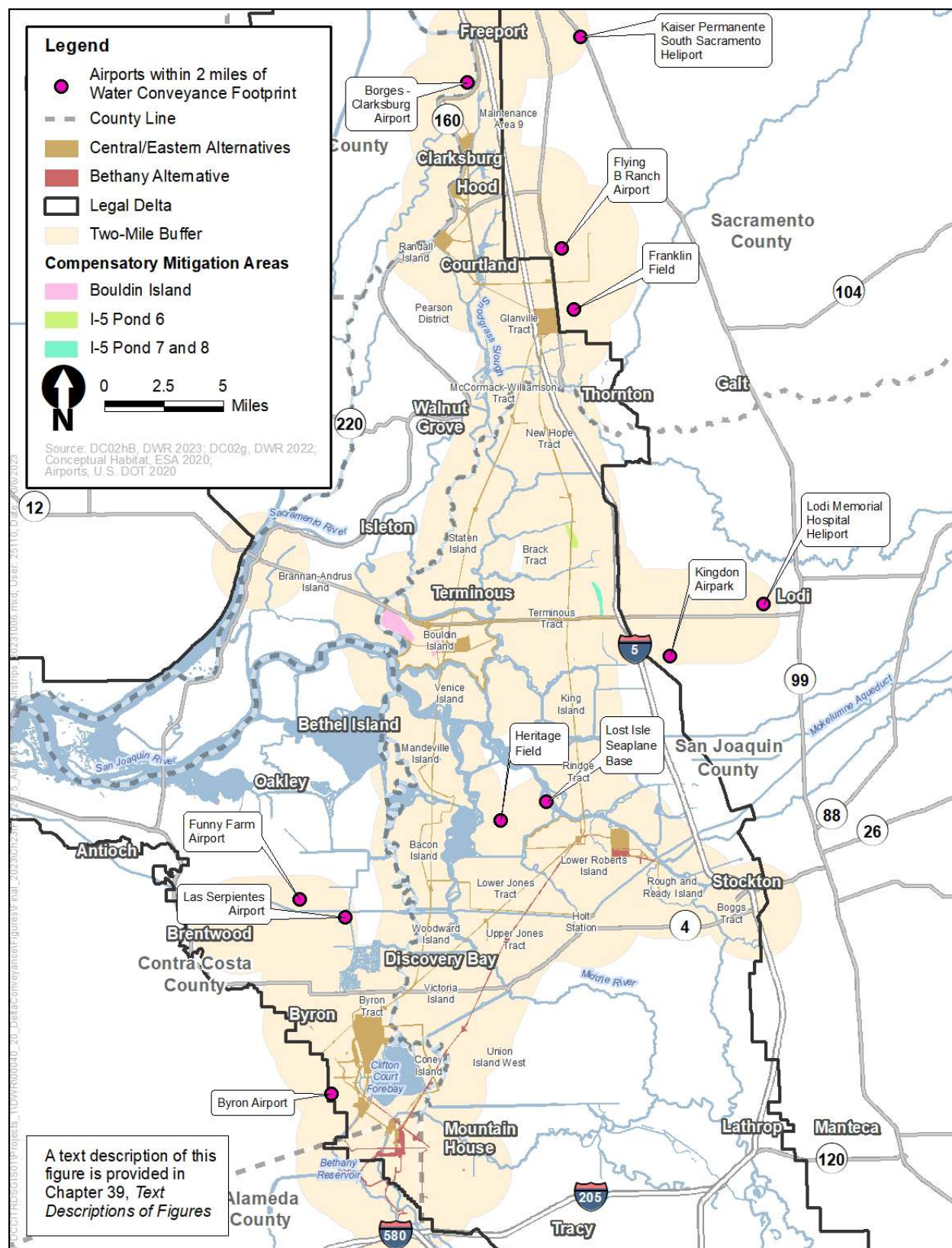


Figure 25-5. Airports within 2 Miles of Water Conveyance Facilities

25.1.3.2 Private Airports

Kaiser Permanente South Sacramento Heliport. The Kaiser Permanente South Sacramento Hospital heliport is located at 6600 Bruceville Road, Sacramento. The heliport used for hospital business and patient care is a private 40-foot by 40-foot helipad (AirNav, LLC 2021b).

Borges-Clarksburg Airport. This airport is approximately 2 miles northeast of Clarksburg and has one turf runway. There is no control tower, and permission is required to land. The Borges-Clarksburg Airport averages approximately 57 operating aircraft per week, based on a 12-month period ending December 31, 2001 (AirNav, LLC 2020d).

Lodi Memorial Hospital Heliport. The Lodi Memorial Hospital heliport is a private, medical-use heliport located at 975 South Fairmont Avenue, Lodi (AirNav, LLC 2021c).

Flying B Ranch Airport. This airport is approximately 2.3 miles south of Elk Grove and has two dirt runways. The airport serves single-engine aircraft and has no control tower (AirNav, LLC 2021d).

Heritage Field. This airport is on Mc Donald Island approximately 7 miles northwest of Stockton and has two asphalt runways. There is no control tower, and permission is required to land (AirNav, LLC 2020e).

Funny Farm Airport. This airport is in Brentwood and has two asphalt runways. There is no control tower, and permission is required to land (AirNav, LLC 2021e).

Las Serpientes Airport. This airport is approximately 2 miles southeast of Knightsen and has two dirt runways. There is no control tower, and permission is required to land (AirNav, LLC 2021f).

25.1.4 Evacuation and Emergency Routes

Emergency response for most of the study area is under the jurisdiction of the Sacramento County Office of Emergency Services (SacOES) and San Joaquin County Office of Emergency Services (SJOES). Both agencies are responsible for alerting and notifying appropriate agencies when disaster strikes; coordinating all agencies that respond; ensuring resources are available and mobilized in times of disaster; developing plans and procedures in response to and recovery from disasters; and developing and providing preparedness materials for the public (County of Sacramento 2020; County of San Joaquin 2019:5). SacOES and SJOES are responsible for coordinating plans for all types of emergencies including emergency evacuations. Yolo, Contra Costa, and Alameda Counties also have offices of emergency services that provide coordinated emergency management. Local emergency response teams, including fire, police, and sheriff's departments, provide most of the services in an emergency response.

Emergency evacuations are implemented by local jurisdictions according to local laws, policies, and authority. The decision to evacuate depends on the nature, scope, and severity of the emergency, as well as the number of people affected and what actions are necessary to protect the public. Local jurisdictions activate their own resources and emergency operation centers for an evacuation of their communities based on the local situation. Mitigation Measure TRANS-1 requires that the project would develop site-specific Transportation Demand Management and Traffic Management Plans in consultation with the applicable transportation entities, including the following.

- Caltrans for state and federal roadway facilities.
- Local agencies for local roadway facilities.

- Local agencies for local intersection facilities (vehicles, pedestrians, and bicyclists).

25.1.5 Known Hazardous Materials Sites

To identify potential hazardous materials sites within the study area, the California Department of Toxic Substances Control (DTSC) EnviroStor database and the State Water Resources Control Board (State Water Board) GeoTracker database (i.e., Cortese List) were reviewed. Both resources are included in the Cortese List, a planning document used by state and local agencies and developers to comply with CEQA requirements in providing information about the locations of hazardous materials release sites. Per Government Code Section 65962.5, the Cortese List must be updated at least once annually. DTSC's EnviroStor database identifies sites that have known contamination or sites requiring further investigation, including State Response and Voluntary Cleanup sites. State Water Board's GeoTracker database identifies sites that impact, or have the potential to impact, water quality in California, with emphasis on groundwater such as Cleanup Program Sites (also known as Site Cleanups). The search area covered the study area (Department of Toxic Substances Control 2021a). Most hazardous materials sites identified were related to leaking underground storage tanks (LUSTs) and oil and/or gasoline pipeline leaks. Sites identified in the database search along with their location, site summary, and current status are listed in Table 25-1.

Table 25-1. Sites of Concern within or near the Study Area

Site Name	Location	Site Type	Summary and Site Status	Alignment and Alternatives	Site within Study Area
GTE Data Services	7901 Freeport Blvd, Sacramento	LUST	Aquifer contamination was caused by diesel leaking from an underground storage tank. Cleanup was completed. The case was closed in 1996.	North Delta intakes, north tunnels (all alternatives)	No. Near SCADA fiber line route
MNTN Shop #32	3250 Meadowvie w Road, Sacramento	LUST	Soil contamination was caused by gasoline leaking from an underground storage tank. The tank was removed, and soil remediation was completed. The case was closed in 1990.	North Delta intakes, north tunnels (all alternatives)	No. Near SCADA fiber line route
Chevron	8110 Freeport Blvd, Sacramento	LUST	Soil contamination caused by benzene was reported January 1990. Soil and groundwater testing commenced. The case was listed as completed and closed in 1990.	North Delta intakes, north tunnels (all alternatives)	Yes. Near SCADA fiber line route and access road
Delta Shores	8145 Freeport Blvd, Sacramento	Cleanup Program Site	Soil and groundwater contamination from gasoline was reported in 2007. The site was assessed and remediated starting in 2008. It was listed as completed and the case was closed in October 2019.	North Delta intakes, north tunnels (all alternatives)	No. Near SCADA fiber line route and access road
Freeport Marina	8250 Freeport Blvd, Sacramento	LUST	Soil contamination was caused by gasoline leaking from an underground storage tank. First reported in 1994, the case was closed in 1996.	North Delta intakes, north tunnels (all alternatives)	Yes. Near SCADA fiber line route and access road
Gil's Garage	10413 Franklin Blvd, Elk Grove	LUST	Soil contamination was caused by gasoline leaking from an underground storage tank. First reported in 1997, the case was closed in 2000.	North Delta intakes, north tunnels (all alternatives)	No. Near permanent utility line

Site Name	Location	Site Type	Summary and Site Status	Alignment and Alternatives	Site within Study Area
Govan Property	10464 Franklin Blvd, Elk Grove	LUST	Soil contamination was caused by gasoline leaking from an underground storage tank. First reported in 1992, the case was closed in 1996.	North Delta intakes, north tunnels (all alternatives)	No. Near permanent utility line
Primasing Residence	10751 6th Street, Hood	LUST	Soil contamination was caused by diesel leaking from an underground storage tank. The tank was removed in 1998 and soil remediation was completed. The case was closed in 1999.	North Delta intakes, north tunnels (all alternatives)	No. Near access route for employee van to intake sites
Southern Pacific Pipeline Shell	West side of Cook Road, Holt	Voluntary Cleanup	Groundwater and soil contamination of various TPHs. The pipeline leak occurred under the Arcady Oil Company site in 1986. Surface water affected by the petroleum fuel leak was cleaned up by Arcady and Southern Pacific Pipelines, Inc. Groundwater and soil may have been affected by the fuel leak; this was never addressed. The contamination from the leak is on the same site as Arcady Oil Company's drilling mud disposal landfill, also a hazardous waste site. The RWQCB is currently working with Arcady Oil Company to close the landfill and address contamination at the site. This case is ongoing.	Eastern alignment (Alternatives 3, 4a, 4b, 4c)	No. Near access road
KMEP Holt Petroleum Pipeline	3851 South Whiskey Slough Road, Holt	Cleanup Program Site	Soil and water contamination of fuels from underground pipeline in 1986. Site investigations and remedial activities commenced and included groundwater monitoring, bailing of free product, operation of a groundwater extraction and treatment system, and operation of a soil vapor extraction system. In 2005 and 2006, KMEP implemented phytoremediation and planted about 240 trees at the site. KMEP is using phytoremediation to remove soil contamination that is within the peat layer. Monitoring ongoing as of May 2009 and the case is still open.	Eastern alignment (Alternatives 3, 4a, 4b, 4c)	No. Near access road
Flag City Shell	6437 West Banner Street, Lodi	LUST	Groundwater contamination from fuel oxygenates was reported in 2005. Groundwater monitoring indicated that the plume affected other wells. The case was closed in 2012.	Eastern alignment (Alternatives 3, 4a, 4b, 4c)	No. Near permanent utility line, SCADA fiber route
Flag City Chevron	6421 Capital Road, Lodi	LUST	Groundwater contamination of gasoline from a LUST was reported in 2005. The tank was removed, and the case was closed in 2012.	Eastern alignment (Alternatives 3, 4a, 4b, 4c)	No. Near permanent utility line, SCADA fiber route

Site Name	Location	Site Type	Summary and Site Status	Alignment and Alternatives	Site within Study Area
Three B's Truck Plaza	14749 Thornton Road, Lodi	LUST	Groundwater contamination of gasoline from four LUSTs. Tanks removed and remediation completed. The case was closed in 2016.	Eastern alignment (Alternatives 3, 4a, 4b, 4c)	No. Near permanent utility line, SCADA fiber route
Byron Corners	15031 Byron Highway, Byron	LUST	Soil contamination from a leaking pipeline was reported in 2004. Remedial action included pipeline repair. The case was closed in 2008.	Central and eastern alignments (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c)	No. Near park-and-ride lot
Byron Garage	14711 Byron Highway, Byron	LUST	Soil contamination of diesel was first reported in 1996. The leak was stopped, and the case closed in 1996.	Central and eastern alignments (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c)	No. Near park-and-ride lot
Bay Standard	24485 March Creek Road, Brentwood	Evaluation	The facility manufactures bolts, nuts, screws, and washers. Operations include zinc plating. The waste from this operation was discharged to an unlined pond on-site. The pond was closed and replaced with a lined pond. This pond was also eventually closed. On May 13, 1993, the regional water quality board approved the closure of the pond.	Central and eastern alignments (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c)	No. Near power transmission line
King's Island	21334 Highway 4 West, Stockton	LUST	Storage tank leaking gasoline was reported in 1995. No files were found to indicate that investigation or cleanup was undertaken; however, the case was completed and closed in January 1997.	Central and eastern alignments (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c)	Yes. Near Southern Forebay
Chevron Texaco	Byron Road (milepost 225.6), Byron	Cleanup Program Site	Discharge of heating oil/fuel from former Old Valley Pipeline was discovered during geotechnical investigations in 1991. The case was closed in November 2003.	Central and eastern alignments (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c)	Yes. Near access railroad: Southern Forebay on-site rail
Chevron, Holey-Byron Road	Holey Road, Byron	Cleanup Program Site	Petroleum-impacted soil was discovered in 2003 from former Old Valley Pipeline. No files were found to indicate that investigation or cleanup was undertaken; however, the case was completed and closed in September 2012.	Central and eastern alignments (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c)	Yes. Near SCADA fiber line route
Chevron Old Valley Pipeline	Bruns and Byron Roads	Voluntary Cleanup	Leakage of unspecified oil from historic pipelines resulted in soil and groundwater contamination. Central Valley RWQCB is lead agency for the site and is overseeing the soil and groundwater investigation. Investigations are ongoing.	Central and eastern alignments (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c)	Yes. Near construction water pipeline

Site Name	Location	Site Type	Summary and Site Status	Alignment and Alternatives	Site within Study Area
Chevron, Bruns Property	999 W. Byron Highway, Byron	Cleanup Program Site	Site status was updated to “Completed, Case Closed” following inactive case review in March 2017.	Central and eastern alignments (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c)	Yes. Southern Forebay
Shell Pipeline – Kelso Road	16091 Kelso Road, Byron	Cleanup Program Site	Soil and groundwater contamination from petroleum hydrocarbons was reported in 2010. Remediation in 2011 included excavation of contaminated soils and groundwater. Remediation was deemed complete and the case was closed in 2014.	Bethany Reservoir alignment (Alternative 5)	Yes. SCADA fiber line and adjacent to the Bethany Reservoir Pumping Plant and Surge Basin facility
D&D Flying Services	1540 N. Inland Drive, Stockton	Cleanup Program Site	It was reported that airplane tanks used for aerial pesticide application were rinsed in field. However, inspection indicated that the airstrip looked clean, and no spills or evidence of washing were observed. The flying service closed in 1988. Listed as inactive since 1985.	Eastern alignment (Alternatives 3, 4a, 4b, 4c), Bethany Reservoir alignment (Alternative 5)	No. Near Lower Roberts Island RTM and levee improvements
Stockton Naval Communication Station	Rough and Ready Island, Stockton	State Response	Former naval base and firing range with various soil and groundwater contaminants including organochlorine pesticides (e.g., DDT) and petroleum. To expedite reuse of the property and to comply with environmental cleanup requirements, the site has completed an Environmental Baseline Survey. Remediation is ongoing and listed as active April 2020.	Eastern alignment (Alternatives 3, 4a, 4b, 4c), Bethany Reservoir alignment (Alternative 5)	Yes. Near SCADA fiber routes
Tiki Lagoon Resort & Marina	12988 Mc Donald Island Road West, Stockton	LUST	Soil contamination from leaking gasoline tank was reported in 1993. No files were found to indicate that investigation or cleanup was undertaken; however, the case was completed and closed as of September 1996.	Eastern alignment (Alternatives 3, 4a, 4b, 4c) and Bethany Reservoir alignments (Alternative 5)	Yes. Near levee access road on Lower Roberts Island
Byron Bethany Irrigation District	7995 Bruns Road, Byron	LUST	Discharge of gasoline onto soil was discovered and reported in 1989 during tank testing. The case was completed and closed in September 1989.	Bethany Reservoir alignment (Alternative 5)	Yes. Near permanent utility line

Site Name	Location	Site Type	Summary and Site Status	Alignment and Alternatives	Site within Study Area
Byron Power Company	4901 Bruns Road, Byron	Cleanup Program Site	This site was a former power plant. Petroleum hydrocarbons were detected in soil samples collected in operational areas of the facility. Site investigations commenced. After demolition, remedial excavation was conducted beneath the foundation of the power plant building. Remedial excavations were also conducted in the areas of the evaporator pads and lined surface impoundment. The case was closed on May 20, 2014.	Bethany Reservoir alignment (Alternative 5)	No. Near water treatment plant and storage tanks near Bethany Reservoir Aqueduct
Schropp Ranch	3880 Mountain House, Byron	LUST	Groundwater contamination by gasoline leak. The tank was removed, and the site was remediated in 1993. The case was closed in 2006.	Bethany Reservoir alignment (Alternative 5)	Yes. SCADA fiber routes; access road
Willow Berm Marina	140 Brannan Island Road, Isleton	LUST	Aquifer was contamination from gasoline leak. Monitoring wells were installed, and the site was sampled. The case was completed and closed in 2011.	Compensatory Mitigation Area (Bouldin Island)	No

Sources: Department of Toxic Substances Control Board 2021b, 2021c, 2021d, 2021e; State Water Resources Control Board 2021a, 2021b, 2021c, 2021d, 2021e, 2021f, 2021g, 2021h, 2021i, 2021j, 2021k, 2021l, 2021m, 2021n, 2021o, 2021p, 2021q, 2021r, 2021s, 2021t, 2021u, 2021v, 2021w, 2021x, 2021y.

LUST = leaking underground storage tank; RTM = reusable tunnel material; RWQCB = Regional Water Quality Control Board; SCADA = supervisory control and data acquisition; TPH = Total Petroleum Hydrocarbon.

25.2 Applicable Laws, Regulations, and Programs

The applicable laws, regulations, and programs considered in the assessment of project impacts related to hazards, hazardous materials, and wildfire are indicated in Section 25.3.1, *Methods for Analysis*, or the impact analysis, as appropriate. Applicable laws, regulations and programs associated with state and federal agencies that have a review or potential approval responsibility have also been considered in the development of CEQA impact thresholds or are otherwise considered in the assessment of environmental impacts. A listing of some of the agencies and their respective potential review and approval responsibilities, in addition to those under CEQA, is provided in Chapter 1, *Introduction*, Table 1-1. A listing of some of the federal agencies and their respective potential review, approval, and other responsibilities, in addition to those under NEPA, is provided in Chapter 1, Table 1-2.

25.3 Environmental Impacts

This section describes the direct and cumulative environmental impacts associated with hazards, hazardous materials, and wildfires that would result from project construction, operation, and maintenance of the project. It describes the methods used to determine the impacts of the project and lists the thresholds used to conclude whether an impact would be significant. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts are provided. Indirect impacts are discussed in Chapter 31, *Growth Inducement*.

25.3.1 Methods for Analysis

This section addresses the assessment methods used for the analysis of potential environmental impacts associated with construction, operation, and maintenance of the project alternatives. As a result of the project, potential impacts would be generated and/or created by reasonably foreseeable upset or accident conditions involving the release of hazardous materials; routine transport, use, and disposal of hazardous materials; construction activities; and routine operation and maintenance activities.

25.3.1.1 Process and Methods of Review for Hazards and Hazardous Materials

The baseline for hazards and hazardous materials includes known hazardous materials facilities and sites that currently exist in the study area, and which are identified in sources cited in Section 25.1, *Environmental Setting*.

In general, the analysis methodology was developed by reviewing previous documents prepared for the study area; searching DTSC's EnviroStor and State Water Board's GeoTracker databases for tracking hazardous waste facilities and sites; and reviewing engineering project reports, technical memoranda, and preliminary engineering drawings pertaining to the construction, operation, and maintenance of the water conveyance facilities.

Impacts related to hazards and hazardous materials were assessed by identifying recognized environmental conditions located in the study area and hazards within 2 miles of airports.¹

The impact analysis associated with wildfires uses data from various state sources to determine the proximity of the study area to various wildfire responsibility and risk locations. CAL FIRE data of State Responsibility Areas were used to determine if the study area is in or near a designated State Responsibility Area.

25.3.1.2 Evaluation of Construction Activities

Project construction could potentially cause impacts associated with the creation of hazards and accidental release of hazardous materials, as well as the routine transport, use, and disposal of hazardous materials. Specifically, potential impacts would occur if construction resulted in one of the following conditions.

- Encountering contaminated soils, sediment, or groundwater resulting from historical land use practices.
- Release of hazardous constituents into the environment as a result of the disturbance of pipelines or other subsurface infrastructure.
- Increase in the risk of releases from vehicles carrying hazardous materials to construction sites and from rerouting hazardous materials vehicles around the construction activities.
- Improper use and/or disposal of hazardous materials.

¹ A *recognized environmental condition* is defined as hazardous substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances into structures or into the ground, groundwater, or surface water of a property.

Potential effects were determined using a variety of resources and standards as described below.

Designated Hazardous Materials Transportation Routes

Construction impacts related to potential upset (e.g., loss of cargo) or accident conditions regarding transport of hazardous materials via trucks, trains, ships, and pipelines were evaluated qualitatively. Designated transportation routes were mapped and compared with the construction footprint and the study area boundaries to evaluate the increased potential for releases/spills of hazardous materials as a result of traffic rerouting.

Soil or Groundwater Contamination from Known Hazardous Materials Sites

DTSC's EnviroStor database and the State Water Resources Control Board GeoTracker database (i.e., Cortese List), compiled pursuant to California Government Code Section 65962.5, was searched. The mapped locations of listed hazardous materials sites and facilities were compared to the construction footprints of the alternatives to assess the relative risk of encountering contaminated soil or groundwater during clearing, grading, excavation, tunneling, and construction of the alternatives. For the purpose of the impact analysis presented in Section 25.3.3, *Impacts and Mitigation Approaches*, a conservative approach was taken, and any sites within 0.25 mile of the construction footprint were considered to have the potential to pose a hazard resulting from migration of contaminants in groundwater.

Oil and Natural Gas Wells and Processing Facilities

Mapped locations of oil and natural gas wells and processing facilities within the construction footprints (Figures 25-1 and 25-2) were overlaid to assess the relative risk of disturbing a well or encountering petroleum products or processing chemicals in soil or groundwater, respectively. The numbers of oil and natural gas wells within the study area were obtained from publicly available data on the California Energy Commission's California Natural Gas Pipeline and Station ARC/GIS website.

Reusable Tunnel Material

RTM is the by-product of tunnel excavation using an earth pressure balance tunnel boring machine (TBM). RTM from the construction of the water conveyance facilities would be a mixture of soil cuttings and soil conditioning agents (water, foaming agents, and/or polymers). Tunnel boring operations would require the use of soil conditioners to control the behavior of excavated material. The soil conditioners would consist of slightly ionized organic molecules that would affect neither soil pH, nor the leachability of metals from the RTM. The main purpose of soil conditioners is to help support the face and encourage loose, coarse-grained soils to move smoothly through the excavation chamber. Secondary benefits of using conditioners include reduced torque of the cutter head, reduced wear of tunneling components, and lower risk of blockages.

RTM intended for reuse as structural fill would require drying. After excavation, the RTM would be moved to a mechanical dewatering facility for drying. RTM mechanical dryers would be used at the Twin Cities Complex and the Southern Complex (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c). Mechanical dryers considered include rotary mechanical dryers utilizing electric, natural gas, or propane heat sources. Natural drying and long-term storage of RTM would occur at Lower Roberts Island and Bouldin Island. For natural drying, RTM would be spread over a broad area and allowed to dry and drain naturally for up to 1 year.

1 At the Twin Cities Complex and the Southern Complex, RTM would be moved to lined, temporary
2 stockpiles to be tested for hazardous materials. If the test results are negative for hazardous
3 substances, the RTM would be moved to a dry stockpile storage area near the tunnel launch shaft
4 sites at the Twin Cities Complex and Southern Complex. If test results indicate soils contain
5 hazardous constituents above regulatory thresholds, that material would be transported to a
6 disposal location licensed to receive those constituents (Delta Conveyance Design and Construction
7 Authority 2022a:44, 2022b:23).

8 At the sites with only natural drying, the RTM would be moved to lined, temporary stockpiles to be
9 tested for hazardous materials. The nonhazardous RTM would then be moved to areas for natural
10 drying.

11 There would not be any long-term stockpiles of RTM at the Southern Complex for Alternatives 1, 2b,
12 2c, and 4b (see Chapter 3, *Description of the Proposed Project and Alternatives*, Section 3.4.4,
13 *Reusable Tunnel Material*, for details regarding RTM handling and storage.)

14 Impacts associated with RTM management were analyzed based on stated toxicity of the soil
15 conditioners, estimates of the volume of anticipated residue, and the results of tests done using soil
16 samples mixed with representative soil conditioners (Delta Conveyance Design and Construction
17 Authority 2022a:2).

18 Previous soil tests were conducted for the California WaterFix project. Soil samples were obtained
19 from the tunnel horizon (100 to 170 feet below ground surface [bgs]) from 19 boreholes along the
20 Central Corridor.² Initial testing of soil samples was conducted to measure the consistency of
21 moisture-conditioned baseline soils (without conditioner added) to help guide conditioner type
22 selection and application rates. This was done to mimic the field conditions of the TBM excavating
23 moisture-laden soils. Then, soils were mixed in two batches, with different conditioner foams. The
24 concentration of conditioner added to water for testing soil samples ranged from 3% to 5%. The
25 amount of soil conditioner added to the soil samples varied according to manufacturer
26 recommendations. Application rates of the soil conditioner used for testing were purposefully
27 higher than recommended by the conditioner manufacturers. These mixture samples were tested to
28 assess the geotechnical properties to determine if RTM would be suitable as structural fill; the
29 potential toxicity; and the suitability for plant growth for both wildlife habitat and agricultural use
30 (URS 2014:2-5).

31 It should be noted that during testing, the conditioned soil samples were saturated and allowed to
32 air dry at room temperature for one week. Originally, the testing plan included one month for air
33 drying to simulate anticipated field construction procedures and allow for biodegradation of the
34 conditioner products. However, after one week the conditioned soil samples were dry enough for
35 testing to begin. Testing did not include mechanical drying methods, although it is not anticipated
36 that mechanical drying would alter the properties of conditioned soils (URS 2014:2-4).

37 Although the study consisted of a limited number of samples and tests, and does not constitute a
38 complete evaluation of RTM, California Department of Water Resources (DWR) concluded from the
39 results that RTM, following storage and drying, is suitable for strengthening Delta levees; habitat
40 restoration; fill on subsiding Delta islands; and as structural fill for construction of conveyance
41 facilities (Delta Conveyance Design and Construction Authority 2022a:43). The construction

² The Central Corridor of the California WaterFix project varies slightly from the central alignment proposed for this project.

contractor would be required to verify, by certification of the supplier, that the additives used for soil conditioning during tunneling operations were inert, biodegradable, and nontoxic to prevent contamination of the surrounding ground and the RTM.

Potential Hazards in Proximity to Schools

For the purposes of this analysis, existing or proposed schools are considered sensitive receptors. Schools are places where sensitive populations, (i.e., children) congregate. Children are generally more susceptible to the significant impacts of exposure to toxic chemicals and other pollutants.

The proximity of project facilities to schools was calculated using geographic information system (GIS) methods to determine the distance from the construction footprints to schools in the study area. Hazardous emissions and accidental release or combustion of hazardous materials near existing schools could result in health risks or other dangers to students.

Under Alternative 5, the Mountain House Elementary School (3950 Mountain House Road, Byron) is approximately 0.18 mile south of the proposed Bethany Reservoir Aqueduct. There are no public or private schools within 0.25 mile of the project footprints under Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c.

Potential air quality effects on sensitive receptors such as schools, hospitals, and parks are discussed in Chapter 23.

Wildland Fire Hazard Analysis

Wildland fire safety hazards were analyzed using GIS methods to map Fire Hazard Severity Zones. GIS maps were obtained from CAL FIRE's Fire Hazard Severity Zone Re-Mapping Project. County fire hazard maps from Alameda, Contra Costa, Sacramento, and San Joaquin Counties were compared to the alternatives for each of the project construction footprints to assess the relative risk of wildland fire hazard throughout the study area.

Air Safety Hazard Analysis

The locations of airports within 2 miles of construction footprints were mapped and identified. The airports were then evaluated to determine whether they were classified as public or private airports by the Federal Aviation Administration (FAA). Airport locations were analyzed to assess the risk of the project interfering with aircraft operations and the potential for the project to increase the risk of bird-aircraft strikes.

25.3.1.3 Evaluation of Operations

Alternative narratives and conceptual engineering drawings found in the *Delta Conveyance Final Draft Engineering Project Reports* (Delta Conveyance Design and Construction Authority 2022a, 2022b) were reviewed for information on operation and maintenance activities, frequencies, and materials, and expected operations and maintenance parameters that may present hazards to operations and maintenance workers, the public, and the environment. These were evaluated to determine if these activities could expose workers, the public, or the environment to hazards or hazardous materials.

25.3.2 Thresholds of Significance

The project would be considered to have a significant impact if it would result in any of the conditions listed below.

- Create a substantial hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials. For the purposes of this analysis, a substantial hazard is defined as the direct exposure of the public, including construction or operation and maintenance personnel, or surface water and groundwater to physical and/or chemical hazards (i.e., hazardous materials as defined by Health & Saf. Code § 25501) through construction or operational activities or interference with hazardous materials transport routes.
- Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment. For the purposes of this analysis, a “substantial hazard” related to “the release of hazardous materials to the environment” is defined as circumstances in which project construction or operational activities involving the use of hazardous materials would result in the release of hazardous materials, where these hazardous materials could directly or indirectly negatively affect surface water, groundwater, or the public.
- Expose sensitive receptors at an existing or proposed school within 0.25 mile of project facilities to hazardous materials, substances, or waste.
- Be located on a site that is included on the list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, create a substantial hazard to the public or the environment. For the purposes of this analysis, a “substantial hazard” is defined as circumstances in which project construction or operational activities could result in the release of hazardous materials from hazardous materials sites and thereby have the potential to directly or indirectly negatively affect surface water, groundwater, or the public.
- Result in a safety hazard associated with an airport or private airstrip. For the purposes of this analysis, air “safety hazards” are defined as conditions in which high-profile construction equipment (200 feet or taller) or project structures could be located within 2 miles of an airport and would potentially result in aircraft accidents. Further, increasing the risk of bird-aircraft strikes as a result of the project alternatives within 2 miles of an airport would also be considered an air safety hazard.
- Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan.
- Expose people or structures, either directly or indirectly, to a substantial risk of loss, injury, or death involving wildland fires. For the purposes of this analysis, “substantial risk” is defined as circumstances in which construction or operational activities would increase the potential for wildland fire hazards or occur within an area designated as a High or Very High Fire Hazard Severity Zone.

25.3.2.1 Evaluation of Mitigation Impacts

CEQA also requires an evaluation of potential impacts caused by the mitigation measures. Following the CEQA conclusion for each impact, the chapter analyzes potential impacts associated with implementing both the Compensatory Mitigation Plan (CMP) and the other mitigation measures required to address with potential impacts caused by the project. Mitigation impacts are considered

in combination with project impacts in determining the overall significance of the project. Additional information regarding the analysis of mitigation measure impacts is provided in Chapter 4, *Framework for the Environmental Analysis*.

25.3.3 Impacts and Mitigation Approaches

25.3.3.1 No Project Alternative

As described in Chapter 3, CEQA Guidelines Section 15126.6 directs that an EIR evaluate a specific alternative of “no project” along with its impact. The No Project Alternative in this Final EIR represents the circumstances under which the project (or project alternative) does not proceed and considers predictable actions, such as projects, plans, and programs, that would be predicted to occur in the foreseeable future if the Delta Conveyance Project is not constructed and operated; these predictable actions are identified in Appendix 3C, *Defining Existing Conditions, No Project Alternative, and Cumulative Impact Conditions*, Section 3C.3.2, *No Project Alternative Conditions*, including Table 3C-2. This description of the environmental conditions under the No Project Alternative first considers how hazards, hazardous materials, and wildfire could change over time and then discusses how other predictable actions described in Appendix 3C, Section 3C.3.2.5, *No Project Alternative Assumptions for Water Agency Actions*, could affect hazards, hazardous materials, and wildfire.

Future Hazards, Hazardous Materials, and Wildfire Conditions

For hazardous materials, hazards, and wildfire, future conditions are not anticipated to substantially change compared to existing conditions because land uses are not expected to change if the project (or project alternative) does not proceed.

However, indirect impacts relating to hazards and hazardous materials within the Delta may occur under the No Project Alternative as the result of changes in sea level rise and continuing seismic risk to Delta levees. In the instance of levee failure causing flooding, inundation could result in the release of a range of hazardous materials including, but not limited to, fuel, chemicals, fertilizers, and pesticides. A large-scale seismic event could also rupture gas and oil pipelines resulting in exposure to hazardous materials. Thus, there would be a potential for adverse effects on the environment and public in the case of a catastrophic event due to climate change or a seismic event. Continued, periodic area flooding could also affect roadways and, thus, emergency response and evacuation routes. Potential impacts related to wildfire for the No Project Alternative would be the same as existing conditions because other foreseeable projects would occur in the same geographic area and involve the presence of personnel and equipment, both of which could inadvertently cause a fire (e.g., from smoking, sparks from equipment). However, under future conditions, indirect impacts of climate change, such as an increase in temperature, could cause drier conditions and create drought, leading to longer and more intense wildfire seasons.

Predictable Actions by Others

A list and description of actions included as part of the No Project Alternative are provided in Appendix 3C, Section 3C.3.2.5. As described in Chapter 4 and Appendix 3C, the No Project Alternative analyses focus on identifying the additional water-supply-related actions public water agencies may opt to follow if the Delta Conveyance Project does not occur.

Public water agencies participating in the Delta Conveyance Project have been grouped into four geographic regions. The water agencies within each geographic region would likely pursue a similar suite of water supply projects under the No Project Alternative (Appendix 3C, Section 3C.3.2.5). Construction of water supply projects, regardless of project type or region, could result in exposing people and the environment to hazards and hazardous materials through various means described below.

Construction could involve ground-disturbing activities that would require equipment for earthmoving. The use of these types of equipment and vehicles would involve the handling and use of different quantities of commonly used materials, such as fuels, lubricants, and oils, to operate equipment. Accidental releases of small quantities of these substances during construction could result in a potential safety hazard through soil, water, or air contamination.

Hazardous emissions and accidental release or combustion of hazardous materials near schools could result in health risks or other dangers to students. This could occur for any of the project types, regardless of region if the project is near schools or other sensitive receptors.

During construction, contaminated soils, sediments, and groundwater may be encountered where historical releases have occurred, such as former gasoline stations, farms, and mining sites. Ground-disturbing activities in these areas could expose workers and the public to contaminants that are harmful to human health. Also, demolition of older buildings and handling of certain structure components have the potential to release lead particles and asbestos fibers to the air where they may be inhaled by construction workers and the public.

Construction or operations of any of the project types, regardless of region, that include equipment or structures 200-feet tall within 2 miles of an airport would have the potential to interfere with the airspace of an airport. Other water reliability projects might consider surface water storage as a means to provide flexibility during dry years. If located within 2 miles of an airport, the creation of large waterbodies could attract wildlife, potentially endangering local aircraft due to the possibility of bird strike incidents.

It is unlikely that project operations for any of the project types would impair or interfere with any adopted emergency response or evacuation plans. However, during construction, projects could cause temporary changes in emergency access because of potential lane closures or detours that could result in interference with the designated evacuation routes and access for emergency service vehicles.

Project proximity to various wildfire responsibility and risk locations determines the potential for wildland fire risks. Project construction would involve the use of heavy equipment, welding, and other activities that have potential to ignite fires. Increase in human presence in a wildland/urban interface also has the potential to increase fire risks (e.g., smoking, handling of combustible chemicals).

Desalination projects would most likely be pursued in the northern and southern coastal regions. The southern coastal regions would likely require larger and more desalination projects than the northern coastal region in order to replace the water yield that otherwise would have been received through the Delta Conveyance Project. These projects would be sited near the coast. Groundwater recovery (brackish water desalination) would involve similar types of ground disturbance but could occur across the northern inland, southern coastal, and southern inland regions, and in both coastal and inland areas, such as the San Joaquin Valley. Grading and excavation at the desalination and

groundwater recovery plant sites would be necessary to construct foundations, and trenching would occur to install water delivery pipelines and utilities. Ground-disturbing activities for these projects would require construction equipment and involve the same hazards and hazardous materials described above. Operation and maintenance of desalination projects could require the storage and use of chemical cleaning solutions (e.g., antiscalants) to remove deposits from filtration membranes, as well as chemicals (e.g., chlorine) used to treat product water. Improper storage or handling of some of these materials could expose workers and the environment to increased health risks.

The northern and southern coastal regions are also most likely to explore constructing groundwater management projects. Groundwater management projects could occur in a variety of locations and require use of equipment, and the associated use of hazardous materials (fuels, lubricants, and oils), to operate equipment for construction of recharge basins, conveyance canals, and pipelines.

Water recycling projects could be pursued in all four regions. The northern inland region would require the fewest number of wastewater treatment/water reclamation plants, followed by the northern coastal region, followed by the southern coastal region. The southern inland region would require the greatest number of water recycling projects to replace the anticipated water yield that it otherwise would have received through the Delta Conveyance Project. Construction techniques for water recycling projects would vary depending on the type of project (e.g., for landscape irrigation, groundwater recharge, dust control, industrial processes) but could require earth moving activities, grading, excavation, and trenching. Because construction would involve ground-disturbing activities, such actions could involve the handling and use of hazardous materials, such as fuels, lubricants, and oils, to operate equipment. Accidental releases of these substances during construction could result in a potential safety hazard to workers and the environment.

Water conservation projects could be pursued in all four regions and involve a wide variety of project types, such as flow measurement or automation in a local water delivery system, lining of canals, use of buried perforated pipes to water fields, and additional detection and repair of commercial and residential leaking pipes. These projects could occur anywhere in the regions, and most would involve little ground disturbance or handling of hazardous materials.

As detailed above, all project types across all regions would involve relatively typical construction techniques and be required to comply with regulations enforced by the local Certified Unified Program Agency (CUPA), California Division of Occupational Safety and Health (Cal/OSHA), DTSC, and U.S. Environmental Protection Agency (EPA) regarding the use, storage, and disposal of hazardous materials. In addition, all storage of hazardous materials would be compatible with the recommendations of the supplier of the hazardous materials and comply with all relevant regulations. If needed, projects would prepare and implement Hazardous Materials Management Plans, which describe procedures and protocols for the safe storage, handling, transport, and disposal of hazardous materials. Compliance with these regulations and implementation of standard best management practices (BMPs), such as spill prevention plans, would reduce the potential for accidental release or exposure of hazardous materials during either project operation or construction.

The potential for hazardous emissions and accidental release of hazardous materials near existing and proposed schools is similar for most projects involving the use and storage of hazardous materials. Schools are located throughout the state in all regions. Projects would undergo environmental review and be required to identify and assess the risks to nearby schools and other sensitive receptors prior to project construction or implementation.

The potential for encountering known and previously unknown hazardous materials sites (including those on the Cortese List) is similar regardless of region. Existing regulations would ensure that sites containing hazardous materials be cleaned up to existing standards for the proposed land use prior to development.

As airports are located throughout California, potential impacts associated with airport operations are the same regardless of region. Identification of airports near projects would occur during environmental review. The airports would then be evaluated to analyze and assess the risk of the project interfering with aircraft operations. Also, projects would comply with FAA regulations reducing the potential for conflicts between projects and airport operations.

Any project involving construction could cause temporary changes in emergency access or evacuation routes. If needed, projects would prepare TMPs, which could include measures such as signage, notifications, flaggers, and coordination with local jurisdictions. Preparation of TMPs and compliance with existing local requirements would ensure continued emergency and evacuation route access.

The potential for wildland fire risks is similar regardless of region because Very High and High Fire Hazard Severity Zones are located throughout California. Project types involving any kind of construction could increase these fire risks. However, wildfire risks would be assessed during environmental review, and project proponents would be required to comply with all pertinent fire prevention laws and regulations including Cal/OSHA fire prevention and safety standards. The use and staging of equipment would follow standard BMPs (e.g., spark arrestors for vehicles in high grass, no smoking zones). The use and storage of flammable materials would also comply with regulations enforced by the local CUPA and Cal/OSHA.

25.3.3.2 Impacts of the Project Alternatives Related to Hazards and Hazardous Materials

Impact HAZ-1: Create a Substantial Hazard to the Public or the Environment through the Routine Transport, Use, or Disposal of Hazardous Materials

All Project Alternatives

This section addresses potential impacts associated with the routine transport, use, or disposal of hazardous materials as a result of construction and operation of all nine project alternatives. Under any of the alternatives (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5), the same type of hazardous materials would be handled and used in a similar manner (e.g., fuel and oil for equipment), but the volumes may differ because of the varying scope of facilities. The nature of potential impacts under all nine project alternatives is similar, and all alternatives are discussed together.

Project Construction

Construction of any one of the alternatives (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) would involve the handling and use of different quantities of commonly used hazardous materials, such as fuels, lubricants, and oils, to operate equipment at the intakes and pumping plants. All project alternatives would involve construction of multiple fuel storage areas at the intakes, tunnel shaft sites, and pumping plants at the Southern Complex or Bethany Complex and South Delta Conveyance (part of the Southern Complex). Fuel storage locations are shown in Mapbooks 3-1, 3-2, and 3-3.

1 Bulk fuel stored at fuel storage areas would potentially pose the risk of vehicle fueling spills and
2 leakage from aboveground storage tanks at fuel storage areas.

3 In addition to fuel use and bulk fuel storage, oils, lubricants, and other hazardous materials would be
4 stored on-site and used in equipment, such as compressors, generators, pile drivers, cranes, forklifts,
5 excavators, pumps, and soil compactors throughout the construction footprint. Spills and releases
6 could occur during transfer and use of these materials in the field and over water or adjacent to
7 waterways. Hazardous materials, including paints, solvents, and sealants, would be used to
8 construct water conveyance facilities (e.g., intakes, pumping plants, conveyance piping). During
9 fueling and transfer of oils, lubricants, and other materials during construction, there could be spills
10 or other releases to the environment that may result in a hazard.

11 Construction equipment maintenance is expected to be performed in the field and in maintenance
12 facilities operated by contractors during construction of the water conveyance facilities. While
13 equipment could be maintained at any work area identified for all project alternatives, the highest
14 risk of hazards related to maintenance activities would be anticipated to occur at those sites where
15 the duration and intensity of construction activities would be greatest. Construction equipment
16 maintenance activities would also be expected to be performed at work areas related to main tunnel
17 construction shaft sites. For a map of all permanent facilities and temporary work areas associated
18 with all conveyance alignments, see Mapbooks 3-1, 3-2, and 3-3. Construction equipment
19 maintenance at these facilities would likely include rebuilding pumps or motors, maintaining
20 equipment hydraulic systems, minor engine repairs and routine lubrication, and replacing worn
21 parts. Spills and other accidental releases of degreasers, fuels, oils, or lubricants could result in
22 temporary human health hazards to workers related to chemical exposure immediately adjacent to
23 these releases.

24 Field investigations that would occur under all of the project alternatives would involve activities
25 such as geotechnical and hydrogeologic sampling and other construction test projects supporting
26 geotechnical analysis. These investigations would be used to more specifically identify appropriate
27 construction methodologies given existing site conditions and guide the development of any
28 geological and groundwater monitoring programs for the project. Field investigations for project
29 construction would occur within the construction footprints and in portions of the underground
30 tunnel alignments of the individual alternatives and may involve the use of similar quantities of
31 fuels, lubricants, and oils to operate equipment. Accidental release of these materials could result in
32 a safety hazard to human health or the environment. Geotechnical and hydrogeologic testing would
33 result in soil disturbance and the possibility of encountering contaminated soils which could be
34 hazardous to human health or the environment.

35 While there would be no difference in the nature of the potential impacts between the project
36 alternatives, the magnitude of potential impacts may be greater under Alternatives 2a and 4a.
37 Construction of these alternatives would occur over a longer duration (13 and 14 years,
38 respectively) and include three intakes and larger diameter tunnels, which would require additional
39 excavation and therefore, an increased use of hazardous materials. This would increase the potential
40 for exposure to hazardous materials possibly causing harm to workers' health and the environment.
41 Therefore, this analysis is based on these longer duration alternatives (i.e., a more conservative
42 approach).

43 Regardless of the alternative, maintenance and repair of equipment would be completed on-site.
44 Accidental releases of hazardous substances (e.g., fuels, lubricants, and oils) during construction, or

1 maintenance activities could contaminate soils and degrade the quality of surface water and
2 groundwater, or be released into the air, resulting in a potential public safety hazard to workers'
3 health. The transport, handling, use, and disposal of hazardous materials would comply with
4 regulations enforced by regulatory agencies such as CUPAs and Cal/OSHA. The project includes the
5 testing of RTM to further reduce potential exposure to hazardous materials (Chapter 3, Section
6 3.4.4.1, *Disposal of Reusable Tunnel Material*), as well as Environmental Commitments EC-2: *Develop*
7 *and Implement Hazardous Materials Management Plans*, which would provide detailed information
8 on hazardous materials used and stored and protocols to reduce the likelihood of a spill of
9 hazardous materials, and EC-3: *Develop and Implement Spill Prevention, Containment, and*
10 *Countermeasure Plans*, which requires that personnel be trained in emergency response and spill
11 containment techniques. The full text of these measures can be found in Appendix 3B, *Environmental*
12 *Commitments and Best Management Practices*. In addition, Environmental Commitment EC-4b:
13 *Develop and Implement Stormwater Pollution Prevention Plans*, as described under the Stormwater
14 Pollution Prevention Plan (SWPPP), would further reduce the potential for accidental releases or
15 exposure during construction and operation through weekly site inspections and maintaining
16 equipment and materials necessary for spill cleanup (Appendix 3B).

17 Operations and Maintenance

18 Operations and maintenance would involve the handling and use of different quantities of
19 commonly used hazardous materials, such as fuels, lubricants, and oils, to operate vehicles and
20 equipment at the intakes and pumping plants. Accidental releases of these substances during
21 operations and maintenance activities could contaminate soils and degrade the quality of surface
22 water and groundwater, or be released into the air, resulting in a potential public safety hazard to
23 workers' health. The transport, handling, use, and disposal of these materials would comply with
24 regulations enforced by regulatory agencies such as CUPAs and Cal/OSHA. In addition,
25 Environmental Commitments EC-2: *Develop and Implement Hazardous Materials Management Plans*
26 and EC-3: *Develop and Implement Spill Prevention, Containment, and Countermeasure Plans* would
27 further reduce the potential for accidental release or exposure during project operations and
28 maintenance.

29 **CEQA Conclusion—All Project Alternatives**

30 The nature of construction, operation, and maintenance impacts would be the same under all project
31 alternatives. During construction and operations, the project would comply with regulations
32 enforced by CUPAs and Cal/OSHA and other applicable laws and regulations.

33 The magnitude of impacts may be greater under alternatives with longer construction durations and
34 three intakes (Alternatives 2a and 4a) that would require more excavation over a longer time period
35 (13 and 14 years, respectively) and require excavation at more intake sites and for larger diameter
36 tunnels. Regardless of the magnitude, the nature of potential impacts of all the project alternatives is
37 the same and could create a substantial hazard to the public or the environment through the routine
38 transport, use, or disposal of hazardous materials because of the use of hazardous materials over the
39 multi-year period of construction. However, compliance with applicable laws and regulations would
40 reduce potential impacts resulting from the transport, handling, use, and disposal of these materials.
41 BMPs for the disposal of RTM (Chapter 3) and the environmental commitments described in
42 Appendix 3B, such as Environmental Commitment EC-2: *Develop and Implement Hazardous*
43 *Materials Management Plans*; EC-3: *Develop and Implement Spill Prevention, Containment, and*
44 *Countermeasure Plans*; and EC-4b: *Develop and Implement Stormwater Pollution Prevention Plans*

would reduce the potential for hazardous materials effects by identifying known hazardous materials sites, designing protocols for reducing hazardous materials exposure, and treating and disposing of hazardous substances at construction sites. Therefore, impacts from construction, operations, or maintenance of any of the project alternatives would be less than significant.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F, *Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources*, does not act as mitigation for hazards, hazardous materials, and wildfire impacts from project construction or operations, its implementation could result in hazards, hazardous materials, and wildfire impacts.

Construction of compensatory mitigation (on Bouldin Island, at three ponds along I-5, and within the North Delta Arc, as described in Appendix 3F) would require equipment for earthmoving activities, such as grubbing, soil excavation, and placement of fill or gravel. The use of these types of equipment and vehicles would involve the handling and use of different quantities of commonly used materials, such as fuels, lubricants, and oils, to operate equipment. In addition, herbicide application could occur at Bouldin Island and the pond sites for weed control and management of riparian habitat. Impacts associated with construction of compensatory mitigation together with the project would not vary by alternative because the same types of equipment would be used and require the use of similar hazardous materials. The type and magnitude of activities on the CMP sites does not vary by alternative. Accidental releases of fuels, lubricants, or oils during construction or improper herbicide application could result in a potential safety hazard through soil, water, or air contamination. However, compliance with applicable laws and regulations would reduce potential impacts resulting from the transport, handling, use, and disposal of these materials. BMPs for the disposal of RTM would reduce the potential for hazardous materials effects for the same reasons identified for project alternatives. Environmental Commitments EC-2: *Develop and Implement Hazardous Materials Management Plans*; EC-3: *Develop and Implement Spill Prevention, Containment, and Countermeasure Plans*; and the BMPs as described under EC-4b: *Develop and Implement Stormwater Pollution Prevention Plans* (Appendix 3B) would further reduce the potential for accidental release or exposure during construction by reducing the potential for accidental releases of hazardous materials at construction sites. Therefore, impacts from the project alternatives together with the CMP from the routine transport, use, or disposal of hazardous materials during construction would not change the impact conclusion of less than significant.

Other Mitigation Measures

Some mitigation measures would involve the use of heavy equipment, such as graders, excavators, dozers, and haul trucks, that would have the potential to involve the handling and use of different quantities of commonly used materials, such as fuels, lubricants, and oils, to operate equipment. In addition, pesticide application could occur for mosquito control. The mitigation measures with potential to result in increased impacts from handling and use of hazardous materials are: Mitigation Measures BIO-2c: *Electrical Power Line Support Placement*, AG-3: *Replacement or Relocation of Affected Infrastructure Supporting Agricultural Properties*, AES-1c: *Implement Best Management Practices in Project Landscaping Plan*, AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP Operational Pumping Emissions to Net Zero*, and PH-1b: *Develop and Implement a Mosquito Management Plan for Compensatory Mitigation*

1 *Sites on Bouldin Island and I-5 Pond 6.* Temporary increases in the handling and use of hazardous
2 materials resulting from other mitigation measures would be similar to construction effects of the
3 project alternatives in certain construction areas and would contribute to handling and use of
4 hazardous materials impacts of the project alternatives. Compliance with applicable laws and
5 regulations would reduce potential impacts resulting from the handling and use of these materials.
6 Therefore, mitigation measures are unlikely to create a substantial hazard through the transport,
7 use, or disposal of hazardous materials, and the impact of hazardous materials would be less than
8 significant.

9 Overall, increased transport and use of hazardous materials impacts for construction of
10 compensatory mitigation and other mitigation measures, combined with project alternatives, would
11 not change the less-than-significant impact conclusion.

12 **Impact HAZ-2: Create a Significant Hazard to the Public or the Environment through**
13 **Reasonably Foreseeable Upset and Accident Conditions Involving the Release of Hazardous**
14 **Materials into the Environment**

15 ***All Project Alternatives***

16 ***Project Construction***

17 The physical footprints of the project alternatives vary with the three alignments (central, eastern,
18 and Bethany Reservoir), as does the number of intakes (one, two, or three), and there are also small
19 differences in total acreages among project alternatives. Under Alternatives 2a and 4a, three intakes
20 would be constructed, requiring more excavation and therefore a greater potential to encounter
21 hazardous materials in soil and sediment (e.g., mercury in river sediments).

22 Except for the West Tracy Fault and Bethany Fault studies, field investigations for project
23 construction would occur within the facility footprints and tunnel alignments of the individual
24 alternatives and could involve encountering the potentially hazardous scenarios described below.
25 The West Tracy Fault study would involve trenching along a line running from the southeast of
26 Byron to the southeast of the Clifton Court Forebay. This area was included as part of the study area
27 for hazards and hazardous materials. Therefore, the following impacts and mitigation measures
28 described for project construction would also apply to all field investigations. The Bethany Fault
29 study is primarily a Cone Penetration Test study.

30 ***General Construction Activities***

31 Construction of the project could create a hazard to the public or the environment through
32 reasonably foreseeable upset and accident conditions involving the release of hazardous materials
33 into the environment. Potentially toxic substances (such as petroleum and other chemicals used to
34 operate and maintain construction equipment) would be used in the construction footprint and
35 transported to and from the area during construction. Accidental releases of these substances could
36 contaminate soils and degrade the quality of surface water and groundwater, resulting in a public
37 safety hazard. However, the use and disposal of these materials would be compliant with regulations
38 enforced by CUPAs and Cal/OSHA, as previously discussed. In addition, standard BMPs, as discussed
39 above, would further reduce the potential for an accidental release of hazardous materials. The
40 project also includes BMPs for the disposal of RTM, which includes testing of RTM to further reduce
41 exposure to hazardous materials (Chapter 3). Environmental Commitments EC-2: *Develop and*
42 *Implement Hazardous Materials Management Plans*, which would provide detailed information on

hazardous materials used and stored and protocols to reduce likelihood of a spill of toxic chemicals, and EC-3: *Develop and Implement Spill Prevention, Containment, and Countermeasure Plans*, which requires that personnel be trained in emergency response and spill containment technique, would reduce the potential for hazardous materials release during construction.

Reusable Tunnel Material

RTM would be transported for handling, drying, and storage near launch shaft sites, as described in Chapter 3, Section 3.4.4. Drying of RTM would be accomplished through air drying and/or the use of mechanical dryers depending upon the tunnel launch shaft location. RTM would be moved to a concrete-lined area, and temporary stockpiles would be tested for hazardous materials. At tunnel launch shaft sites where mechanical drying would be used, RTM would be dried prior to testing. When RTM generation rate is greater than the capacity of the mechanical drying equipment, the RTM would be placed in a temporary wet stockpile and tested prior to drying. When natural drying is used, RTM would be tested prior to drying.

Potential hazards associated with handling the RTM include metals and inorganic elements normally present in soil, organic compounds introduced to soil (such as agricultural fertilizers, herbicides, and pesticides), accidental release of hazardous materials or petroleum products and potential chemical additives included in soil conditioners used during tunneling as described above. Soil conditioners or additives used to facilitate tunneling could cause eye and skin irritation if mishandled. Therefore, construction personnel and the public could be inadvertently exposed to RTM contaminants.

Excavated RTM would be tested in accordance with the requirements of the Central Valley Regional Water Quality Control Board and DTSC for the presence of hazardous materials at concentrations above the regulatory threshold criteria. As described in Chapter 10, the geologic materials encountered during tunneling are expected to be comprised of alluvial sediments consisting of a mixture of clay, silt, sand, gravel, and minor amounts of organic matter, the majority of which was deposited prior to the arrival of settlers to California and subsequent mining, agricultural, and urban land uses that have produced potential contaminants of concern, as discussed above.

Previous soil tests were conducted for the California WaterFix project. Soil samples were obtained from the tunnel horizon (100 to 170 feet bgs) from 19 boreholes along the Central Corridor.³ These samples were blended to generate a baseline sample of anticipated RTM (Delta Conveyance Design and Construction Authority 2022c). Test results on native soil samples indicated that no petroleum hydrocarbons or pesticide residues would likely be detected in RTM samples. Metals and inorganic elements were detected throughout the soil profile resembling naturally occurring levels, with the exception of cadmium. Although cadmium was detected, levels remained acceptable and far below regulatory thresholds. Arsenic and chromium concentrations were the same as those found in naturally occurring soils, and the addition of conditioners did not affect concentrations of arsenic. Mercury concentrations were below naturally occurring levels (Delta Conveyance Design and Construction Authority 2022c).

Preliminary studies indicated that use of soil conditioners in the tunneling process would not pose a risk to human health, wildlife, or the environment provided standard procedures are followed (Delta Conveyance Design and Construction Authority 2022c). As per standard Cal/OSHA

³ The Central Corridor of the California WaterFix project varies slightly from the central alignment proposed for this project.

regulations, personnel would use personal protective equipment. Chapter 3 describes the disposal of RTM, which requires testing of RTM for hazardous materials concentrations above regulatory thresholds and the proper disposal of any contaminated soils. The project also includes Environmental Commitments EC-2: *Develop and Implement Hazardous Materials Management Plans*, which includes protocols for proper handling and storage of contaminated soil, and EC-3: *Develop and Implement Spill Prevention, Containment, and Countermeasure Plans*, which requires compliance with applicable legal requirements in relation to recovered materials (Appendix 3B). These measures would reduce potential RTM impacts on workers, the public, and sensitive receptors.

The RTM would be placed in temporary stockpile areas while it is tested for the potential presence of hazardous materials. It is anticipated that several stockpiles would be developed to allow for determination of the changes in geology and geographic locations as the TBM proceeds. Each temporary area would be generally sized to accommodate up to 1 week of RTM production and lined with impermeable lining material.

Despite testing results indicating safe use of RTM, testing only included samples. It is possible that some RTM could still contain constituents that may not be suitable for reuse. To determine if RTM is suitable for safe reuse, it would be tested for hazardous constituents present in concentrations that exceed applicable regulatory thresholds, in accordance with the requirements of the Central Valley Regional Water Quality Control Board and DTSC. Any RTM that does not meet the requirements for safe reuse would be transported to a disposal location licensed to receive the material.

At sites with mechanical drying, the RTM would be dried prior to testing. However, when RTM generation rate is greater than the capacity of the mechanical drying equipment, the RTM would be placed in a temporary wet stockpile and tested prior to drying. Mechanical dryers would not be used under Alternative 5. If portions of the RTM were identified as hazardous, that material would be transported in trucks licensed to handle hazardous materials to a disposal location licensed to receive those constituents. If the RTM meets the criteria for reuse, the material would be moved by conveyor to a long-term on-site storage site or transported off site for subsequent reuse.

For the RTM not slated for reuse, the RTM would be spread over a broad area in relatively thin lifts (e.g., 18 inches) and allowed to drain and dry naturally over a period of up to 1 year. Continuous spreading in thin lifts would allow RTM that is not mechanically dried to be dried naturally without excessive earth moving requirements. This method of natural drying would prevent any decant liquid from seeping into the soil. Testing RTM before reuse, complying with Cal/OSHA regulations and standard SWPPP BMPs, and implementing EC-2: *Develop and Implement Hazardous Materials Management Plans* would reduce the potential for this impact.

Electrical Transmission and Distribution Lines

DWR has identified eight overhead transmission/distribution lines that could be potentially crossed with the project alternatives (Chapter 21, *Public Services and Utilities*, Table 21-4). The table identifies areas where any of the surface impacts of the project (e.g., intakes, access roads, other aboveground infrastructure) would cross an existing overhead transmission/distribution line. Crossing a utility does not necessarily mean there would be a physical conflict but shows where potential conflicts could occur. At some locations, electrical lines may require relocation to maintain utility service.

Disturbance of electrical infrastructure during construction activities that employ high-profile equipment, such as cranes, could result in safety hazards for construction workers in the immediate

vicinity of an energized line. The most significant risk of injury from any power line is the danger of electrical contact between an object on the ground and an energized conductor. Generally, there is less risk of contact with higher voltage lines as opposed to low-voltage lines because of the height of the conductors. When work is performed near transmission and distribution lines, electrical contact can occur even if direct physical contact is not made because electricity can arc across an air gap. Accidental or inadvertent contact with energized transmission and distribution lines could result in substantial public health and safety impacts, including serious injury, electrocution, and in some instances, death.

The State Water Project (SWP) Power and Risk Office would coordinate with WAPA, PG&E, TANC, SMUD, and the California Independent System Operator to identify, evaluate, and establish the electrical interconnection of the project facilities to the California electric grid. In addition, DWR would comply with Cal/OSHA and electrical safety standards, including California Code of Regulations, Title 8, Sections 2299-2599 (Low Voltage Electrical Safety Orders) and Sections 2700-2989 (High Voltage Electrical Safety Orders). These measures detail safe electrical work practices and procedures on and around transmission lines and would ensure that worker and public safety is safeguarded during work on or in immediate proximity to low- and high-voltage transmission lines. Compliance with the existing regulations would reduce impacts regarding electrical transmission line hazards by employing standard construction safety requirements.

Other hazards associated with electrical transmission lines include potential health risks from exposure to electromagnetic fields. These potential effects are described and assessed in Chapter 26.

Oil and Gas Facilities

As previously discussed in Section 25.1.2.4, *Hazards from Oil and Gas Production and Processing*, hazards associated with oil and natural gas production include emissions of BTEX compounds as well as n-hexane and other volatile organic compounds. Abandoned and plugged oil and natural gas wells may be present in areas where excavation is planned. Improperly sealed natural gas wells have the potential to act as natural gas conduits from deep reservoirs where flammable gases may pose hazards to excavation or tunneling activities. Figures 25-1 and 25-2 show oil and natural gas facilities and wells along the water conveyance facilities alignments. Two active natural gas wells have been identified in the project footprint. The first is located near King Island just outside the footprint of the eastern tunnel alignment. The second active gas well is located within the footprint of the central tunnel alignment on Staten Island. Pre-excavation surveys would identify, confirm, and pinpoint exact locations of oil and gas wells to ensure tunnel excavation does not intersect with pipelines. As a result, tunnel activities are not expected to intersect with any natural gas wells.

All alignment tunnels (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) would cross several natural gas pipelines. Some of the facilities under all project alternatives would be excavated within an area of natural gas fields. The natural gas pipelines are generally located near the surface, with depths of less than 10 feet below the surface and pipe diameters less than 24 inches. The top of the tunnel excavation nearest the natural gas lines would be approximately 115 to 120 feet below the surface. Pre-excavation surveys would identify pipeline locations to ensure tunnel excavation does not intersect with pipelines. In addition, tunnel shafts and tunnel facilities would be significantly deeper than pipelines. As a result, tunnel activities are not expected to intersect with any natural gas pipelines.

1 Soil and groundwater contamination can also be associated with abandoned oil and gas wells.
2 Previous mining activities, such as the use of petroleum drilling fluids, may have deposited
3 hydrocarbons in the soil or groundwater.

4 Project construction involving ground-disturbing activities (e.g., tunneling) could expose
5 construction personnel and the public to contaminated soils or groundwater in the form of
6 petroleum products or processing chemicals. Exposure to these compounds can result in short-term
7 and long-term health effects.

8 During the design phase of the project, additional desktop surveys of documented wells would be
9 conducted and include research of historical topographic mapping that may document the presence
10 of wells that were not previously identified in the California Geologic Energy Management Division
11 (CalGEM) oil and natural gas database. The locations of identified wells within the tunnel alignment
12 would be used to determine methods to abandon, relocate, or avoid the wells (Delta Conveyance
13 Design and Construction Authority 2022a:104; 2022b:66).

14 In addition, during the design phase, a comprehensive exploration program would be conducted
15 using the suitable geophysical methods to identify and/or confirm the location of well casings along
16 the alignment, including wells that have not been previously identified. These methods could include
17 wide-area airborne (i.e., drone, helicopter, or fixed-wing aircraft) magnetic surveys followed by
18 more site-specific walk- or tow-over ground-based magnetic surveys (Delta Conveyance Design and
19 Construction Authority 2022a:104; 2022b:66).

20 These measures to identify and avoid oil and natural gas wells that would potentially pose risks to
21 project personnel or facilities would reduce the potential impact of encountering hazardous
22 constituents from abandoned or previously unidentified oil and gas wells.

23 *Gas Accumulation in Tunnels*

24 All project alignments pass through areas of the Delta that are underlain with natural gas fields that
25 extend more than 1,000 feet below the ground surface. During construction, there is the potential to
26 encounter these gases, which could enter and accumulate to flammable or explosive concentrations
27 in tunnel bores or other excavations. Gases could include methane generated by peat and organic
28 soils or other natural gases, which could seep from deep natural gas reservoirs either through
29 improperly sealed boreholes or natural conduits such as faults and fractures.

30 Tunneling activities in areas with flammable gases and hydrocarbons are regulated by the Cal/OSHA
31 Mining and Tunneling Unit (M&T Unit). The M&T Unit outlines the rules and regulations for safety,
32 monitoring frequency for gas levels, and procedures for notifying Cal/OSHA based upon the
33 expected level of flammable gases and/or hydrocarbons. Although the tunnel classification for the
34 project has not yet been provided by Cal/OSHA, it may receive a “potentially gassy” or “gassy”
35 classification due to the presence of gas fields in the region.

36 Tunnel boring operations for the project in areas with a potential for flammable gases would be
37 required to include redundant safety features and practices. For example, TBMs are required to be
38 equipped with gas monitoring equipment that automatically shuts down the TBM if gas is detected.
39 Additional special access and egress requirements may be imposed by Cal/OSHA. These
40 requirements would be determined later during the design phase. If a particular reach of tunnel is
41 classified as “gassy” then all equipment used in the tunnels would be required to be incapable of
42 causing an explosion (Delta Conveyance Design and Construction Authority 2022a:104).

1 In addition, the contractor would be required to follow gas monitoring and fire prevention
2 requirements mandated by Cal/OSHA based on the tunnel gas classification in accordance with the
3 Tunnel Safety Orders set forth in California Code of Regulations, Title 8, Section 8400 to Appendix E
4 (Tunnel Classifications). Compliance with safety regulations for tunneling would reduce the
5 potential for accidents involving gas accumulation in tunnels.

6 *Mercury*

7 Due to historic mining operations, it is possible that mercury-contaminated sediments would be
8 resuspended during sediment-disturbing activities related to in-river construction activities (e.g.,
9 cofferdam construction at intake sites). In general, sediment-bound mercury concentrations in
10 rivers can vary seasonally by source and depend on weather patterns that influence runoff and river
11 flows. However, concentrations of potential contaminants in the sediments where in-river
12 construction activities would be taking place are not known; therefore, the associated risk cannot be
13 identified.

14 Exposure to mercury-contaminated sediments is unlikely to be a hazard for construction workers
15 because it is not expected that workers would be in direct contact with sediments during in-river
16 construction activities. Also, during construction, sediments would be contained to a relatively small
17 area, limiting exposure to the public and environment. Furthermore, the project includes BMPs for
18 the disposal of RTM (Chapter 3), which require testing of sediment for hazardous materials
19 concentrations above regulatory thresholds and the proper disposal of any contaminated soils. The
20 project also includes the environmental commitments, such as EC-2: *Develop and Implement*
21 *Hazardous Materials Management Plans*, which would provide detailed information on hazardous
22 materials used and stored and protocols to reduce the likelihood of a spill of toxic chemicals; EC-3:
23 *Develop and Implement Spill Prevention, Containment, and Countermeasure Plans*, which requires
24 compliance with applicable legal requirements in relation to recovered materials. The full text of
25 these measures can be found in Appendix 3B.

26 *Agricultural and Railroad Land Uses*

27 As previously discussed, much of the study area was and still is used for agricultural purposes. As a
28 result, soils contaminated with pesticides, herbicides, and other agricultural chemicals may be
29 present within the study area. Ground-disturbing activities, such as grading and excavation, may
30 expose construction workers and the general public to hazardous materials in agricultural soils and
31 near railroad tracks that may result in health effects. Similarly, if soils adjacent to railroad tracks are
32 disturbed during construction (e.g., construction of an overpass road over BNSF railroad tracks),
33 workers could be exposed to heavy metals and total petroleum hydrocarbons such as diesel, fuel oil,
34 and polychlorinated biphenyls.

35 The project would comply with BMPs and requirements of state and federal permits (i.e., National
36 Pollutant Discharge Elimination System [NPDES], SWPPP), and this would reduce the potential for
37 impacts. Environmental commitments include EC-2: *Develop and Implement Hazardous Materials*
38 *Management Plans*, which includes development of a plan that details protocols for proper handling
39 and storage of contaminated soil. These measures would reduce impacts for handling of
40 contaminants but do not address preconstruction identification.

Previously Unknown Hazardous Materials Sites

There may be contaminated areas within the study area that have not been previously identified because of inadequate or missing data or poor record keeping. During construction, contaminated soils, sediments, and groundwater may be encountered where historical releases have occurred, such as former storage and distribution facility locations (e.g., gasoline stations, farms). Ground-disturbing activities during construction in these areas could expose workers and the public to soil contaminants that are harmful to human health.

Hazardous Materials Routes

Project construction under any alternative would require substantial transportation facility improvements to serve the construction and material delivery processes. Chapter 3 provides details regarding road relocations, new construction, and improvements.

Federally designated hazardous materials routes in the study area include SR 4, SR 12, and SR 113; I-5, I-80, I-205, and I-580 (Figure 25-3). These routes are preferred designated routes for the transportation of hazardous materials (Federal Motor Carrier Safety Administration 2014).

Traffic rerouting and relocation of hazardous materials routes together with increased construction traffic could increase the potential for releases/spills of hazardous materials due to increased traffic and less familiar routes.

To address project construction traffic issues, analysis was conducted on potential truck routes, including SR 4, SR 12, and SR 160; I-5 and I-205; and over 30 local roads with direct access to potential construction sites (Delta Conveyance Design and Construction Authority 2022b:48). As a result of the analysis, it was determined that a portion of SR 160 would be temporarily rerouted during intake construction to east of the existing alignment and subsequently realigned near the existing location, and Byron Highway near the Southern Forebay would be realigned west of the current alignment. Neither road is a hazardous materials transportation route designated by the Federal Motor Carrier Safety Administration.

Assumptions for access roads to construction sites would be included in the design specifications for each key feature and designed to further reduce traffic impacts (see Chapter 3 for additional information regarding design specifications). To further reduce the daily effect of truck trips on local roadways, certain construction material hauling would be assigned to rail lines. Materials transported include tunnel liner segments, TBM equipment, and aggregate to tunnel launch shaft sites. Under all alternatives except Alternative 5, RTM could also be transported from the tunnel launch shaft sites at Twin Cities Complex by railway to the Southern Complex, and for the central alignment, RTM material would be transported from Twin Cities Complex to tunnel shaft sites on Mandeville and Bacon islands. Project design specifications and realignment of SR 160 would reduce the potential for releases/spills of hazardous materials due to increased traffic and travel on less familiar routes.

Operations and Maintenance

Operations and maintenance would include regular dredging of the sedimentation basins at each intake and removing the sediment to drying lagoons. When dry, sediment would be collected and disposed of at a permitted offsite disposal location. There is the potential to encounter hazardous materials in the sediment in the form of mercury. However, handling of sediment during operations would comply with proper Cal/OSHA regulations to limit workers', the public's, and other sensitive

receptors' exposure. Furthermore, the project includes BMPs for the disposal of RTM and Environmental Commitments EC-2: *Develop and Implement Hazardous Materials Management Plans*, and EC-3: *Develop and Implement Spill Prevention, Containment, and Countermeasure Plans*. The full text of these measures can be found in Appendix 3B.

If project facilities are sited on or near a previously unknown hazardous materials site, workers, the public, or other sensitive receptors or the environment could be exposed to previously unknown hazardous materials sites.

CEQA Conclusion—All Project Alternatives

Construction of any one of the alternatives (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) would involve handling and storage of RTM and excavated soils that could contain hazardous materials such as petroleum products. This could expose workers to potential human health hazards. However, the depths of excavation for tunnels indicate low potential to encounter historic contaminants of concern from mining, agricultural, and urban land uses. Testing of soil samples representative of RTM indicated that levels of metals and inorganic compounds were below regulatory thresholds. Finally, compliance with Cal/OSHA regulations and standard SWPPP BMPs and testing of RTM before reuse (Chapter 3) would reduce potential impacts on workers, the public, and the environment regarding the handling and reuse of RTM.

Excavation and tunneling could expose workers, the public, and the environment to soil and groundwater contamination associated with abandoned oil and gas wells. Previous mining activities, such as the use of petroleum drilling fluids, may have deposited hydrocarbons in the soil or groundwater. However, project design would include desktop surveys and research of historical topographic mapping to identify and avoid wells. Other methods used could include airborne surveys and site-specific ground-based magnetic surveys. These measures would reduce the potential impact of encountering hazardous constituents from abandoned or previously unidentified oil and gas wells to a less-than-significant level.

Gas accumulation in tunnels during construction could pose a danger to workers and the public if gases are inadvertently ignited. This could expose workers or the public to potential human health hazards. However, compliance with safety regulations for tunneling would reduce the potential for accidents involving gas accumulation in tunnel. In addition, compliance with gas monitoring and fire prevention requirements in accordance with the Tunnel Safety Orders set forth in the Tunnel Classifications regulations would reduce potential impacts regarding gas accumulation in excavated areas. EC-2: *Develop and Implement Hazardous Materials Management Plans* would further reduce the potential for encountering hazardous materials during excavation activities. This impact would be less than significant.

Construction involving excavation and tunneling could expose workers, the public, and the environment to agricultural chemicals and contaminated soil and groundwater from previously unknown hazardous waste sites. Compliance with BMPs and requirements of state and federal permits would reduce this impact but does not address preconstruction identification (i.e., potential to encounter previously unknown hazards and hazardous waste). This is considered a significant impact.

In addition to the inclusion of BMPs for the disposal of RTM and environmental commitments such as EC-2: *Develop and Implement Hazardous Materials Management Plans*; EC-3: *Develop and Implement Spill Prevention, Containment, and Countermeasure Plans* (Appendix 3B), the following

actions would reduce the potential for releases/spills of hazardous materials during project construction under all alternatives: transportation facility improvements, design specifications to reduce project construction traffic, offsetting of traffic via rail use, and early consultation with California Department of Transportation and local jurisdictions.

Overall, considering the potential for release of hazardous materials during construction, operations and maintenance of the project alternatives, the potential exists for accidental spills and exposure to hazardous materials to occur. The environmental commitments described above could partially reduce impacts related to hazardous materials but not to a less-than-significant level because of the uncertainty that exists about the locations and nature of potential hazardous materials sites and the potential for construction worker and public exposure to hazardous materials. Implementing Mitigation Measure HAZ-2: *Perform a Phase I Environmental Site Assessment Prior to Construction Activities and Remediate* would include a Phase I environmental site assessment before construction, the identification and evaluation of potential sites of concern within the construction footprint, and the development of a remediation plan before construction and operations commence. This would reduce all impacts related to accidental release of hazardous materials into the environment to a less-than-significant level with mitigation.

Mitigation Measure HAZ-2: Perform a Phase I Environmental Site Assessment Prior to Construction Activities and Remediate

1. Prior to construction, DWR will conduct a Phase I environmental site assessment in conformance with the American Society for Testing and Materials Standard Practice E1527-05. All environmental investigation, sampling, and remediation activities associated with properties in the project area will be conducted under a work plan approved by the regulatory oversight agency (e.g., DTSC, EPA) and will be conducted by an appropriate environmental professional.
 - a. Areas to be excavated as part of construction (e.g., for water conveyance facilities, shaft locations, concrete batch plants, intake locations, RTM areas, staging areas) where historical contamination has been identified or where contamination is suspected (e.g., as evidenced by soil discoloration, odors, differences in soil properties, abandoned underground storage tanks [USTs]) will undergo soil and/or groundwater testing at a certified laboratory provided that existing data are not available to characterize the nature and concentration of the contamination. A Phase I environmental site assessment must include the following components (40 CFR § 312.20).
 - i. An on-site visit to identify current conditions (e.g., vegetative dieback, chemical spill residue, presence of aboveground or underground storage tanks [ASTs or USTs]).
 - ii. An evaluation of possible risks posed by neighboring properties.
 - iii. Interviews with persons knowledgeable about the site's history (e.g., current or previous property owners, property managers).
 - iv. An examination of local planning files to check prior land uses and any permits granted.
 - v. File searches with appropriate agencies (e.g., State Water Board, fire department, county health department) having oversight authority relative to water quality and groundwater and soil contamination.

- vi. Examination of historical aerial photography of the site and adjacent properties.
 - vii. A review of current and historical topographic maps of the site to determine drainage patterns.
 - viii. An examination of chain-of-title for environmental liens and/or activity and land use limitations.
- b. If the Phase I environmental site assessment indicates likely site contamination, a Phase II environmental site assessment will be performed (also by an appropriate environmental professional).
 - c. A Phase II environmental site assessment will comprise the following components.
 - i. Collection of original surface and/or subsurface samples of soil, groundwater, and building materials to analyze for quantities of various contaminants.
 - ii. An analysis to determine the vertical and horizontal extent of contamination (if the evidence from sampling shows contamination).
 - d. If contamination is uncovered as part of Phase I or II environmental site assessments, remediation (e.g., cleaning, removing, or capping contaminants in accordance with DTSC regulations) will be required. If materials such as asbestos-containing materials, lead-based paint, or PCB-containing equipment are identified, these materials will be properly managed and disposed of prior to or during the demolition process.
 - e. Any contaminated soil identified on a project site must be properly disposed of in accordance with the DTSC regulations in effect at the time.
 - f. If, during construction/demolition of structures, soil or groundwater contamination is suspected, the construction/demolition activities will cease and appropriate health and safety procedures will be implemented, including the use of appropriate personal protective equipment (e.g., respiratory protection, protective clothing, helmets, goggles).

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for hazards, hazardous materials, and wildfire impacts from project construction or operations, its implementation could result in hazards, hazardous materials, and wildfire impacts.

The compensatory mitigation would consist of local grading and inundation of some locations associated with restoration sites, including the creation of tidal wetland and channel margin habitat in the North Delta Arc as described in Appendix 3F. There is the potential for encountering soil and or groundwater contamination from the historical use of agricultural chemicals and contaminated soil and groundwater from previously unknown waste sites at restoration locations. This could expose construction personnel and the public to contaminated soils or groundwater, potentially causing adverse health effects and contamination of surface water, which would be a significant impact.

The project, together with compensatory mitigation, would implement EC-2: *Develop and Implement Hazardous Materials Management Plans*, which includes development of a plan that details protocols

1 for proper handling and storage of contaminated soil. These measures would reduce impacts for
2 handling of contaminants but do not address preconstruction identification (i.e., potential to
3 encounter previously unknown hazards and hazardous waste). However, Mitigation Measure HAZ-
4 2: *Perform a Phase I Environmental Site Assessment Prior to Construction Activities and Remediate*
5 would require preconstruction surveys to identify potentially hazardous conditions and remediate,
6 if necessary. This mitigation measure would reduce the potential for encountering previously
7 unknown hazardous materials sites. Therefore, with Mitigation Measure HAZ-2, the combined
8 impact of project alternatives and the CMP relating to accidental release of hazardous materials
9 would be less than significant with mitigation.

10 There are gas fields on Bouldin Island (Figure 25-1). No other natural gas or oil facilities were
11 identified in the compensatory mitigation areas. However, abandoned and plugged oil and natural
12 gas wells may be present in areas where excavation is planned. Inadvertent contact with a
13 previously unknown gas or oil facility could expose workers or the public to human health hazards,
14 which would be a significant impact.

15 The same measures to identify oil and gas wells in the project footprints (including desktop surveys
16 of documented wells and research of historical topographic mapping and a comprehensive
17 exploration program using geophysical methods to identify the location of well casings and wide-
18 area airborne and ground-based magnetic surveys) would be implemented for compensatory
19 mitigation. Furthermore, Mitigation Measure HAZ-2 would help identify previously unknown gas
20 and oil facilities and other potentially hazardous conditions. These measures and Mitigation
21 Measure HAZ-2 would reduce this impact. Therefore, impacts from the project alternatives together
22 with the CMP would not increase the potential for accidental release of hazardous materials into the
23 environment. Impacts of the CMP, combined with project alternatives, would not change the impact
24 conclusion of less than significant with mitigation.

25 Other Mitigation Measures

26 Some mitigation measures would involve the use of heavy equipment such as excavators and dozers
27 that would have the potential for encountering previously contaminated soil and or groundwater
28 and accident conditions involving the release of hazardous materials. The mitigation measures with
29 potential to result in accident conditions involving the release of hazardous materials are Mitigation
30 Measures BIO-2c: *Electrical Power Line Support Placement*; AG-3: *Replacement or Relocation of*
31 *Affected Infrastructure Supporting Agricultural Properties*; AES-1c: *Implement Best Management*
32 *Practices in Project Landscaping Plan*; CUL-1b: *Prepare and Implement a Built-Environment*
33 *Treatment Plan in Consultation with Interested Parties*; and AQ-9: *Develop and Implement a GHG*
34 *Reduction Plan to Reduce GHG Emissions from Construction and Net CVP Operational Pumping*
35 *Emissions to Net Zero*. Temporary accident conditions involving the release of hazardous materials
36 resulting from mitigation measures would be similar to construction effects of the project
37 alternatives in certain construction areas. This would increase the potential for impacts from the
38 release of hazardous materials for the project alternatives. Mitigation Measure HAZ-2: *Perform a*
39 *Phase I Environmental Site Assessment Prior to Construction Activities and Remediate* would require
40 preconstruction surveys to identify potentially hazardous conditions and remediate, if necessary.
41 This would reduce the potential for encountering previously unknown hazardous materials to a
42 less-than-significant level. Therefore, other mitigation measures are unlikely to create a substantial
43 hazard from the accidental release of hazardous materials, and the potential impact of encountering
44 hazardous materials would be less than significant with mitigation.

Overall, the impact from accident release of hazardous materials for construction of compensatory mitigation and other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant with mitigation.

See Chapter 26 for a full discussion of methylmercury and human health.

Impact HAZ-3: Expose Sensitive Receptors at an Existing or Proposed School Located within 0.25 Mile of Project Facilities to Hazardous Materials, Substances, or Waste

All Project Alternatives

This section addresses potential impacts on schools, existing or proposed, that could be exposed to hazardous materials as a result of project construction or operation due to their proximity to the project footprint. Except for Alternative 5, there are no public or private preschools or K–12 schools within 0.25 mile of proposed water conveyance facilities. Therefore, there is no potential for the project to expose sensitive receptors at schools to hazardous materials under Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c either from construction or from operations and maintenance activities.

Under Alternative 5, the Mountain House Elementary School (3950 Mountain House Road, Byron) is approximately 0.18 mile south of the Bethany Reservoir Aqueduct. The aqueduct system would consist of four 15-foot-diameter belowground pipelines that would convey water from the Bethany Reservoir Pumping Plant to the Bethany Reservoir Discharge Structure. Access to the aqueduct would be provided by an access road constructed approximately 0.22 mile east of the school. This road would be a 2.1-mile-long paved road to provide access to the Bethany Complex via Byron Highway Frontage Road to Mountain House Road. No RTM storage would occur at the Bethany Complex.

Potential air quality effects on sensitive receptors are discussed in Chapter 23.

Project Construction

Construction of Alternative 5 would occur within 0.25 mile of Mountain House Elementary School. Construction activities could result in the release of hazardous emissions or entail the use of hazardous materials, substances, or waste. However, consistent with applicable laws and regulations, the transport, use, and disposal of hazardous materials would comply with regulations enforced by regulatory agencies such as CUPAs and Cal/OSHA. Environmental commitments include EC-2: *Develop and Implement Hazardous Materials Management Plans*, which would provide detailed information on hazardous materials used and stored and protocols to reduce the likelihood of a spill of toxic chemicals, and EC-3: *Develop and Implement Spill Prevention, Containment, and Countermeasure Plans*, which requires that personnel be trained in emergency response and spill containment technique. In addition, BMPs as described under the SWPPP (EC-4b: *Develop and Implement Stormwater Pollution Prevention Plans*) would further reduce the potential for accidental release or exposure during construction. Therefore, the sensitive receptors at Mountain House Elementary School are not anticipated to be exposed to hazardous materials related to construction of Alternative 5.

Operations and Maintenance

Once constructed, operations and maintenance at the Bethany Reservoir Aqueduct may require the occasional use of hazardous materials for vehicles and equipment. The storage and use of these

materials, however, would be regulated by CUPAs and Cal/OSHA. Regulations and laws pertaining to these materials, in addition to Environmental Commitments EC-2: *Develop and Implement Hazardous Materials Management Plans*, and EC-3: *Develop and Implement Spill Prevention, Containment, and Countermeasure Plans*, would further reduce the potential for accidental release or exposure during project operations and maintenance.

CEQA Conclusion—All Project Alternatives

There are no schools located within 0.25 mile of the water conveyance facilities under Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c. Therefore, these alternatives would not expose sensitive receptors at schools to hazardous materials, substances, or waste, and there would be no impact.

Under Alternative 5, the Bethany Reservoir Aqueduct and associated access road would be within 0.25 mile of Mountain House Elementary School. Construction, operations, and maintenance may require the use of hazardous materials and, if mishandled, could expose people at the school to hazardous materials. Construction of the access road at the Bethany Reservoir Aqueduct would take half a year. An emergency response facility would be located south of the Bethany Reservoir Pumping Plant near the aqueduct alignment. The facilities would include a fire truck with accommodations for a full-time crew (nominally comprised of five personnel covering each construction shift). Emergency personnel would be available to respond to emergency situations such as a hazardous materials spill. Additionally, the Lammersville Unified School District (which Mountain House Elementary School is a part of) regularly runs emergency drills designed to train students in evacuation procedures and to allow district employees to test their emergency response plans (Rizzo 2016). The District's Safe Schools Plan is updated every fall and includes provisions for a Hazardous Spill or Release (Lammersville Unified School District 2019:40). Also, the project would comply with all applicable laws and regulations regarding the transportation, use, and disposal of these materials and implement EC-4b: *Develop and Implement Stormwater Pollution Prevention Plans*, which would reduce the potential for accidental release or exposure during construction and operation through weekly site inspections; EC-2: *Develop and Implement Hazardous Materials Management Plans*, which includes detailed contact information for applicable city, county, state, and federal emergency response agencies and emergency response procedures; and EC-3: *Develop and Implement Spill Prevention, Containment, and Countermeasure Plans*, which requires that personnel be trained in emergency response and spill containment technique. Therefore, the potential for hazardous materials to be emitted near Mountain House Elementary School under Alternative 5 would be less than significant.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for hazards, hazardous materials, and wildfire impacts from project construction or operations, its implementation could result in impacts on this resource as analyzed in this chapter.

There are no public or private K–12 schools within 0.25 mile of the compensatory mitigation (on Bouldin Island, at three ponds along I-5, and within the North Delta Arc as described in Appendix 3F). Therefore, compensatory mitigation together with the project under Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c would have no potential to expose sensitive receptors at schools to hazardous materials or emissions. Therefore, compensatory mitigation would not change the no impact

1 conclusion for Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c. For Alternative 5, the effect of
2 compensatory mitigation would create no additional impact related to the Mountain House
3 Elementary School or other schools because they are not located within 0.25 mile of compensatory
4 mitigation sites. Therefore, compensatory mitigation would not change the overall impact
5 conclusion of less than significant for Alternative 5.

6 Other Mitigation Measures

7 There are no schools located within 0.25 mile of the water conveyance facilities under Alternatives
8 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c. Therefore, mitigation measures would not expose sensitive receptors
9 at schools to hazardous materials, substances, or waste, and there would be no impact.

10 Under Alternative 5, the Bethany Reservoir Aqueduct and associated access road would be within
11 0.25 mile of Mountain House Elementary School. Some mitigation measures would involve the use of
12 heavy equipment such as graders, excavators, dozers, and haul trucks that would have the potential
13 to expose sensitive receptors at schools to hazardous materials, substances, or waste. The mitigation
14 measures with potential to expose sensitive receptors at schools to hazardous materials are
15 Mitigation Measures BIO-2c: *Electrical Power Line Support Placement*; AG-3: *Replacement or*
16 *Relocation of Affected Infrastructure Supporting Agricultural Properties*; AES-1c: *Implement Best*
17 *Management Practices in Project Landscaping Plan*; CUL-1b: *Prepare and Implement a Built-*
18 *Environment Treatment Plan in Consultation with Interested Parties*; and AQ-9: *Develop and*
19 *Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP*
20 *Operational Pumping Emissions to Net Zero*. Temporary exposure of sensitive receptors at schools to
21 hazardous materials resulting from mitigation measures would be similar to construction effects of
22 the project alternatives in certain construction areas and would contribute to exposure at schools to
23 hazardous materials impacts of the project alternatives. Compliance with applicable laws and
24 regulations regarding the transportation, use, and disposal of these materials, and the BMPs as
25 described under the SWPPP (EC-4b: *Develop and Implement Stormwater Pollution Prevention Plans*)
26 would further reduce the potential for accidental release or exposure during construction. In
27 addition, Environmental Commitments EC-2: *Develop and Implement Hazardous Materials*
28 *Management Plans*, and EC-3: *Develop and Implement Spill Prevention, Containment, and*
29 *Countermeasure Plans* would further reduce the potential for accidental release or exposure during
30 project operations and maintenance. Therefore, other mitigation measures is unlikely to expose
31 sensitive receptors at schools to hazardous materials, substances, or waste, and the impact of
32 hazardous materials exposure would be less than significant.

33 Overall, the impact from exposing sensitive receptors at schools to hazardous materials, substances,
34 or waste from construction of compensatory mitigation and other mitigation measures would not
35 change the Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c no impact conclusion or the Alternative 5 less-
36 than-significant impact conclusion.

Impact HAZ-4: Be Located on a Site That Is Included on a List of Hazardous Materials Sites Compiled Pursuant to Government Code Section 65962.5 and, as a Result, Create a Substantial Hazard to the Public or the Environment

All Project Alternatives

The results of the database review did not indicate differences between alternatives with respect to the potential to encounter sites on the Cortese List (Cortese sites). See Table 25-1 for a summary of all sites discussed in the following sections.

Project Construction

The preliminary search of government databases to identify Cortese List sites revealed that there are sites within 0.25 mile of project facilities, as shown in Table 25-1. Project construction would include ground-disturbing activities and, in some cases, dewatering. If these activities were to occur in contaminated media, workers and the public could be exposed to contaminants harmful to human health.

North Delta Intakes, North Tunnels (All Alternatives)

Eight Cortese List sites are within 0.25 mile of the north Delta intakes and North Tunnels. Of these eight, six are within 0.25 mile of the project footprint, but not within the project footprint. All six are listed as “case closed.” The other two sites (Chevron and Freeport Marina) are within the project footprint. Both are LUST sites located at the proposed SCADA fiber optic line routes and access roads. Both sites have completed cleanup, and both sites have been closed (State Water Resources Control Board 2021c, 2021e). Therefore, neither site within the project footprint is expected to expose workers, the public, or the environment to contaminants during project construction.

Eastern Alignment (Alternatives 3, 4a, 4b, 4c)

Seven listed sites are within 0.25 miles of the eastern alignment (Table 25-1). Three are LUST sites that have completed remediation, and their cases have been closed. Two sites, Southern Pacific Pipeline Shell and KMEP Petroleum Pipeline, are undergoing remediation of contaminated soil and water involving TPHs (i.e., jet, diesel, gas fuels) (Department of Toxic Substances Control 2021b; State Water Resources Control Board 2021i). Project activities at these locations include temporary surface impacts for road upgrades near Holt. Since road upgrades would not involve dewatering, there would be no risk of exposing workers or the public to contaminated water. However, contaminated soil could still be present in areas of proposed ground disturbance, thereby exposing workers or the public to hazardous constituents.

One site, D&D Flying Services is located within both the eastern alignment (Alternatives 3, 4a, 4b, and 4c) and the Bethany Reservoir alignment (Alternative 5). D&D Flying Services was inspected for possible pesticide misuse. However, inspection indicated that the airstrip looked clean, and no spills or evidence of washing were observed. The flying service closed in 1988. This site is near the Lower Roberts Island RTM and levee improvements, but because no violations were found, work in this area would not expose workers or the public to site contaminants.

The Stockton Naval Communication Station is within both the eastern alignment (Alternatives 3, 4a, 4b, and 4c) and the Bethany Reservoir alignment (Alternative 5) and is discussed below under *Bethany Reservoir Alignment (Alternative 5)*.

Southern Complex (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c)

Eight Cortese List sites are within 0.25 mile of the Southern Complex. Two are LUST sites and one is an evaluation site that completed remediation; these three cases are closed (Table 25-1). The remaining five are Cleanup Program Sites/voluntary cleanup sites.

Soils at the Chevron, Holey-Byron Road site were contaminated by petroleum from the former Old Valley Pipeline. No files were found to indicate that investigation or cleanup was undertaken; however, the case was listed by the State Water Board as completed and closed September 2012. Project activities near this location include installation of SCADA fiber line route.

Chevron Texaco near Byron Road is in the project footprint near the access railroad for Byron Tract on-site rail line. Discharge of heating oil/fuel from former Old Valley Pipeline was discovered during geotechnical investigations in 1991. The case was closed in November 2003.

The Chevron Old Valley Pipeline site is a voluntary cleanup site where there was soil and groundwater contamination due to oil leaking from historic pipelines. Soil and groundwater remediation and investigations are ongoing. This site is near the construction water pipeline.

The Chevron Bruns Property site is within the Southern Complex project footprint at the forebay at Bryon Tract. This site was known as the Arcady Oil Company opened in 1960. It was used as a landfill for drilling muds and closed in 1984. In 1986, a section of Southern Pacific Pipeline's fuel pipeline that passed beneath the site leaked. The Central Valley Regional Water Quality Control Board has been involved in oversight of environmental investigations at this site. It is listed as completed and closed as of March 2017.

Bethany Reservoir Alignment (Alternative 5)

Seven sites are listed within the Bethany Reservoir alignment. Four are LUST sites that have completed remediation, and the cases are closed. Three LUST sites (Tiki Lagoon Resort, Byron Bethany Irrigation District, Schropp Ranch) are within the project footprint for Alternative 5 and involved petroleum/gasoline leaks that contaminated both soil and groundwater. The three sites are near project facilities: proposed utility line, SCADA fiber line route, and levee access road. Because the three sites have undergone remediation and their cases have been closed, it is not expected that the project would expose workers or the public to contaminants.

The Shell Pipeline—Kelso Road site is within 0.25 mile of a proposed SCADA fiber line and adjacent to the Bethany Reservoir Pumping Plant and Surge Basin facility. This site involved soil and water contamination from petroleum hydrocarbons. Remediation in 2011 included excavation of contaminated soils and groundwater. Remediation was deemed complete, and the case was closed in 2014. Therefore, it is not expected to pose a risk of exposing workers or the public to contaminated soil or water.

Two sites, D&D Flying Services and Byron Power Company, are listed under cleanup programs. D&D Flying Services is discussed above under eastern alignment (Alternatives 3, 4a, 4b, 4c). There were no reported violations, and it is not a site of concern for contaminants. Byron Power Company is near the proposed water treatment and storage tanks at 4901 Bruns Road in Byron. This site was a former power plant. Petroleum hydrocarbons were detected in soil samples collected in areas of the facility. Remedial excavations were conducted at the site, and the case was closed on May 20, 2014. Because remediation was completed at this site, it is not expected that project activities at this location would expose workers or the public to contaminants.

The Stockton Naval Communication Station is listed as a state Response Site and is part of a former naval base and firing range with various soil and groundwater contaminants, including organochlorine pesticides (e.g., DDT) and petroleum hydrocarbons. To expedite reuse of the property and to comply with environmental cleanup requirements, the site has completed an Environmental Baseline Survey. Remediation, however, is ongoing, and this site is listed as active as of April 2020. This site is within the project footprint for SCADA fiber routes on Rough and Ready Island. If project construction in this area involves ground disturbance, workers could be exposed to contaminants in the soil.

Conclusion

The potential for construction activities to encounter hazardous materials at a Cortese List site is increased where remediation has not been completed or verified. The following four sites within or near the project footprint have the potential to expose workers and the public to hazardous materials.

- Southern Pacific Pipeline Shell and KMEP Petroleum Pipeline sites in the eastern alignment for Alternatives 3, 4a, 4b, and 4c.
- Chevron, Holey-Byron Road, Chevron Old Valley Pipeline, and the Chevron Bruns Property site in the Southern Complex for Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c.
- Chevron Bruns Property site in the South Delta Conveyance/Southern Complex for Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c.
- Stockton Naval Communication Station site in the Bethany Reservoir alignment for Alternative 5.

Except for the West Tracy Fault and Bethany Fault studies, field investigations for project construction would occur within 0.25 mile of the footprints of the individual alternatives. The West Tracy Fault study would involve trenching along five fault trench lines running from the southeast of Byron to the southeast of the Clifton Court Forebay. This area was included as part of the study area for hazards and hazardous materials, including Cortese List sites. Therefore, the potential for field investigations to encounter hazardous materials at a Cortese List site is the same as under project construction. The Bethany Fault study is primarily a Cone Penetration Test study.

Operations and Maintenance

Operation and maintenance under all project alternatives would occur within the same footprint as construction. Project operations and maintenance activities would occur after identified Cortese List sites were evaluated and, if needed, remediated. Therefore, the risk to expose workers, the public, or environment to hazardous materials from a known Cortese List site is low.

CEQA Conclusion—All Project Alternatives

The project alternatives would construct facilities on or near known Cortese List sites. Ground-disturbing activities and dewatering at or near sites that have not been fully remediated could expose workers and the public to contaminated soil and/or groundwater resulting in adverse health effects. The potential for exposure during construction would be a significant impact because of the proximity of these sites to project alternatives and the potential for hazardous materials exposure during site excavation and grading. Operations and maintenance activities at project alternatives

would not result in employee exposure because a plan (e.g., Environmental Site Assessment) for remediating hazardous sites would be implemented prior to project operations.

For all alternatives, Mitigation Measure HAZ-2: *Perform a Phase I Environmental Site Assessment Prior to Construction Activities and Remediate* would reduce the potential for significant impacts to a less-than-significant level by requiring preconstruction investigations and remediation to reduce the potential for encountering contaminants and other hazardous materials at construction sites.

Mitigation Measure HAZ-2: Perform a Phase I Environmental Site Assessment Prior to Construction Activities and Remediate

See description of Mitigation Measure HAZ-2 under Impact HAZ-2.

Mitigation Impacts

Compensatory Mitigation

Compensatory mitigation would result in the creation of wetlands and other habitats on Boudin Island, the I-5 ponds (Ponds 6, 7, 8), and tidal wetland and channel margin habitat in the North Delta Arc, as described in Appendix 3F. Although the CMP does not act as mitigation for hazards, hazardous materials, and wildfire impacts from project construction or operations, its implementation could result in hazards, hazardous materials, and wildfire impacts.

One Cortese List site designated as a LUST site (Willow Berm Marina) is within 0.25 mile of the compensatory mitigation. Willow Berm Marina is in Isleton, adjacent to Boudin Island. Records indicate aquifer contamination at this location resulted from a gasoline leak at an underground storage tank. Remediation at the site was completed and the case closed in 2011. Because remediation activities were completed, the site is not expected to expose workers or the public to soil or groundwater contamination as a result of compensatory mitigation construction, operations, or maintenance. Therefore, the combined impact of project alternatives and CMP implementation would not change the overall impact conclusion of less than significant with mitigation.

Other Mitigation Measures

The project alternatives would construct facilities on or near known Cortese List sites. Some other mitigation measures would involve the use of heavy equipment such as excavators and dozers that would have the potential to expose workers and the public to contaminated soil and/or groundwater from a known Cortese List site. The other mitigation measures with potential to expose workers and the public to contaminated soil and/or groundwater are: Mitigation Measures BIO-2c: *Electrical Power Line Support Placement*; AG-3: *Replacement or Relocation of Affected Infrastructure Supporting Agricultural Properties*; AES-1c: *Implement Best Management Practices in Project Landscaping Plan*; and AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP Operational Pumping Emissions to Net Zero*. Temporary exposure of workers and the public to contaminated soil and/or groundwater resulting from mitigation measures would be similar to construction effects of the project alternatives in certain construction areas and would contribute to exposing workers and the public to contaminated soil and/or groundwater impacts of the project alternatives thereby resulting in a significant impact. However, Mitigation Measure HAZ-2: *Perform a Phase I Environmental Site Assessment Prior to Construction Activities and Remediate* would reduce potential impacts by requiring preconstruction investigations and remediation to reduce the potential for encountering contaminants and other

hazardous materials at construction sites. Therefore, other mitigation measures are unlikely to expose workers and the public to contaminated soil and/or groundwater from a known Cortese List site, and the impact of hazardous materials exposure would be less than significant with mitigation.

Overall, the impact of exposing workers and the public to contaminated soil and/or groundwater from a known Cortese List site for construction of compensatory mitigation and other mitigation measures, combined with project alternatives, would not change the less than significant with mitigation impact conclusion.

Impact HAZ-5: Result in a Safety Hazard Associated with an Airport or Private Airstrip

All Project Alternatives

Impacts under all nine project alternatives (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) described in Chapter 3 would be similar and are discussed together.

Project Construction, Operations, and Maintenance

Airspace safety hazards occur when project components, such as buildings or construction equipment, encroach on the airspace of an airport runway. Federal law requires that the FAA determine whether a structure that is proposed to be built or altered 200 feet above ground level or higher, or near an airport, poses a hazard to the airspace (Federal Aviation Administration 2015).

In addition, under 14 CFR Part 77, the FAA requires project proponents to inform them about proposed construction or alteration of objects within 20,000 feet of a public-use or military runway and having a height exceeding a 100:1 imaginary surface (1 foot upward per 100 feet horizontally) beginning at the nearest point of the runway for runways greater than 3,200 feet in length. For shorter public-use or military runways, the notification surface has a 50:1 slope and extends 10,000 feet from the runway. Notice must be provided for temporary objects such as construction cranes and any permanent facility or object more than 200 feet in height above ground level or above the established airport elevation. Upon FAA evaluation of the effects of the proposed object on air navigation, an aeronautical study (Obstruction Evaluation/Airport Airspace Analysis [OE/AAA]) would be prepared by the FAA and indicate whether the project would have an impact on air safety.

As described in the *State Aeronautics Act*, Caltrans requires notification for proposed construction of any state building or enclosure within two miles of any airport before an agency acquires title to the property for the building or enclosure or for an addition to an existing site (Public Util. Code § 21655). Caltrans would respond with a written investigation report of the proposed site and provide recommendations, as necessary, to reduce potential hazards to air navigation.

No aspect of the project under any alternative would require equipment that would exceed 200 feet in height. The tallest equipment used during construction would be cranes. Mobile cranes would be used to load and unload intake features, are approximately 15 feet tall, and would include a 100-foot-long boom. During operation and maintenance, no structures would be tall enough to impede aircraft use of runways. Gantry cranes used to move equipment during maintenance procedures would be approximately 25 feet tall, reaching a total height of 75 feet when placed on other structures (e.g., intake structure). Neither type of crane is tall enough to interfere with airplanes or their airspace. The tallest permanent facilities would be the intakes, which would be approximately 21 to 28 feet from top of the river's water surface to the top of the structure's deck. As such, no permanent project structures would impede airspace.

1 As discussed in Section 25.3.1, *Methods for Analysis*, 11 public and private airports/heliports are
2 within 2 miles of project facilities (Figure 25-5). Six of these airports are within 2 miles of proposed
3 access roads and SCADA fiber optic routes: Funny Farm Airport and Las Serpientes Airport (central
4 alignment Alternatives 1, 2a, 2b, and 2c); Lodi Memorial Hospital Heliport and Kingdon Airpark
5 (eastern alignment Alternatives 3, 4a, 4b, and 4c); and Kaiser Permanente South Sacramento
6 Heliport and the Borges-Clarksburg Airport (all project alternatives).

7 Flying B Ranch Airport is 0.64 mile east of a proposed utility line and 1.06 miles west of a SCADA
8 fiber optic route along all alternatives (SCADA underground fiber optic route along the central
9 alignment and utility line [to be added to existing lines] along the eastern alignment and Bethany
10 Reservoir alignment). However, DWR would coordinate with Flying B Ranch Airport prior to
11 initiating construction to determine if transmission line stringing could interfere with airport
12 operations.

13 Franklin Field is approximately 0.8 mile east of the Twin Cities Complex under all project
14 alternatives. The project alternatives would comply with the policies in the Franklin Field
15 Comprehensive Land Use Plan (Sacramento Area Council of Governments 1988). The plan
16 designates different land use and development policies based on proximity to the airport within
17 three safety zones: a Clear Zone that covers the runway and extends outward 1,000 feet from the
18 ends; an Approach/Departure Zone located under the takeoff and landing slopes; and an Overflight
19 Zone that generally coincides with normal air traffic patterns. Project components in the vicinity of
20 the safety zones include intakes, launch shaft, access roads, underground utilities, and rail spur.
21 DWR would coordinate with Sacramento County prior to initiating construction to determine if the
22 project could interfere with airport land uses.

23 Lost Isle Seaplane Base is within 1.4 miles west of proposed tunnels of the eastern alignment
24 (Alternatives 3, 4a, 4b, and 4c) and Bethany Reservoir alignment (Alternative 5). Heritage Field is
25 1.3 miles west of proposed levee improvements of the eastern alignment (Alternatives 3, 4a, 4b, and
26 4c) and Bethany Reservoir alignment (Alternative 5). Construction, operations, and maintenance
27 would not include equipment or structures that would have the potential to interfere with the
28 airspace of these airports.

29 Byron Airport is within 1 mile of the Southern Complex under Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b,
30 and 4c, as well as a proposed access road and a SCADA fiber optic route. Similarly, project
31 components do not include structures or equipment over 200 feet tall. However, the Southern
32 Complex is within the Byron Airport influence area in Compatibility Zones including a Height
33 Exception Overlay Zone (County of Contra Costa 2000:4–12). Policies regarding these zones
34 stipulate consultation with and review by the Contra Costa Airport Land Use Commission for any
35 proposed object taller than 100 feet. Construction of structures more than 100 feet above ground
36 level within the airport influence zones could cause an obstruction or hazard to air navigation.

37 DWR would coordinate with Contra Costa Airport Land Use Commission prior to initiating
38 construction and comply with its recommendations based on its investigations and with the
39 recommendations of the Obstruction Evaluation/Airport Airspace Analysis for Byron Airport. These
40 recommendations, which could include limitations necessary to minimize potential problems such
41 as the use of temporary construction equipment, supplemental notice requirements, and marking
42 and lighting high-profile structures, would reduce the potential for impacts on the Byron Airport.
43 Recommendations to avoid conflicts with existing airports located near construction areas would be
44 implemented prior to construction. Field investigations for project construction would occur

1 primarily within the footprint of the individual alternative and would not include structures that
2 would impede airspace. Likewise, the West Tracy Fault study involves trenching and would not
3 interfere with airspace. Helicopters could be used to facilitate surveys but would operate under all
4 applicable FAA regulations, thereby reducing the potential for airspace interference. Field
5 investigations would not result in a safety hazard involving airports.

6 The Southern Complex includes the Southern Forebay with a water surface of approximately 750
7 acres. Located northwest of the existing Clifton Court Forebay, the addition of a large waterbody
8 could become a bird attractant. More birds near the Byron Airport could increase the possibility of
9 airplane-bird strikes. Although most bird strikes do not result in significant damage to airplanes or
10 their passengers, large birds can get sucked into airplane engines, causing significant damage and
11 sometimes even causing a crash.

12 The combination of open water and vegetation is particularly attractive to waterfowl. Nearby
13 waterbodies in the Delta, such as the Clifton Court Forebay, sloughs and rivers, and wildlife refuges,
14 already attract ducks, gulls, and other waterbirds to the area, especially in the winter months.
15 Generally, these birds are foraging and roosting on the water, not flying in large flocks. It is not likely
16 that the addition of the Southern Forebay would cause a substantial increase of birds in the area.
17 Birds would not necessarily be drawn westward to the proposed forebay because other aquatic
18 roosting habitat would be to the east and foraging habitat located in uplands. Also, the forebay
19 would not contain fish, and the depth of the forebay along with maintenance activities, including
20 biannual removal of aquatic vegetation, would limit suitability of habitat for waterfowl. Periodic
21 removal of roosting materials for structures near the Byron Airport (e.g., outlet structure, control
22 structure) would also reduce the likelihood of birds gathering in the forebay during nesting season.
23 Lastly, bird strikes do not appear to be a significant issue at Byron Airport, according to the FAA
24 Wildlife Strike Database. Since 1990, one bird strike, resulting in no damage, was reported in 2017
25 at Byron Airport (Federal Aviation Administration 2022).

- 26 • The FAA identifies activities such as agriculture, landfills, or large waterbodies as potential
27 wildlife attractants and cautions that considerations should be given as to whether a proposed
28 land use would increase wildlife hazards. For airports serving turbine-powered aircraft (such as
29 Byron Airport) the FAA AC 150/5200-33C recommends a 10,000-foot (1.89-mile) separation
30 distance between hazardous wildlife attractants and the nearest airport operations area. The
31 proposed Southern Forebay is located approximately 1.78 miles (9,398 feet) from the Byron
32 Airport runway and within Zones B1, B2, C1, and D as designated by the Contra Costa Airport
33 Land Use Commission. FAA AC 150/5200-33C suggests the airport prepare a Wildlife Hazard
34 Assessment for FAA review. If FAA determines a hazard risk may be present as a result of the
35 project, per FAA direction, a Wildlife Hazards Management Plan (WHMP) could be prepared for
36 the airport to evaluate the risks associated with the project. The plan would include an
37 assessment methodology prepared in accordance with FAA Advisory Circular 150/5200-38,
38 *Protocol for the Conduct and Review of Wildlife Hazard Site Visits, Wildlife Hazard Assessments,*
39 *and Wildlife Hazard Management Plans* and appropriate measures to eliminate the hazard risk
40 and would be developed in consultation with DWR. Title 14 CFR Section 139.337 (“Wildlife
41 hazard management”) defines requirements for the preparation and implementation of wildlife
42 hazard management protocols and plans. Some specific requirements include: The wildlife
43 hazard assessment must be conducted by a wildlife damage management biologist who has
44 professional training and/or experience in wildlife hazard management at airports or an
45 individual working under direct supervision of such an individual.

- 1 • The wildlife hazard assessment must contain, in part:
 - 2 ○ An analysis of the events or circumstances that prompted the assessment.
 - 3 ○ Identification of the wildlife species observed and their numbers, locations, local
 - 4 movements, and daily and seasonal occurrences.
 - 5 ○ Identification and location of features on and near the airport that attract wildlife.
 - 6 ○ A description of wildlife hazards to air carrier operations.
 - 7 ○ Recommended actions for reducing identified wildlife hazards to air carrier operations.

8 ***CEQA Conclusion—All Project Alternatives***

9 Airspace safety hazards occur when project components, such as buildings or construction
10 equipment, encroach on the airspace of an airport runway. The locations of airports within 2 miles
11 of the project are shown on Figure 25-5. Eleven airports are within 2 miles of the construction
12 footprint. No aspect of the project under any alternative would include equipment or structures that
13 would be taller than 200 feet. Also pursuant to the State Aeronautics Act, DWR would adhere to FAA
14 and Caltrans recommendations and comply with the recommendations of the OE/AAA.

15 In areas where the project intersects with the Byron Airport influence area, construction of
16 structures more than 100 feet above ground level could cause an obstruction or hazard to air
17 navigation. However, construction would not introduce equipment or temporary structures in
18 locations that could obstruct an airport or conflict with airport land uses. In addition, consultation
19 with the Contra Costa Airport Land Use Commission would ensure that potential impacts of airspace
20 interference would be reduced. As such, impacts on airports within 2 miles of the construction
21 footprint due to construction of any of the project alternatives would be less than significant.

22 Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c would include construction of the Southern Forebay,
23 which, under operation, could serve as a bird attractant and might increase hazards to aircraft from
24 birds flying in the area and colliding with aircraft. This potential effect is considered a significant
25 impact because of the proximity of the proposed forebay to an existing airport and the potential for
26 it to attract waterfowl and other birds.

27 However, nearby waterbodies in the Delta already attract birds to the area and the addition of the
28 forebay would not necessarily increase the number of birds relative to baseline conditions and bird
29 strikes are not currently an issue at Byron Airport (Federal Aviation Administration 2022).
30 Landscaping and ground cover around the forebay and within the project boundary would be
31 maintained so as to minimize attractants to wildlife. This would decrease the potential for food
32 sources, resting areas, and the creation of cover for wildlife species that could be a hazard to
33 aviation. Other bird-deterrent measures, such as mechanical removal of vegetation from the interior
34 and exterior embankments of the forebay, would be conducted quarterly and would reduce the use
35 of the forebay by birds near Byron Airport. Lastly, Mitigation Measure HAZ-5: *Wildlife Hazards*
36 *Management Plan and Wildlife Deterrents (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c)* would reduce this
37 impact from significant to less than significant by requiring consultation with the Contra Costa
38 Airport Land Use Commission and, if deemed necessary, preparation of a WHMP by the Byron
39 Airport, and implementation of wildlife deterrent measures within the project footprint to reduce,
40 minimize, and/or avoid wildlife hazards on air safety.

Mitigation Measure HAZ-5: Wildlife Hazards Management Plan and Wildlife Deterrents

Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c

1. The FAA requires public service airports to maintain a safe operation, including conducting hazard assessments for wildlife attractants within 5 miles of an airport. The hazard assessment is submitted to FAA, which determines if the airport needs to develop a Wildlife Hazard Management Plan (15 CFR Part 139). The airport's Wildlife Hazard Management Plan contains measures to reduce wildlife hazards, including habitat modification (e.g., vegetation management, filling in of wetlands), wildlife control measures (e.g., harassment, trapping and removing), and use of a radar-based alert system.
- a. DWR will consult with the Contra Costa Airport Land Use Commission during the project-level environmental assessments, when site-specific locations and design plans are finalized. At that time, appropriate management plans, strategies, and protocols will be developed to reduce, minimize, and/or avoid wildlife hazards on air safety. Wildlife deterrent measures to be used to reduce, minimize, and/or avoid wildlife hazards will include one or more physical, mechanical, visual, or biological devices and features to deter avian wildlife attraction to the Southern Forebay.
- b. DWR will incorporate the following wildlife (specifically bird) deterrents:
 - i. Conduct periodic (e.g., biannual) removal of roosting/nesting materials from DWR-managed structures within 5 miles of the Byron Airport.

Nonmigratory birds, left undisturbed, will establish territories on building roofs, ledges, and open girders associated with nearby waterbodies such as the Southern Forebay. Techniques to exclude birds from the area will be incorporated into final project design. Examples include anti-perching devices (spikes or other obstructions) installed on ledges, roof peaks, rafters, signs, posts, and other roosting and perching areas; netting and wire can also be used for larger areas.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for hazards, hazardous materials, and wildfire impacts from project construction or operations, its implementation could result in hazards, hazardous materials, and wildfire impacts.

Because there are no airports within 2 miles of the compensatory mitigation sites, compensatory mitigation would not affect airports operations. No impact would occur. Therefore, the combined impact of the CMP and Alternative 5 would not change the Alternative 5 impact conclusion of less than significant. The impact of Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c combined with the impact of the CMP would be the same as the impacts of those alternatives alone and would not change the overall impact conclusion of less than significant with mitigation.

Other Mitigation Measures

Other mitigation measures proposed would not have impacts on safety hazards associated with an airport because no mitigation measures would introduce equipment or temporary structures in locations that could obstruct an airport or conflict with airport land uses in the area where the

project alternatives would be constructed or operated. Therefore, other mitigation measures is unlikely to result in a safety hazard associated with an airport, and there would be no impact.

Overall, safety hazards associated with an airport for construction of compensatory mitigation and other mitigation measures, combined with project alternatives, would not change the impact conclusion for Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, and 4c of less than significant with mitigation and would not change the impact conclusion for Alternative 5 of less than significant.

Impact HAZ-6: Impair Implementation of or Physically Interfere with an Adopted Emergency Response Plan or Emergency Evacuation Plan

All Project Alternatives

The potential impacts under all nine project alternatives (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) would be similar and are discussed together.

Project Construction

As discussed above under Section 25.1.4, *Evacuation and Emergency Routes*, each local jurisdiction in the study area has policies, regulations, and plans related to emergency response and evacuation. Local emergency response plans identify specific routes for emergency evacuations. Generally, construction of any project alternative could result in short-term, temporary traffic delays on existing roads used to access project facilities and infrastructure, and consequently, could potentially interfere with implementation of an emergency response plan and delay emergency responders.

Under all project alternatives, transportation facility improvements are provided to serve the construction and material delivery processes. Access roads would be constructed to serve the project alternatives, which would help alleviate traffic congestion on existing roads in the study area. Access road activities would involve widening and improving roads, constructing new roads and bridges, and widening bridges. See Chapter 3 for assumptions regarding access roads to construction sites. These assumptions include restricting project traffic on many heavily used roadways for each key feature to reduce construction traffic on local roadways.

As described in Chapter 3, emergency response facilities would be located at each intake and launch shaft construction site, and at the Southern Complex (for central and eastern alignment alternatives) and Bethany Complex (Alternative 5). Resources would include a full-time crew and a helipad for emergency evacuations. Intakes would also have a rescue boat. These facilities would help reduce the burden on local emergency providers.

Except for the West Tracy Fault and Bethany Fault studies, field investigations for project construction would occur within the facility footprint of project alternatives and along tunnel alignments and not substantially conflict with emergency response plans. The West Tracy Fault study would involve trenching along a line running from southeast of Byron to southeast of the Clifton Court Forebay and not directly conflict with emergency plans and evacuation routes. Therefore, impacts on emergency plans and evacuation routes from the project alternative facilities would be similar to, but of lower magnitude than, the West Tracy Fault study. The Bethany Fault study is primarily a Cone Penetration Test study.

Operations and Maintenance

During operations and maintenance, all construction work would be completed, and the project alternatives would not impair or interfere with any adopted emergency response or evacuation plans. Generally, these activities would involve employees commuting to facilities daily, annually, or as-needed for the life of the facilities. Operation and maintenance of facilities under all project alternatives could increase traffic on local roads to facilities when regular and routine tasks are scheduled. However, these activities would be spread over 24 hours and consist of a relatively low number of individuals with few vehicles and equipment; therefore, they would not likely affect emergency access or evacuation routes. In addition, operations and maintenance of the project alternatives would not result in the average vehicle miles traveled (VMT) per operation and maintenance employee to exceed the regional average of 22.5 miles on a daily basis.

CEQA Conclusion—All Project Alternatives

Construction under all project alternatives could result in short-term, temporary traffic delays potentially interfering with implementation of an emergency response plan and delaying emergency responders. This could significantly impact emergency response plans or routes during the multi-year construction period. As stated in Chapter 20, access to and from the project alternatives would be designed to meet local and regional emergency access requirements, including procedures for construction area evacuation in the case of an emergency. Therefore, this impact is considered to be significant because construction-related traffic would increase traffic volumes on local roadways, potentially impacting emergency evacuation routes.

During operations and maintenance, after all construction work is complete, the project would not impair or interfere with any adopted emergency response or evacuation plans. Under all project alternatives, operations and maintenance of the project would not result in the average VMT per operation and maintenance employee to exceed the regional average of 22.5 miles on a daily basis. However, operations would involve additional truck traffic and transportation of materials, as compared to current conditions, that could increase roadway traffic. This would be a significant impact.

As identified in Chapter 20, Mitigation Measure TRANS-1: *Implement Site-Specific Construction Transportation Demand Management Plan and Transportation Management Plan* requires preparation and implementation of a Transportation Demand Management Plan that addresses specific steps (e.g., signage, notifications, flaggers) to be taken before, during, and after construction to minimize traffic impacts, limit hours of construction, and make good-faith efforts to enter into mitigation agreements with affected state, regional, or local agencies.

With Mitigation Measure TRANS-1, additional evaluations and discussions with local agencies would be required during the design phase to determine the most appropriate method to coordinate between project-provided emergency response services at the construction sites and integration with local agencies. Because project construction would not take place without a Transportation Demand Management Plan and good-faith coordination with local agencies on appropriate emergency response services, impacts from construction or operations and maintenance of any of the alternatives would be reduced to less than significant with mitigation.

Mitigation Measure TRANS-1: Implement Site-Specific Construction Transportation Demand Management Plan and Transportation Management Plan

See description of Mitigation Measure TRANS-1 under Impact TRANS-1 in Chapter 20, *Transportation*.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for hazards, hazardous materials, and wildfire impacts from project construction or operations, its implementation could result in hazards, hazardous materials, and wildfire impacts.

Compensatory mitigation (Appendix 3F) would occur on Bouldin Island, at three ponds along I-5 (Ponds 6, 7, and 8), and within the North Delta Arc. Construction of the compensatory mitigation would consist of breaching levees, local grading, and inundation of the locations. Operation of the compensatory mitigation areas would entail ongoing vegetation and water management to disk vegetation, excavate sediment, and repair berms and water control structures. The potential impact with respect to emergency plan and evacuation routes would be construction interference with roadways near the compensatory mitigation sites. However, the number of personnel and equipment required for compensatory mitigation would not be enough to impair emergency access. Early coordination with local jurisdictions and compliance with all local plans pertaining to emergency evacuations at the compensatory mitigation sites would also occur.

While the number of personnel and equipment required for these occasional activities would not be enough to impair emergency access, compensatory mitigation, together with the project, could result in short-term, temporary traffic delays potentially interfering with implementation of an emergency response plan and delaying emergency responders. This would be a significant impact.

However, Mitigation Measure TRANS-1 would require additional evaluations and discussions with local agencies during the design phase to determine the most appropriate method to coordinate between project-provided emergency response services at the construction sites and integration with local agencies. Therefore, impacts of project alternatives combined with CMP implementation would not change the overall impact conclusion of less than significant with mitigation.

Other Mitigation Measures

Some mitigation measures would involve the use of heavy equipment such as graders, excavators, dozers, and haul trucks that would have the potential to increase construction-related traffic volumes on local roadways, potentially impacting emergency evacuation routes. The mitigation measures with potential to result in increased construction-related traffic and emergency evacuation route impacts are Mitigation Measures BIO-2c: *Electrical Power Line Support Placement*; AG-3: *Replacement or Relocation of Affected Infrastructure Supporting Agricultural Properties*; AES-1c: *Implement Best Management Practices in Project Landscaping Plan*; CUL-1b: *Prepare and Implement a Built-Environment Treatment Plan in Consultation with Interested Parties*; and AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP Operational Pumping Emissions to Net Zero*. Temporary increases in traffic volumes impacting emergency evacuation routes resulting from mitigation measures would be similar to construction effects of the project alternatives in certain construction areas and would contribute to traffic

volumes on local roadways and emergency evacuation route impacts of the project alternatives. Mitigation Measure TRANS-1: *Implement Site-Specific Construction Transportation Demand Management Plan and Transportation Management Plan* would minimize traffic impacts, limit hours of construction, and make good-faith efforts to enter into mitigation agreements with affected state, regional, or local agencies. Therefore, other mitigation measures are unlikely to impair or interfere with an emergency response plan or emergency evacuation plan, and the impact of emergency response would be less than significant with mitigation.

Overall, impairment of an emergency response plan or emergency evacuation plan impacts for construction of compensatory mitigation and other mitigation measures, combined with project alternatives, would not change the less than significant with mitigation impact conclusion.

Impact HAZ-7: Expose People or Structures, Either Directly or Indirectly, to a Substantial Risk of Loss, Injury, or Death Involving Wildland Fires

All Project Alternatives

This section addresses impacts associated with the potential for all project alternatives to expose people or structures to wildland fires. Under all of the alternatives (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5), the risk of wildland fire is similar. The magnitude of these risks could differ depending on the longer construction duration of some project alternatives (Alternatives 2a, 3, 4a, 4b, and 5). The nature of potential impacts under all nine project alternatives is similar and discussed together.

Project Construction

Human activities are the primary reason wildfires start, although lightning strikes do occasionally start wildfires. Project construction would involve the use of heavy equipment, welding, and other activities that have the potential to ignite fires. Construction of any one of the project alternatives (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5), including field investigations, would involve the presence of personnel and equipment, both of which could inadvertently start a fire. The probability of starting a fire would be greater under Alternatives 2a, 3, 4a, 4b, 4c, and 5 because construction of these alternatives would take 1 to 2 years longer to complete than Alternatives 1, 2b, and 2c; thereby, they would require the presence of personnel and equipment for a longer duration (Table 25-2).

Table 25-2. Construction Durations

Construction Duration	12 years	13 years	14 years
Alternative(s)	1, 2c	2a, 2b, 3, 4b, 4c, 5	4a

As discussed above, peat is found throughout the study area, particularly along the central and eastern alignments (Figure 11-2), and the study area is at risk for peat fires. As noted above, peat consists of partially decayed wetland vegetation (tule) that has built up and when ignited it can cause fires that are particularly difficult to handle compared to fires fueled by trees or grass. Peat fires are usually started by forest or grassland fires or on rare occasions, by lightning strikes. See Impact HAZ-2 for a discussion of gas accumulation in tunnels.

No portion of the project would be located in or near an area designated as a High or Very High Fire Hazard Severity Zone (Figure 25-4). Although there are heat sources (e.g., construction equipment,

vehicles) that would be present during project construction, standard BMPs (e.g., spark arrestors for vehicles in high grass, no smoking zones) would reduce the potential for a fire to start. Additionally, as described in Chapter 3, emergency response facilities would include fire, rescue, medical equipment, a helipad, and trained emergency personnel at main construction sites (intakes, tunnel launch shaft sites, and the Southern Complex [for central and eastern alignment alternatives] and Bethany Complex [Alternative 5]).

Operations and Maintenance

Project operations and facility maintenance of any one of the alternatives (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) would consist of activities such as painting, cleaning, repairs, and other routine tasks. Some of these activities would involve the use of flammable chemicals, such as fuels and solvents, which could be inadvertently ignited by sparks from equipment/machinery if proper safety measures were not employed. During project operation, however, fewer personnel and equipment would be on-site, thereby lowering the potential for fire. Also, the project would comply with all pertinent fire prevention laws and regulations including Cal/OSHA fire prevention and safety standards.

CEQA Conclusion—All Project Alternatives

Construction of any one of the project alternatives (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5), including field investigations, would involve the presence of personnel and equipment, both of which could inadvertently cause a fire (e.g., smoking, sparks from equipment). However, no portion of the project is in or near an area designated as a High or Very High Fire Hazard Severity Zone. To further prevent the potential for fire, emergency response facilities would be on-site and include a fire truck and full-time crew located at each intake and launch shaft construction site and at the Southern Complex (for central and eastern alignment alternatives) and Bethany Complex (Alternative 5). This impact would be less than significant because conditions do not exist near the project that would result in exposure of people or structures to significant risk of exposure to wildfire, and standard fire safety and prevention measures would be implemented.

Operations and maintenance involve equipment and personnel that could inadvertently start a fire. Project operation could also involve the use of flammable materials such as fuels and solvents, which could be inadvertently ignited by sparks from equipment or machinery. However, use of flammable materials would comply with regulations enforced by CUPAs and Cal/OSHA. In addition, all standard fire safety and prevention measures would be implemented.

Compliance with applicable laws and regulations regarding fire prevention and safety and Environmental Commitment EC-5: *Develop and Implement a Fire Prevention and Control Plan* would include provisions such as consultation with fire agencies, spark arrestors on construction equipment, and maintaining appropriate fire suppression equipment to further reduce impacts related to wildland fires. The potential for the project and field investigations to expose people or structures to a substantial risk of wildland fire would be less than significant.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for hazards, hazardous materials, and wildfire impacts from project construction or operations, its implementation could result in hazards, hazardous materials, and wildfire impacts.

Construction of compensatory mitigation (on Bouladin Island, the three ponds along I-5 (Ponds 6, 7, and 8), and within the North Delta Arc, as described in Appendix 3F) would involve the presence of personnel equipment and vehicles, all of which could inadvertently spark a fire. However, no portion of the project or compensatory mitigation area is in or near an area designated as a High or Very High Fire Hazard Severity Zone. Emergency response facilities would be on-site and include a fire truck and full-time crew located at each intake and launch shaft construction site and at the Southern Complex (for central and eastern alignment alternatives) or Bethany Complex (Alternative 5). Finally, standard BMPs (e.g., spark arrestors for vehicles in high grass, no smoking zones) and compliance with applicable laws and regulations regarding fire prevention and safety would reduce the potential for wildland fires. Therefore, the potential for the project, combined with compensatory mitigation, to expose people or structures to a substantial risk of wildland fire would not change the overall impact conclusion of less than significant.

Other Mitigation Measures

Some mitigation measures would involve the presence of personnel equipment and vehicles that would have the potential to inadvertently spark a fire. The mitigation measures with potential to result in increased exposure of people or structures to wildfire risk are Mitigation Measures BIO-2c: *Electrical Power Line Support Placement*; AG-3: *Replacement or Relocation of Affected Infrastructure Supporting Agricultural Properties*; AES-1c: *Implement Best Management Practices in Project Landscaping Plan*; CUL-1b: *Prepare and Implement a Built-Environment Treatment Plan in Consultation with Interested Parties*; and AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP Operational Pumping Emissions to Net Zero*. Temporary increases in the risk of fires resulting from mitigation measures would be similar to construction effects of the project alternatives in certain construction areas and would contribute to fire risk impacts of the project alternatives. However, no portion of the project is in or near an area designated as a High or Very High Fire Hazard Severity Zone. To further prevent the potential for fire, emergency response facilities would be on-site. Conditions do not exist near the project that would result in exposure of people or structures to substantial risk of exposure to wildfire, and standard fire safety and prevention measures would be implemented. Therefore, other mitigation measures are unlikely to expose people or structures to a substantial fire risk and the impact of fire risk would be less than significant.

Overall, increased fire risk impacts for construction of compensatory mitigation and other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant.

25.3.4 Cumulative Analysis

This cumulative impact analysis considers past, present, and probable future projects in the study area that could affect the same resources and, where relevant, occur within the same timeframe as

the project alternatives. The cumulative geographical context for hazards and hazardous materials is the Delta. In general, a project's potential impacts related to hazards are individual and localized, depending on activities occurring at the project site and in proximity to hazardous facilities.

When the effects of the project alternatives and compensatory mitigation are considered in combination with the effects of the projects listed in Table 25-3, the cumulative impacts on hazards, hazardous materials, and wildfire are potentially significant. Table 25-3 identifies past, present, and probable future projects relating to cumulative hazards and hazardous materials impacts that are outside of DWR's control. For a description of each jurisdiction's general plan, see Appendix 3C.

Table 25-3. Cumulative Impacts on Hazards, Hazardous Materials, and Wildfire from Plans, Policies, and Programs

Program/Project	Agency	Status	Description of Program/Project	Impacts on Hazards, Hazardous Materials, and Wildfire
Lower Mokelumne River Spawning Habitat Improvement Project	EBMUD	Ongoing	Placement of 4,000 to 5,000 cubic yards of salmonid spawning gravel annually for a 3-year period at two specific sites, and then annual supplementation of 600 to 1,000 cubic yards thereafter.	Hazardous material impacts associated with the use of chemicals, such as diesel fuel and oil in machinery during construction. Wildfire impacts due to increased presence of construction personnel.
Lookout Slough Tidal Habitat Restoration Project	DWR and Ecosystem Investment Partners	DWR certified EIR November 2020	Tidal restoration project located in the Cache Slough area of the Delta northwest of Liberty Island. Project goals are to restore approximately 3,400-acre site to a tidal wetland, creating habitat and producing food for delta smelt and other listed fish species.	Hazardous material impacts associated with the use of chemicals, such as diesel fuel and oil in machinery during construction. Wildfire impacts due to increased presence of construction personnel.
Lower Yolo Ranch Restoration Project	DWR and SFCWA	Ongoing	Project is near Liberty Island in the Delta and would restore about 1,670 acres on a site that has historically been used for pasture/cattle grazing.	Hazardous material impacts associated with the use of chemicals, such as diesel fuel and oil in machinery during construction. Wildfire impacts due to increased presence of construction personnel.
Lower Cache Creek/Woodland Flood Risk Management Project	City of Woodland, USACE, DWR, CVFPB	Ongoing	Project would identify and implement flood-risk-reduction measures to meet the state's urban level of protection requirements. Project components include secondary earthen levees and diversion channel to redirect overland flood flows into the Yolo Bypass, modification of the Cache Creek Settling Basin to allow conveyance of flood flows into the Yolo Bypass, and various bridge and/or culvert improvements to facilitate conveyance of flood flows in the diversion channel.	Hazardous material impacts associated with the use of chemicals, such as diesel fuel and oil in machinery during construction. Wildfire impacts due to increased presence of construction personnel.

CDFW = California Department of Fish and Wildlife; DWR = California Department of Water Resources; EBMUD = East Bay Municipal Utility District; EIR = environmental impact report; SFCWA = State and Federal Contractors Water Agency; USACE = U.S. Army Corps of Engineers; CVFPB = Central Valley Flood Protection Board.

25.3.4.1 Cumulative Impacts of the No Project Alternative

The ongoing projects and programs in the Delta under the No Project Alternative, in addition to the cumulative projects, involve constructing new facilities or implementing restoration and habitat enhancement goals. SWP/CVP operations would require repair, maintenance, or protection of infrastructure such as levees and may also include actions for water quality management, habitat and species protection, and flood management. These actions require construction activity throughout the Delta and other areas of California and could potentially result in significant hazards to the public through the routine transport, use, or disposal of hazardous materials, or the release of hazardous materials into the environment. However, construction and operations/maintenance of these types of projects would include standard BMPs to reduce accidental spills and ensure proper handling, transport, and disposal of hazardous materials to reduce injury or risk to people and the environment. These projects would also adhere to existing regulations regarding the transport, disposal, and handling of hazardous materials and minimizing wildfires.

25.3.4.2 Cumulative Impacts of the Project Alternatives

Construction and operations/maintenance of projects often requires the use of heavy construction equipment, the operation and maintenance of which would involve the use and handling of hazardous materials, including diesel fuel, gasoline, lubricants, and solvents (Table 25-3). Simultaneous construction and operations and maintenance of the Delta Conveyance Project and other projects in the vicinity could potentially result in significant hazards to the public through the routine transport, use, or disposal of hazardous materials or the release of hazardous materials into the environment. However, impacts from minor spills or releases would be avoided by thoroughly cleaning up minor spills as soon as they occur. While foreseeable projects have the potential to cause similar impacts, it is assumed that these projects would also implement similar BMPs and follow all regulations regarding the transport, disposal, and handling of hazardous materials and wastes during construction. Furthermore, if the project results in the remediation of contaminated sites within the study area, conditions would improve. Accordingly, the combined effects of construction of the project alternatives with other projects in the vicinity would not result in a significant cumulative impact.

The Delta is at moderate risk for wildland fire hazards. Although the project alternatives and the cumulative projects would introduce new facilities and personnel in the study area, the project would not contribute to wildland fire risk because it would develop and implement a fire prevention and control plan that would further reduce the potential for impacts related to wildland fires. Additionally, existing regulations are in place to minimize fire hazards. These measures reduce fire risks associated with project construction and operations. Similar practices can be assumed for foreseeable projects in the study area. As such, any incremental contribution of the project alternatives to the cumulative conditions with regards to hazards, hazardous materials, and wildfire in the Delta would not be cumulatively considerable and would not result in a significant cumulative impact.

This chapter describes the environmental setting and study area for public health; analyzes impacts that could result from construction, operation, and maintenance of the project; and provides mitigation measures to reduce the effects of potentially significant impacts. This chapter also analyzes the impacts that could result from compensatory mitigation required for the project and describes any additional mitigation necessary to reduce those impacts, and analyzes the impacts that could result from other mitigation measures associated with other resource chapters in this Final Environmental Impact Report (EIR).

26.0 Summary Comparison of Alternatives

Table 26-0 provides a summary comparison of important impacts on public health by alternative. The table presents the CEQA finding after all mitigation is applied. If applicable, the table also presents quantitative results after all mitigation is applied. Important impacts to consider include increases in vector-borne diseases, substantial mobilization of or increases in chemical constituents known to bioaccumulate, and adverse effects on public health due to exposure of sensitive receptors to new sources of electromagnetic fields (EMF).

Table ES-2 in the Executive Summary provides a summary of all impacts disclosed in this chapter.

1 **Table 26-0. Comparison of Impacts on Public Health by Alternative**

Chapter 26 – Public Health	Alternative								
	1	2a	2b	2c	3	4a	4b	4c	5
Impact PH-1: Increase in Vector-Borne Diseases	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS
Impact PH-2: Exceedance(s) of Water Quality Criteria for Constituents of Concern Such That Drinking Water Quality May Be Affected	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS
Impact PH-3: Substantial Mobilization of or Increase in Constituents Known to Bioaccumulate	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS
Impact PH-4: Adversely Affect Public Health Due to Exposing Sensitive Receptors to New Sources of EMF	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS
Impact PH-5: Impact Public Health Due to an Increase in <i>Microcystis</i> Bloom Formation	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS

2 EMF = electromagnetic fields; LTS = less than significant.

26.1 Environmental Setting

This section describes the environmental setting and potential environmental impact area (study area) for public health. Specifically, this section summarizes existing conditions as they relate to specific drinking water constituents, the bioaccumulation of toxicants in aquatic resources, disease-carrying vectors, and EMF from Delta Conveyance Project transmission lines within the study area in the context of public health.

The discussion of drinking water constituents of concern includes disinfection byproducts, trace metals, and pesticides. Bioaccumulation concerns the uptake of toxicants into the tissues of fish and shellfish and has the potential to affect the health of those who consume fish and shellfish on a regular basis. The discussion of vectors concerns the spread of disease through mosquitoes. Although the California Public Utilities Commission (CPUC) does not currently recognize the potential adverse health impacts related to exposure to EMF generated by power transmission lines because no consistent link has been found, this chapter discusses the potential for adverse health effects associated with EMF exposure in relation to new transmission lines in the study area.

26.1.1 Study Area

For the purposes of the analysis in this chapter, the study area for public health as it relates to water quality and vector-borne disease consists of the statutory Sacramento–San Joaquin Delta (Delta). The statutory Delta includes parts of Yolo, Solano, Alameda, Contra Costa, San Joaquin, and Sacramento Counties. Potential public health impacts occurring as a result of implementing the project alternatives primarily would be localized. This chapter does not discuss public health water quality-related effects in the area upstream of the Delta because, as described in Chapter 9, *Water Quality*, the project alternatives would not affect surface water quality in the reservoirs and rivers upstream of the Delta. In addition, given downstream flows, potential health effects from water quality-related impacts would not be transported upstream. Potential drinking water impacts would occur first and most prominently in the study area because water is treated and distributed by water purveyors and districts after it is exported to other areas of the state. Potential spread of disease through mosquitoes is expected to occur only within the study area because of the life cycle of mosquitoes and the distance they travel. It is not expected that there would be significant impacts from vectors outside of the study area due to the project alternatives.

The study area for public health as it relates to vectors and EMF is generally the statutory Delta, where power transmission lines would be constructed. Where proposed power transmission lines are sited outside of the Delta, this area is considered as well.

26.1.1.1 Drinking Water

Water conveyed through the Delta and water from the Delta provide drinking water for two-thirds of California's population (Water Education Foundation 2022). Surface water and groundwater resources are both used to provide drinking water resources for populations in the study area, as well as throughout California.

Constituents of Concern

Constituents that are of concern in Delta waters are those that have the potential to directly or indirectly adversely affect or impair one or more of the Delta's beneficial uses related to drinking

water, species habitat, or recreational facilities by exceeding the water quality objectives intended to protect those beneficial uses. At high enough concentrations, these constituents can be directly harmful to human health if consumed. Constituents of concern, associated water quality objectives/criteria, and beneficial uses are discussed in detail in Chapter 9. The constituents of concern with regard to drinking water quality that are discussed in this impact analysis for public health include disinfection byproducts, non-bioaccumulative pesticides, and trace metals, which are all described below.

Disinfection Byproducts

Trihalomethanes (THMs) and haloacetic acids (HAAs) are chemicals that are formed along with other disinfection byproducts (DBPs) when chlorine or other disinfectants used to control microbial contaminants in drinking water react with naturally occurring organic and inorganic matter in water. THMs are chloroform, bromodichloromethane, dibromochloromethane, and bromoform. HAAs include monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid. The disinfection process for drinking water includes adding chlorine to drinking water sources prior to release into public drinking water distribution systems. The chlorine reacts with the organic carbon (total organic carbon and dissolved organic carbon [DOC]) and bromide that are in water sources and forms DBPs. Generally, if organic carbon is not chlorinated, or bromide is not present, the risk of DBP formation at drinking water plants is greatly reduced. Existing conditions for bromide and organic carbon in the study area are described in Chapter 9.

The U.S. Environmental Protection Agency (EPA) indicates that consumption of water containing relatively high levels of DBPs has been associated with bladder cancer and developmental effects in some studies (U.S. Environmental Protection Agency 2015:2). EPA developed the Stage 1 and Stage 2 Disinfectants and Disinfection Byproducts Rules to limit exposure to DBPs. Together, these rules establish maximum residual level goals and maximum residual levels for disinfectants; set maximum contaminant level goals and maximum contaminant levels for DBPs; and require of water systems that use surface water and conventional filtration treatment to remove specified percentages of organic materials.

Trace Metals

Trace metals occur naturally in the environment and can be toxic to human and aquatic life in high concentrations. Trace metals include aluminum, arsenic, cadmium, copper, iron, lead, nickel, silver, and zinc. The primary sources of trace metals to the Delta include acid mine drainage (e.g., zinc, cadmium, copper, lead) from abandoned and inactive mines (i.e., Iron Mountain and Spring Creek mines) in the Shasta watershed area, which enter the Sacramento River system through Shasta Lake and Keswick Reservoir, agriculture (e.g., copper and zinc), wastewater treatment plant (WWTP) discharges (e.g., copper, zinc, and aluminum), and urban runoff (e.g., zinc, copper, lead, cadmium). The beneficial uses of Delta waters most affected by trace metal concentrations include aquatic life uses (i.e., cold freshwater habitat, warm freshwater habitat, and estuarine habitat), harvesting activities that depend on aquatic life (e.g., shellfish harvesting, commercial and sport fishing), and drinking water supplies (i.e., municipal and domestic supply). See Chapter 9 for additional information on trace metals, including water quality objectives/criteria.

Pesticides

Pesticides may be described in two general categories: current-use pesticides and legacy pesticides. *Current-use pesticides* include carbamates (e.g., carbofuran), organophosphates (e.g., chlorpyrifos, diazinon, diuron, malathion), thiocarbamates (e.g., molinate, thiobencarb), and pyrethroids (e.g., permethrin, cypermethrin), a class of synthetic insecticides applied in urban and agricultural areas. These chemicals have toxic effects on the nervous systems of terrestrial and aquatic life, and some are toxic to the human nervous system. The EPA has phased out certain organophosphates, or their uses, because of their potential toxicity in humans, which has led to their gradual replacement by pyrethroids. See Chapter 9 for a discussion on the use of pesticides in the study area. *Legacy pesticides* include primarily organochlorine pesticides, such as dichlorodiphenyltrichloroethane (DDT) and “Group A” pesticides (i.e., aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane [including lindane], endosulfan, and toxaphene). Although banned in the 1970s due to their health and environmental effects, these chemicals are highly persistent in the environment (i.e., not readily degraded) and can bioaccumulate.

26.1.1.2 Bioaccumulative Constituents

Toxicants are present in the existing aquatic environment of the Delta and may be mobilized into the food chain. The toxicants that biomagnify through the food chain, such as methylmercury, organochlorines and other legacy pesticides, and polychlorinated biphenyls (PCBs), resulting in higher concentrations in predator fish such as striped bass, commonly consumed by humans, are of particular concern for public health.

Bioavailability is a measure of the ability of a toxin to cross the cellular membrane of an organism, to become incorporated in that organism, and to enter the food chain (Semple et al. 2004). Not all toxicants are in a form that can be taken up by an organism. Bioavailability is not only chemical-specific, but it also can be specific to the chemical form that a constituent takes. For example, mercury in an organic complex as methylmercury is much more bioavailable and toxic than elemental mercury or mercury complexed with an inorganic compound.

In addition to the availability of the chemical to be taken up by biota, some chemicals are magnified more through the food chain. The term *bioaccumulation* often is used loosely and interchangeably with the term *biomagnification*. Strictly speaking, bioaccumulation occurs at any one trophic level¹ or in any one species (and age-class) as a pollutant is ingested inside of food items or absorbed from the environment and thereby *accumulates* to some concentration in tissues of organisms at that particular trophic level or in that particular species (and age-class). In contrast, *biomagnification* more properly refers to increases in tissue concentrations of a pollutant as it passes upward through the food chain, from prey to predator, to the topmost, mature predators. In these top predators, tissue concentrations may be harmful both to the animal (especially to offspring) and to those that consume it. In summary, bioaccumulation happens within a specific trophic level; biomagnification occurs over multiple trophic levels.

Bioaccumulation is a function of the chemical’s specific characteristics and the way the organism metabolizes the chemical—such as whether it is metabolized and excreted or stored in fat. Toxicants that are bioavailable and lipophilic (tend to accumulate in fatty tissue of an organism and are not

¹ *Trophic levels* identify the position of an organism within the food chain.

very water soluble) typically bioaccumulate at higher rates. These chemicals can biomagnify in the food chain, as does methylmercury and some pesticides, such as organochlorines (e.g., lindane).

In the Delta, the toxicants of primary concern to human health are mercury, pesticides, and PCBs. Selenium can also biomagnify through the food chain under certain conditions, but selenium is a metal required in human diets and does not pose a high level of risk to humans at low concentrations. PCBs are currently present at varying concentrations in Delta fish.

Mercury

In freshwater environments, inorganic mercury is converted by bacteria (sulfate- and iron-reducing) to methylmercury (Fleming et al. 2006:457). Methylmercury is the form of mercury that enters the food web in aquatic environments and bioaccumulates in fish and shellfish through consumption of prey and absorption from water. Fish consumption is the primary exposure route to methylmercury for humans (U.S. Environmental Protection Agency 2020). Health effects of methylmercury include neurotoxicity, reproductive and cardiovascular toxicity, and potentially immunotoxicity (Hong et al. 2012:355–358). The risks to human health from mercury due to fish consumption depend on the concentration of methylmercury in the fish tissue and the quantity of mercury-contaminated fish eaten over time. The concentration of methylmercury in fish species is dependent on the level of methylmercury contamination in the waterbody, or waterbodies, in which the fish reside, as well as the diet and lifespan of the fish species. Applicable water quality objectives for mercury and methylmercury are discussed in Appendix 9H, *Mercury*.

The Sacramento River is the primary transport route of methylmercury to the study area and contributes about 80% of river-borne mercury inputs (Central Valley Regional Water Quality Control Board 2010:iv). In the Sacramento River watershed, the highest concentrations of mercury are found in Cache Creek and the Yolo Bypass where Cache Creek terminates. Cache Creek drains approximately 2% of the Sacramento River watershed but contributes approximately 30% of the mercury from the watershed (Central Valley Regional Water Quality Control Board 2010:144); approximately 50% of the mercury from Cache Creek is trapped in the Cache Creek Settling Basin, and the remainder is exported to the Delta (Central Valley Regional Water Quality Control Board 2011:4). Delta inputs primarily drive mercury concentrations in northern San Francisco Bay, Suisun Bay, and Suisun Marsh (Central Valley Regional Water Quality Control Board 2010:197; San Francisco Bay Regional Water Quality Control Board 2018:49).

In 2011, EPA approved the Sacramento–San Joaquin Delta Estuary methylmercury total maximum daily load (TMDL) to protect human health, wildlife, and aquatic life. TMDL establishes methylmercury fish tissue objectives and waste-load allocations for agricultural drainage, tributary inputs, and point and nonpoint source dischargers in the Delta. In conjunction with the mercury and methylmercury load reduction goals of the TMDL, the Central Valley Regional Water Quality Control Board (Central Valley RWQCB) developed a Delta Mercury Exposure Reduction Program as a multiple interested parties effort to promote a better understanding of mercury bioaccumulation in Delta fish and support approaches for reducing human exposure to mercury from fish caught in the Delta. The Central Valley RWQCB is also developing a statewide mercury control program for reservoirs, which was initiated in 2012, and a Central Valley mercury control program for rivers.

The San Francisco Bay mercury TMDL, adopted in 2008, includes Suisun Bay and describes numeric targets for mercury in fish tissue. TMDL implementation efforts include public outreach to raise awareness of fish contamination issues in the San Francisco Bay and a regional monitoring program

to assess mercury loads in water, sediment, and fish tissue at several locations in the San Francisco Bay (San Francisco Bay Regional Water Quality Control Board 2020).

Polychlorinated Biphenyls

Historically, PCBs were associated with urban discharge, and these contaminants have been detected in fish tissues in San Francisco Bay, although there is little research on PCB levels in the study area. Fish tissue sampling in the San Francisco Bay as part of the regional monitoring program indicates that all eight species of sport fish monitored by the program have average tissue concentrations above the TMDL target (10 micrograms per kilogram wet weight of fish tissue) (Davis et al. 2014:10). Delta PCB concentrations are generally below California Office of Environmental Health Hazard Assessment (OEHHA) screening values (de Vlaming 2008:2). PCB concentrations in sediment from the Central Valley flowing into San Francisco Bay are lower than in sediment within the bay; the Central Valley loading of PCBs to the San Francisco Bay is expected to attenuate naturally, thus eliminating the need for implementing actions to reduce PCBs in the study area waters (San Francisco Bay Regional Water Quality Control Board 2019:7-48).

Legacy Pesticides

As discussed in Chapter 9, legacy pesticides include primarily organochlorine pesticides, such as DDT and “Group A” pesticides (i.e., aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane [including lindane], endosulfan, and toxaphene). These chemicals are highly persistent in the environment, including in sediment and fish tissue.

The Clean Water Act Section 303(d) list of impaired waterbodies identifies the entire Delta as impaired by one or more legacy pesticides (State Water Resources Control Board 2017). Chapter 9 provides a summary of the existing conditions of various pesticides in the Delta.

Bioaccumulation in Fish and Shellfish

Bioaccumulation in fish and shellfish results when fish and shellfish absorb a toxic substance in the water or from food at a rate greater than that at which the substance is eliminated. The organisms then concentrate these chemicals at levels higher than is found in the water. Most health advisories are issued because of high levels of mercury in fish. In a few cases, fish are contaminated with PCBs or other chemicals such as DDT.

Some fish species contain higher amounts of methylmercury, and thus it is not recommended that women who might become pregnant, women who are pregnant or nursing, or young children eat shark, marlin, orange roughy, swordfish, king mackerel, bigeye tuna, or tilefish (Gulf of Mexico) (U.S. Food and Drug Administration 2019). None of these species are commonly found in the Delta. EPA encourages states, territories, and Tribes to also issue safe eating guidelines to convey to the public which fish they can eat safely based on potential contamination.

Local advisories should be checked for the safety of locally caught fish, and if these advisories are unavailable, the weekly consumption of locally caught fish or shellfish species should be limited. Waterways within the Delta have differing levels of contaminants; thus, each waterway has a different advisory for fish or shellfish caught in it. To protect public health, fish consumption advisories have been issued for the Delta, San Francisco Bay, and other California waterways. These advisories are issued by OEHHA and provide guidance on the specific types and number of servings per week of Delta fish that can be eaten safely according to age group. OEHHA provides two sets of

guidelines for fish consumption, one for each of the following populations: women ages 18 to 49 years (pregnant, nursing or who may be pregnant) and children ages 1 to 17 years, and women 50 years and older and men 18 years and older (California Office of Environmental Health Hazard Assessment and California Environmental Protection Agency 2018).

The Delta Mercury Exposure Reduction Program is a collaborative effort of the Sacramento–San Joaquin Delta Conservancy, the California Department of Public Health (CDPH), Central Valley RWQCB, OEHHA, and California Department of Water Resources (DWR) to reduce human exposure to mercury from eating contaminated fish. Program activities include convening an interested parties advisory group, implementing outreach and education projects, developing signs in the Delta, and developing multilingual educational materials.

26.1.1.3 Pathogens

The term *pathogens* refers to viruses, bacteria, and protozoa that pose human health risks. Pathogens of concern include bacteria, such as *Escherichia coli* (*E. coli*) and *Campylobacter*; viruses, such as hepatitis and rotavirus; and protozoa, such as *Giardia* and *Cryptosporidium*. Sources of pathogens include wild and domestic animals, aquatic species, urban stormwater runoff, discharge from WWTPs, and agricultural point and nonpoint sources such as confined feeding lots (Larry Walker Associates 2018:3). Pathogens that have animal hosts can be transported from the watershed to source waters from grazed lands and cattle operations; aquatic species such as waterfowl also contribute pathogens directly to waterbodies. Stormwater runoff from urban or rural areas can contain pathogens carried in waste from domestic pets, birds, or rodents, as well as sewage spills. Pathogen concentrations are greatly influenced by proximity to the pathogen-generating source. Some types of pathogens may experience rapid die-off once excreted from their host, whereas other pathogens, such as *Giardia* and *Cryptosporidium*, can persist in the environment for long periods of time, even under unfavorable conditions (Tetra Tech 2007:2–3; Larry Walker Associates 2018:4).

Municipal and domestic water supply and water contact recreation can be affected by pathogens. Humans can be exposed to and infected by certain pathogens (e.g., *E. coli*) in contaminated rivers, lakes, and coastal waters while participating in recreational activities including swimming, water skiing, surfing, and boating. Waterborne pathogenic microbes are capable of causing illness in people in a dose-dependent way and depending on the physical condition of the individuals exposed. Exposure to waterborne pathogens does not always result in infection, and infection with a pathogen does not always result in clinical illness (Pond 2005:3).

There are numerous potential sources of pathogens in the study area, including urban runoff, wastewater treatment discharges, agricultural discharges, and wetlands (Tetra Tech 2007:ES-1). Specifically, tidal wetlands are known to be sources of coliforms originating from aquatic, terrestrial, and avian wildlife that inhabit these areas (Desmarais et al. 2001; Grant and Sanders et al. 2001; Evanson and Ambrose 2006; Tetra Tech 2007:ES-1). Of the known sources that deposit coliforms into the waters of the Central Valley, wastewater total coliform concentrations for most WWTPs are low (less than 1,000 most probable number [MPN]/100 milliliters [ml]), whereas the highest total coliform concentrations in water (greater than 10,000 MPN/100 milliliters) have been measured in waters influenced by urban areas (Tetra Tech 2007:ES-1). In the San Joaquin Valley, comparably high concentrations of *E. coli* have been measured for waters affected by urban areas and intensive agriculture (Tetra Tech 2007:ES-1). Higher concentrations have been observed during wet months,

possibly indicating the contribution of stormwater runoff (Tetra Tech 2007:ES-2). The Basin Plan water quality objectives for pathogens are detailed in Appendix 9A, *Screening Analysis*.

26.1.1.4 Cyanobacteria Harmful Algae Blooms (CHABs)

As described in Chapter 9, *cyanobacteria* are aquatic photosynthetic bacteria that live in freshwater and saline environments. When cyanobacteria grow out of control, these masses of overgrowth are referred to as cyanobacteria harmful algal blooms (CHABs). To date, the most common and well-studied bloom-forming cyanobacteria in the Delta is *Microcystis*. As such, in this chapter, as well as in Chapter 9, most of the information presented on CHABs is related to *Microcystis*.

Many types of cyanobacteria produce toxins (known as *cyanotoxins*). *Microcystis* produce the cyanotoxin *microcystin*, a liver toxin, as well as a skin, eye, and throat irritant and the most widespread of the cyanotoxins. *Microcystis* blooms can have toxic effects on phytoplankton, zooplankton, and fish. Cyanotoxins, once released, eventually undergo biodegradation and, to a small extent, photodegradation (Gagala and Mankiewicz-Boczek 2012:1128). As described in Chapter 9, saline conditions can stimulate lysing of cells and cease growth of cyanobacteria species such as *Microcystis*.

There are multiple ways by which humans may be exposed to cyanotoxins, including drinking contaminated water, body contact, inhalation, consumption of contaminated food, consumption of algal dietary supplements, and hemodialysis (Massey et al. 2018:4). Human exposure to cyanotoxins in freshwater has the potential to occur during recreational activities (e.g., swimming, boating) through direct contact, by inhaling aerosolized toxins near a contaminated water body, or through accidental ingestion of (or oral exposure to) contaminated water (U.S. Environmental Protection Agency 2019a). There are many reports of a variety of health effects in addition to liver damage (e.g., diarrhea, vomiting, blistering at the mouth, headache) following human exposure to cyanotoxins in drinking water or from swimming in water in which cyanotoxins are present. Such health effects can occur within minutes to days following exposure to cyanotoxins (U.S. Environmental Protection Agency 2019b:4).

As discussed in Chapter 9, no single environmental factor causes the formation and maintenance (i.e., persistence) of CHABs. The five primary environmental factors that have been related to the emergence and subsequent growth of *Microcystis* in the Delta are water temperatures greater than 19°C (approximately 66°F); low flows and channel velocities resulting in low turbulence and long residence times; water column irradiance and clarity; sufficient nutrient availability of nitrogen and phosphorus; and salinity below 10 parts per thousand.

Problematic *Microcystis* blooms have not occurred in the export service areas, but microcystins produced in waters of the Delta have been exported from Banks and Jones Pumping Plants to the SWP and CVP (Archibald Consulting et al. 2012:ES-10). Levels of microcystin measured in water exported from the Delta were below the 1 microgram per liter (µg/L) reportable limit (Archibald Consulting et al. 2012:ES-10). It is unknown if microcystin concentrations were below the California guidance levels or the EPA 10-day Health Advisory.

It is expected that the frequency and intensity of CHABs will increase with the increased frequency and intensity of droughts with climate change (Lehman, Marr et al. 2013:155; Lehman, Kurobe et al. 2017:105). In addition to increased water temperatures, other variables associated with drought conditions such as water stratification, evaporation, hydraulic residence time, salinization, and

duration of the summer season will likely favor the formation of algal blooms (Lehman, Kurobe et al. 2017).

Because *Microcystis* is commonly found in surface water, microcystin is of relevance to drinking water supplies and recreational waters, and therefore to public health. In addition to producing surface scums that interfere with recreation and cause aesthetic problems, microcystin also produces taste and odor compounds. Conventional water treatment can effectively remove unlysed (i.e., intact) cyanobacteria and low concentrations of cyanotoxins in drinking water supplies. However, some water treatment options are effective for some cyanotoxins but not for others (U.S. Environmental Protection Agency 2019b:6–9). Thus, operators of drinking water treatment systems must remain informed about the growth patterns and species of blue-green algae blooming in their surface water supplies to determine appropriate treatment or actions and monitor treated water for cyanotoxins.

The EPA has established recommended criteria for microcystin and cylindrospermopsin (a cyanotoxin) in recreational waters in *Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories (AWQC/SA) for Microcystins and Cylindrospermopsin* (U.S. Environmental Protection Agency 2019c). These recommended criteria have been published under Clean Water Act 304(a) for states to consider as the basis for swimming advisories for notification purposes in recreational waters to protect the public from CHABs and cyanotoxins. For use as a recreational water quality criterion, EPA recommends that states use 10-day assessment periods (not a rolling 10-day period) over the course of a recreation season to evaluate ambient waterbody conditions and recreational use attainment where the water quality criterion for the cyanotoxins microcystins and cylindrospermopsin is 8 µg/L and 15 µg/L, respectively. The 10-day period links the waterbody assessment period to the adverse health effects observed from ingestion of the toxins over short-term exposures. Where the concentration of these cyanotoxins exceeds the criterion during a 10-day period more than three times within a recreational season and this reoccurs in more than 1 year, EPA considers this an indication that the water quality has been or is becoming degraded. EPA recommends as a basis for issuing a swimming advisory that the criteria not be exceeded on any single day and that the advisory remain until the toxin concentration(s) fall below the recommended criterion/criteria.

The EPA has also developed 10-day drinking water health advisories for microcystin and cylindrospermopsin (Table 26-1).

Table 26-1. U.S. Environmental Protection Agency's 10-Day Drinking Water Health Advisories for Cyanotoxins

Cyanotoxin	Drinking Water Health Advisory (µg/L)	
	Bottle-Fed Infants and Pre-School Children	School-Age Children and Adults
Cylindrospermopsin	0.7	3.0
Microcystins	0.3	1.6

Source: U.S. Environmental Protection Agency 2020.
µg/L = micrograms per liter.

26.1.1.5 Vectors

A *vector* is an insect or any living carrier that transmits an infectious agent from one host to another. Vectors that can be found in the study area include mosquitoes and small mammals, such as mice

and rats. Diseases carried by warm-blooded animals, such as hantavirus² and plague³, are not of concern in the study area, as their occurrence is extremely rare in the nation, state, and the Delta (Sutter–Yuba Mosquito and Vector Control District 2022a, 2022b). Given the low rate of infection for both hantavirus and plague in California, these diseases are not further discussed.

Rabies is another vector-borne disease that occurs in California. This disease is a viral infection carried by infected animals and usually is spread through the bite of an infected animal (Sutter–Yuba Mosquito and Vector Control District 2020). Although rabies cases do occur in the Delta, this disease is not discussed in further detail because the project alternatives would not increase the public’s vulnerability or exposure to this disease, as it is not anticipated to increase rabies sources.

The vector of most concern in the study area is the mosquito because it is considered a nuisance to the public through irritating bites and can transmit various diseases, including the West Nile virus (WNV), to birds and humans. Recently, two invasive species of mosquitoes that can potentially transmit dengue⁴ and chikungunya⁵ viruses, *Aedes aegypti* (yellow fever mosquito) and *Aedes albopictus* (Asian tiger mosquito), have been detected in multiple counties in Northern and Southern California; the yellow fever mosquito has been detected in the study area in Yolo, Sacramento, and San Joaquin Counties (California Department of Public Health 2019; Mosquito and Vector Control Association of California 2021; California Department of Public Health 2021a). Currently, the risk of local dengue or chikungunya transmission is low, and there have been no reported cases of either of these diseases being acquired in California. Therefore, these mosquito species and diseases are not discussed further.

The focus of this section is on public nuisances associated with mosquito-borne diseases transmitted to humans. This section provides a description of the habitat and life history of mosquito species that exist in the study area.

The optimal conditions for mosquitoes to carry out their complete growth and reproduction cycles can be found in areas of shallow (generally less than 3 feet in depth) standing water and/or aquatic areas with dense floating or emergent vegetation (U.S. Environmental Protection Agency 2005:1; Walton 2003:4). The majority of mosquito species lay eggs on the surface of fresh or stagnant water. The water may be in various stagnant water locations, such as tin cans, barrels, horse troughs, ornamental ponds, swimming pools, puddles, creeks, ditches, catch basins, or marshy areas. The breeding habitat varies depending on the species of mosquito. Most mosquito species prefer water sheltered from the wind by grass, weeds, or aquatic vegetation. Aquatic vegetation can provide

² *Hantavirus* is a pulmonary disease carried by deer mice, white-footed mice, and rice rats and spread through inhalation or ingestion of contaminated particles of urine, saliva, or excrement. Since 1993, there have only been 73 cases of hantavirus in California (Sutter–Yuba Mosquito and Vector Control District 2022a).

³ *Plague* is a bacterial infection carried by fleas on small mammals and spread through the bite of infected fleas. Since 1900, there have been almost 500 human cases of plague in California (Sutter–Yuba Mosquito Vector Control District 2022b).

⁴ *Dengue* is a mosquito-borne infection transmitted principally by the yellow fever mosquito and secondarily by the Asian tiger mosquito. With the exception of Mexico, Puerto Rico, small areas in southern Texas and southern Florida, and some regions in Hawaii, dengue transmission does not occur in North America. Dengue virus cannot be transmitted from person to person (California Health and Human Services Agency and California Department of Public Health 2015).

⁵ *Chikungunya* is a viral disease transmitted by the yellow fever mosquito and the Asian tiger mosquito. In California, chikungunya infections have been documented only in people who acquired the virus while travelling outside the United States; Chikungunya is not a contagious disease (California Health and Human Services Agency and California Department of Public Health 2016).

habitat for mosquito development because the vegetation can reduce the rippling effect on the water's surface (Cuda n.d.:25). Deep, open-water habitats are poor mosquito breeding areas because the wave action generated over waterbodies disrupts the ability of larvae to penetrate the water surface for respiration (U.S. Fish and Wildlife Service 1992:4M-4). In addition, fluctuation in surface water elevations, specifically rapid drawdown rates, are associated with lower mosquito larval abundance. Experimental reservoir studies have shown that the larval abundance of *Anopheles* mosquitoes can be reduced with increasing water drawdown rates (Kibret and Wilson et al. 2018:6) and that this effect is due to larval stranding in areas that had been submerged prior to drawdown (Endo et al. 2015:5).

Tidally influenced marshes that lack sufficient tidal flow can provide suitable breeding habitat for mosquitoes (Kramer, Collins, Beesley 1992:21; Kramer, Collins, Malamud-Roam 1995:389). However, functional tidal marshes do not provide high-quality habitat for many mosquito species, such as *Aedes dorsalis* and *Aedes squamiger*, and maintenance and restoration of natural tidal flushing in marshes is effective at limiting mosquito populations (Kramer, Collins, Malamud-Roam 1995:393; Philip Williams and Associates, Ltd., and Faber 2004:27). Problems can occur in seasonally ponded wetlands, in densely vegetated tidal areas that pond water between tides, or where tidal drainage has been interrupted (Philip Williams and Associates, Ltd., and Faber 2004:27). Therefore, tidal wetland restoration can reduce mosquito populations as tidal fluctuations keep water moving so that mosquitoes do not have standing water in which to breed (Philip Williams and Associates, Ltd., and Faber 2004:27; Kramer, Collins, Malamud-Roam 1995:392). Semi-permanent and permanent nontidal wetlands can produce *Anopheles freeborni* and *Culex tarsalis*; however, because of their limited acreage, stable water levels, and abundance of mosquito predators (i.e., fish, dragonflies, and other predatory invertebrates), such wetlands are not typically considered mosquito production areas (Kwasny et al. 2004:9).

Suitable mosquito breeding habitat is in close proximity to urban areas along the Sacramento River and the south Delta; therefore, the current urban population is already exposed to vector-borne diseases (see *Potential Mosquito-Borne Diseases in the Delta* below for additional information). The availability of preferable mosquito breeding habitat varies by season and is reduced during dry periods of the year. Available open-water habitat can be expected to increase during the wet season; however, changes in flow volume in the Delta would result in increased flow velocities, limiting preferable mosquito breeding habitat. Different cropping and land use patterns create differing amounts of suitable mosquito breeding habitat, which affects mosquito prevalence in the study area. Currently, the Delta consists primarily of agricultural lands and tidal, riparian, and other water-related habitat that can provide suitable habitat for mosquitoes to breed and multiply.

Common Mosquito Species

There are multiple species of mosquito known to occur in the study area. Factors that affect the productivity and breeding of mosquitoes include water circulation, organic content, vegetation, temperature, humidity, and irrigation and flooding practices.

The habitat for the breeding of mosquitoes varies depending on the combination of habitat conditions. The following discussion presents an overview of mosquito species and their habitat, as well as mosquito-borne diseases, in the study area. Table 26-2 identifies the preferred habitat and seasonal presence of common mosquito species.

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Table 26-2. Preferred Habitat and Seasonal Presence of Common Mosquito Species

General Water Source/Preferred Habitat	Most Active Season			
	Winter	Spring	Summer	Fall
Standing water (e.g., permanent wetlands or foul standing water sources; brackish or freshwater)	<ul style="list-style-type: none"> • Cool weather mosquito (<i>Culiseta incidens</i>)^a • California salt marsh mosquito (<i>Ochlerotatus squamiger</i>)^b • Winter salt marsh mosquito (<i>Aedes squamiger</i>) 	<ul style="list-style-type: none"> • California salt marsh mosquito (<i>Ochlerotatus squamiger</i>)^b 	<ul style="list-style-type: none"> • Encephalitis mosquito (<i>Culex tarsalis</i>) • Northern house mosquito (<i>Culex pipiens</i>) • Western malaria mosquito (<i>Anopheles freeborni</i>) 	<ul style="list-style-type: none"> • Encephalitis mosquito (<i>Culex tarsalis</i>) • Northern house mosquito (<i>Culex pipiens</i>) • Western malaria mosquito (<i>Anopheles freeborni</i>) • Cool weather mosquito (<i>Culiseta incidens</i>)^a
Flood waters (e.g., seasonal/semi-permanent wetlands, including pastures and rice fields)	N/A	<ul style="list-style-type: none"> • Wetlands mosquito (<i>Aedes melanimon</i>) • Inland floodwater mosquito (<i>Aedes vexans</i>) • Pale marsh mosquito (<i>Ochlerotatus dorsalis</i>)^c 	<ul style="list-style-type: none"> • Inland floodwater mosquito (<i>Aedes vexans</i>) • Western malaria mosquito (<i>Anopheles freeborni</i>)^d 	<ul style="list-style-type: none"> • Wetlands mosquito (<i>Aedes melanimon</i>) • Inland floodwater mosquito (<i>Aedes vexans</i>)
Tule and grasses	N/A	<ul style="list-style-type: none"> • Tule mosquito (<i>Culex erythrothorax</i>)^e 	<ul style="list-style-type: none"> • Tule mosquito (<i>Culex erythrothorax</i>)^d 	N/A
Containers (e.g., holes in oak woodlands, containers of standing water, sumps)	<ul style="list-style-type: none"> • Western treehole mosquito (<i>Aedes sierrensis</i>) 	<ul style="list-style-type: none"> • Western treehole mosquito (<i>Aedes sierrensis</i>) 	<ul style="list-style-type: none"> • Northern house mosquito (<i>Culex pipiens</i>) 	<ul style="list-style-type: none"> • Northern house mosquito (<i>Culex pipiens</i>)
Wooded areas, seasonal creeks, and year-round rivers	<ul style="list-style-type: none"> • Woodland malaria mosquito (<i>Anopheles punctipennis</i>)[*] 	<ul style="list-style-type: none"> • Woodland malaria mosquito (<i>Anopheles punctipennis</i>)[*] 	<ul style="list-style-type: none"> • Woodland malaria mosquito (<i>Anopheles punctipennis</i>)[*] 	<ul style="list-style-type: none"> • Woodland malaria mosquito (<i>Anopheles punctipennis</i>)[*]

Sources: Unless otherwise noted, sources in this table are from Sacramento–Yolo Mosquito and Vector Control District 2008.

^a Alameda County Mosquito Abatement District 2011:23–26.

^b Solano County Mosquito Abatement District 2005a.

^c Solano County Mosquito Abatement District 2005b; Napa County Mosquito Abatement District 2006.

^d Marin/Sonoma Mosquito and Vector Control District 2021; Solano County Mosquito Abatement District 2005b.

^e County of Santa Cruz Environmental Health Department 2021.

^{*} Unknown what season the woodland malaria mosquito is most active.

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Potential Mosquito-Borne Diseases in the Delta

Approximately 15 mosquito-borne viruses occur in California; however, of those, only St. Louis encephalitis virus (SLEV), western equine encephalomyelitis virus (WEEV), and WNV have caused significant human disease (California Department of Public Health, Mosquito and Vector Control Association of California et al. 2020:3, 4). Table 26-3 summarizes the types of mosquitoes known to occur in the study area, the types of diseases they commonly carry, and flight range. Depending on the species, mosquitoes have an average maximum flight distance of less than 1 mile to greater than 20 miles, and travel distances are influenced substantially by wind (Verdonschot and Besse-Lototskaya 2014:69). This flight range also applies to mosquito species known to occur in the study area.

Table 26-3. Mosquitoes Known to Occur in the Delta, Diseases they Commonly Carry, and Flight Range

Mosquito	Adult Flight Range	Diseases
Pale marsh mosquito (<i>Ochlerotatus dorsalis</i>) ^a	20 miles	CEV; Dog heartworms
Cool weather mosquito (<i>Culiseta incidens</i>)	<5 miles	Possible secondary WNV vector
Western encephalitis mosquito (<i>Culex tarsalis</i>)	3 to 15 miles	Primary WNV, WEEV, and SLEV vector
California salt marsh mosquito (<i>Ochlerotatus squamiger</i>) ^b	Up to 20 miles or more	CEV; WNV in a limited number of this species in 2004
Western treehole mosquito (<i>Aedes sierrensis</i>)	<1 mile	Dog heartworm vector
Wetlands mosquito (<i>Aedes melanimon</i>)	10 or more miles	Secondary vector of the WEEV Primary carrier of the CEV Potential vector of the WNV
House mosquito (<i>Culex pipiens</i>)	<1 mile	Primary WNV vector, secondary SLEV vector**
Inland floodwater mosquito (<i>Aedes vexans</i>)	10 or more miles	Possible WNV vector; secondary vector for dog heartworms
Tule mosquito (<i>Culex erythrothorax</i>)	<1 mile	Secondary WNV vector
Winter salt marsh mosquito (<i>Aedes squamiger</i>)	10 to 20 miles	Possible CEV vector
Western malaria mosquito (<i>Anopheles freeborni</i>)	10 miles	Malaria
Yellow Fever Mosquito (<i>Aedes aegypti</i>) ^c	Up to 1.5 miles	Zika, dengue, chikungunya, and yellow fever
Woodland malaria mosquito (<i>Anopheles punctipennis</i>)	Less than 1 mile	Malaria

Source: Contra Costa Mosquito and Vector Control District 2021.

* Identified under laboratory conditions as a vector for WEEV but has not yet been found in wild populations.

** Not considered a strong virus vector for humans in Northern California but identified in Southern California and the Gulf Coast as human virus vector.

CEV = Cerebral Encephalitis virus; SLEV = St. Louis encephalitis virus; WEEV = western equine encephalomyelitis virus; WNV = West Nile virus.

^a Marin/Sonoma Mosquito and Vector Control District 2021; Solano County Mosquito Abatement District 2005b.

^b Solano County Mosquito Abatement District 2005a.

^c California Department of Public Health 2016; Verdonschot and Besse-Lototskaya 2014.

Malaria

Malaria is a mosquito-borne disease caused by a single-celled parasite, *Plasmodium* (Reiter 2001). This parasite infects and destroys the red blood cells of its host. Malaria occurs in tropical and subtropical areas with high humidity and temperatures, including Africa and Central and South America. In the United States there are approximately 2,000 diagnosed cases of malaria each year (Centers for Disease Control and Prevention 2020). The majority of these cases in the United States are diagnosed in travelers and immigrants returning from countries where malaria is endemic (Centers for Disease Control and Prevention 2020). In California, the primary vectors of this disease are female western malaria mosquitoes.

Encephalitis

Encephalitis is a virus with symptoms characterized by swelling or inflammation of the brain and spinal cord. Mosquito-borne encephalitis is directly transmitted to humans by mosquitoes and maintained through the contact between virus-carrying birds and mosquitoes. It is most commonly found in California as a consequence of WNV, SLEV, and WEEV. Horses and birds are usually the most important carriers and also the most vulnerable and susceptible to these viruses (California Health and Human Services Agency and California Department of Public Health n.d.).

Yellow Fever

Yellow fever is caused by a virus transmitted by the *Aedes aegypti* mosquito. Symptoms include acute onset of fever, chills, nausea, vomiting, body aches and weakness (Centers for Disease Control and Prevention 2019). Although rare, with severe forms of yellow fever, jaundice, bleeding, and organ failure may occur. Although the yellow fever mosquito has been detected in several counties throughout California, the yellow fever virus is not currently known to have been transmitted in the state (California Department of Public Health 2021b).

West Nile Virus

WNV is a mosquito-borne virus introduced to North America in 1999 (Ronca et al. 2021:1). The *Culex* mosquito genus has been identified as the primary transmitting vector of the virus (Goodard et al. 2002:1385). The majority of victims of this virus develop very few or no symptoms. Some of the common symptoms identified are fever, nausea, body aches, headache, and mild skin rash. A very small proportion (less than 1%) of victims may also develop neurologic illness, including brain inflammation (encephalitis), which could lead to partial paralysis and death (Sejvar 2014:607).

Confirmed human WNV cases in California for the years 2014–2018 are provided in Table 26-4. This virus is commonly identified in small animals, such as squirrels and birds, and can also affect large mammals, including horses and humans.

Table 26-4. Confirmed West Nile Virus Cases in California (2014–2018)

Cases	2014	2015	2016	2017	2018
Number of Counties	40	41	39	47	41
Human Cases	801	783	442	553	217
Mosquito Samples	3,340	3,329	3,528	3,371	1,963

Sources: California Department of Public Health, University of California, Davis Arbovirus Research and Training et al. 2014, 2015, 2016, 2018; California Department of Public Health, University of California, Davis Arbovirus Research and Training et al. 2017.

Confirmed human cases of WNV in counties in the study area for the years 2014–2018 are identified in Table 26-5. Although WNV is a growing concern and a potential threat to the population within the study area and California in small mammals, the documented human occurrences within the study area have been relatively limited.

Table 26-5. Confirmed West Nile Virus Cases by County in Study Area (2014–2018)

County	2014		2015		2016		2017		2018	
	Human Cases	Mosquito Samples	Human Cases	Mosquito Samples	Human Cases	Mosquito Samples	Human Cases	Mosquito Samples	Human Cases	Mosquito Samples
Alameda	1	16	–	16	–	2	1	–	–	15
Contra Costa	5	25	1	8	4	11	4	9	4	17
Sacramento	10	487	4	164	25	455	6	153	15	300
San Joaquin	9	239	2	208	13	350	14	242	14	533
Solano	5	11	1	6	4	16	1	9	–	3
Yolo	15	22	8	17	16	25	6	87	11	90

Sources: California Department of Public Health, University of California, Davis Arbovirus Research and Training et al. 2014, 2015, 2016, 2018; California Department of Public Health, University of California, Davis Arbovirus Research and Training et al. 2017.

– = no record.

St. Louis Encephalitis

SLE is distributed throughout California and generally affects nonhuman mammals, principally horses. The western encephalitis mosquito (*Culex tarsalis*) and common house mosquito (*Culex pipiens*) are the main transmitting vectors in the western United States (Centers for Disease Control and Prevention 2021a). The main sources of infection for mosquitoes are birds; once infected, the mosquito can transmit the virus to other animals and, on few occasions, humans. Symptoms tend to be very mild and usually include fever, headache, and dizziness. However, the disease may also lead to convulsions and death and carries a mortality rate that ranges from 5%–20% (Centers for Disease Control and Prevention 2021b).

Western Equine Encephalitis

Seasonal viral activity is at its highest for WEEV from late spring to early summer, especially in areas with highly irrigated agriculture and stream drainages. The disease has a mortality rate of approximately 4 percent in humans and affects young children most severely (Simon et al. 2020). The western encephalitis mosquitoes are generally identified as primary transmitters of the virus. In

California, the pale marsh mosquito is also a major vector. Symptoms include fever, chills, malaise, weakness, and myalgias (Simon et al. 2020).

Mosquito Control

In California, mosquito and vector control services are provided by mosquito vector control districts (MVCDs), pest abatement districts, and other county environmental health departments and county agricultural departments. These entities, which are collectively referred to as *mosquito and vector control agencies*, are overseen and regulated primarily by the CDPH. Mosquito and vector control agencies collaborate with the CDPH weekly with reports/tests of dead birds within the individual agency's jurisdiction; when a member of the public reports a dead bird to the CDPH, the CDPH notifies the appropriate mosquito and vector control agency. Mosquito and vector control agencies also coordinate with local Office of Emergency Services. The *California Mosquito-Borne Virus Surveillance and Response Plan* (California Department of Public Health, Mosquito and Vector Control Association of California et al. 2020) outlines the roles and responsibilities of local and state agencies involved with mosquito-borne virus surveillance and response. Mosquito and vector control services in the study area are provided by Alameda County Vector Control Services District, Contra Costa Mosquito and Vector Control District, San Joaquin County Mosquito and Vector Control District, and Solano County Mosquito Abatement District.

MVCDs have the authority to conduct surveillance for vectors, prevent the occurrence of vectors, and abate production of vectors (Health & Saf. Code § 2040). MVCDs have broad authority to direct landowners to reduce or abate the source of a vector problem. Actions may include imposing civil penalties of up to \$1,000 per day. Agencies have authority to abate vector sources on private and publicly owned properties (Health & Saf. Code §§ 2060–2065).

Mosquitoes within the Delta require varying degrees of control by MVCDs. Mosquito control techniques employed by different MVCDs generally emphasize minimization and disruption of suitable habitat and control of larvae through chemical and biological means (California Department of Public Health, Mosquito and Vector Control Association of California et al. 2017:9). The local MVCDs monitor mosquito populations and take actions such as eliminating breeding sites and using biological control (predators such as mosquitofish) and chemical control to reduce mosquito population size (California Department of Public Health 2013:20). Furthermore, to address public health concerns about mosquito production in existing managed wetlands and tidal areas, MVCDs have developed guides and habitat management strategies to reduce mosquito production. MVCDs encourage integrated pest management, which incorporates multiple strategies to achieve effective control of mosquitoes and includes the following.

- Source reduction—designing wetlands and agricultural operations to be inhospitable to mosquitoes.
- Monitoring—implementing monitoring and sampling programs to detect early signs of mosquito population problems.
- Biological control—use of biological agents such as mosquitofish (*Gambusia affinis*) to limit larval mosquito populations.
- Chemical control—use of larvicides and adulticides.
- Cultural control—changing the behavior of people so their actions prevent the development of mosquitoes or the transmission of vector-borne disease.

Specifically, the following guidelines are incorporated for habitat management plans in different MVCDs in the study area.

- *Technical Guide to Best Management Practices for Mosquito Control in Managed Wetlands* (Kwasny et al. 2004).
- *Best Management Practices for Mosquito Control on California State Properties* (California Department of Public Health 2008).
- *Best Management Practices for Mosquito Control in California* (California Department of Public Health and the Mosquito and Vector Control Association of California 2012).

Each county, following public health and safety code regulations, designs its individual MVCD programs to control mosquito-borne disease incidence in its individual district. The most common mosquito-borne diseases each district is expected to control include WNV, WEEV, SLEV, heartworm disease, and malaria.

26.1.1.6 Electromagnetic Fields

An EMF is an invisible line of force that is produced by an electrically charged object. It affects the behavior of other charged objects in the vicinity of the field. The EMF extends indefinitely throughout space and can be viewed as the combination of an electric field and a magnetic field. Electric fields are produced by voltage and increase in strength as the voltage increases. Magnetic fields result from the flow of electrical current through wires or electrical devices and increase in strength as the current increases. Most electrical equipment has to be turned on (i.e., current must be flowing) for a magnetic field to be produced. If current does flow, the strength of the magnetic field will vary with power consumption. Electric fields, on the other hand, are present and constant even when the equipment is switched off, as long as the equipment remains connected to the source of electric power (World Health Organization 2016a).

EMFs are present everywhere in the environment. Besides natural sources, such as thunderstorms, the electromagnetic spectrum includes fields generated by human-made sources, such as X-rays. The electricity that comes out of every power socket has associated low-frequency EMFs, and various kinds of higher frequency radio waves are used to transmit information (World Health Organization 2016a).

Electric fields and magnetic fields can be characterized by their wavelength, frequency, and amplitude or strength. The frequency of the field, measured in hertz (Hz), describes the number of cycles that occur in one second. Electricity in North America alternates through 60 cycles per second, or 60 Hz. The time-varying EMFs produced by electrical wiring, electrical appliances and power lines are examples of extremely low-frequency (ELF) fields (National Cancer Institute n.d.). ELF fields generally have frequencies up to 300 Hz; power lines, electrical wiring, and electrical equipment produce ELF fields at 60 Hz (Occupational Safety and Health Administration n.d.).

Overhead power transmission lines produce electric fields and magnetic fields. Electric fields are shielded or weakened by materials that conduct electricity (including trees, buildings, and human skin). Magnetic fields, however, pass through most materials and are therefore more difficult to shield. Underground power lines do not produce electric fields above ground because the field is shielded by the surrounding jacket and soil, but the magnetic fields produced by these buried lines may produce aboveground magnetic fields. Magnetic fields directly above underground distribution lines can vary depending on the current carried by the line and range between 10 and 40 milligauss

(mG). For comparison, most household appliances' magnetic field levels range from 4 mG–1,500 mG (at a distance of 6 inches) (National Institute of Environmental Health Sciences and National Institutes of Health 2002:34). High-voltage (generally above 69 kV) transmission line EMF levels range from 30–90 mG underneath the wires, based on the voltage, height, and placement of the lines. Both electric and magnetic fields decrease as the distance from the source increases (California Public Utilities Commission 2021). Table 26-6 identifies typical electric and magnetic field levels for overhead power transmission lines at the 50-foot and 300-foot distance from the lines.

Table 26-6. Typical EMF Levels for High-Voltage Power Transmission Lines

Transmission Line Voltage (kV)	Electric Field (kV/m)		Magnetic Field (mG)	
	Approximate Edge of Right-of-Way (50 ft)	300 ft	Approximate Edge of Right-of-Way (50 ft)	300 ft
115	0.5	0.003	6.5	0.2
230	1.5	0.01	19.5	0.8
500	3.0	0.1	29.4	1.4

Source: National Institute of Environmental Health Sciences and National Institutes of Health 2002:38.
ft=feet; kV=kilovolt; kV/m=kilovolt per meter; mG=milligauss.

Potential Health Concerns

Extensive research has been conducted over the past 30 years on the relationship of EMF exposure and human health risks. Epidemiological studies, designed to verify whether EMF exposure may be a risk factor for health, have provided inconsistent results. Even with regard to people working in “high magnetic fields,” results from studies are mixed—some studies have reported small increases in some types of cancers, whereas other studies reported no such increases (National Institute for Occupational Safety and Health 2014). To date, the potential health risks caused by EMF exposure remains unknown and inconclusive. Two national research organizations (the National Research Council and the National Institute of Health) have concluded that there is no strong evidence showing that EMF exposures pose a health risk. A recent review of studies published between 2007 and 2017 on the health effects of ELF and EMF exposure determined that exposure may be associated with Alzheimer’s disease; the review focused on occupational, residential, and electric blanket exposures (Habash et al. 2019:323). However, the review found limited evidence to suggest an association with cancer, cardiovascular disease, or reproductive health effects. According to the World Health Organization, to date there is no conclusive evidence that exposure to low level EMF is harmful to human health; research is ongoing regarding potential links between cancer and EMF at power line and radio frequencies (World Health Organization 2016b).

There are no federal or state health-based standards limiting exposure to EMF. CPUC first established an interim policy regarding EMF in 1993 in Decision 93-11-013, where it was stated that “It is not appropriate to adopt any specific numerical standard in association with EMF until we have a firm scientific basis for adopting any particular value.” Due to public concern and scientific uncertainty regarding health effects due to EMF exposure, CPUC authorized electric utilities to implement “no-cost” and “low-cost” actions to reduce EMF levels from new and upgraded electrical facilities. In 2006, after a thorough review of research on EMF and potential health effects, written testimony, and evidentiary hearings, CPUC stated in CPUC Decision 06-01-042 that “at this time we are unable to determine whether there is a significant scientifically verifiable relationship between EMF exposure and negative health consequences” (California Public Utilities Commission 2006a:2).

Nonetheless, in that decision, CPUC re-affirmed Decision 93-11-013 regarding no-cost and low-cost EMF mitigation for new and upgraded projects unless exempted by a utility's design guidelines exemption criteria. Further, decision 06-01-042 ordered utilities to convene a workshop to develop standardized approaches for EMF-reduction design guidelines for electrical utilities. CPUC's *EMF Design Guidelines for Electrical Facilities* (EMF Design Guidelines) are the standardized design guidelines produced as a result of that workshop (California Public Utilities Commission 2006b). The guidelines describe the routine magnetic field reduction measures that all regulated California electric utilities will consider for new and upgraded transmission lines and transmission substations. CPUC requires utilities to update their EMF Design Guidelines to reflect various key elements including low-cost EMF mitigation and how, where and to whom it should be applied.

Proximity to Power Lines

Based on the most recent research from the National Institute of Environmental Health Sciences, residences and other sensitive receptors located 300 feet or more from power lines with kilovolts (kV) of 230 kV or less are not considered to be at risk of high EMF exposure (National Institute of Environmental Health Sciences and National Institutes of Health 2002:35). At this distance, EMF exposure from power lines is no different than from typical levels around the home. Furthermore, recognizing that transmission lines carry different voltages, the California Department of Education created regulations that require schools to be set back from transmission line rights-of-way based on the voltage of the lines. Schools must be placed 100 feet or greater from 50–133 kV lines; 150 feet or greater from 220–230 kV lines; and 350 feet or greater from 500–550 kV lines. Similar to the National Institute of Health's 300-foot setback for sensitive receptors, these distances were based on the fact that the electrical fields from the transmission lines decrease to background levels at the corresponding distances (California Department of Health Services and the Public Health Institute 1999).

As calculated via geographic information system (GIS) mapping, there are currently approximately 719 miles of transmission lines in the study area.⁶ Sensitive receptors to EMF include residences, schools, hospitals or assisted living facilities, parks, and fire stations. Parks and schools provide a location for people to congregate, and fire stations and hospitals could have sensitive communications and health equipment that could be affected by EMF interference. The following list summarizes the number of sensitive receptors within 300 feet of existing 69 kV or 230 kV power transmission lines the study area, as identified using GIS mapping.

- Thirty-two residences
- Four schools
- Two assisted living facilities/nursing homes and no hospitals
- Seventeen parks and recreation areas, and one wildlife refuge (Antioch Dunes National Wildlife Refuge)
- No fire stations

⁶ The length of existing transmission lines was calculated using Esri ArcMap 10.71 by clipping existing transmission lines to the boundary of the public health study area plus a 300' buffer of proposed power transmission lines (California Energy Commission 2017).

26.2 Applicable Laws, Regulations, and Programs

The applicable laws, regulations, and programs considered in the assessment of project impacts on public health are indicated in Section 26.3.1, *Methods for Analysis*, or the impact analysis, as appropriate. Applicable laws, regulations, and programs associated with state and federal agencies that have a review or potential approval responsibility have also been considered in the development of CEQA impact thresholds or are otherwise considered in the assessment of environmental impacts. A listing of some of the agencies and their respective potential review and approval responsibilities, in addition to those under CEQA, is provided in Chapter 1, *Introduction*, Table 1-1. A listing of some of the federal agencies and their respective potential review, approval, and other responsibilities, in addition to those under NEPA, is provided in Chapter 1, Table 1-2.

26.3 Environmental Impacts

This section describes the direct and cumulative environmental impacts associated with public health that would result from project construction and operation and maintenance of the project. It describes the methods used to determine the impacts of the project and lists the thresholds used to conclude whether an impact would be significant. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts are provided. Indirect impacts are discussed in Chapter 31, *Growth Inducement*. Appendix 26A, *Public Health 2040 Analysis*, identifies potential effects of the project alternatives on public health at 2040.

26.3.1 Methods for Analysis

This section addresses the assessment methods used for the analysis of potential impacts on public health from construction, operation, and maintenance of the project alternatives. The potential impacts to public health considered in the analysis are the following.

- Increase in vector-borne diseases (specifically via mosquitoes).
- Effects on drinking water quality through increases in concentrations of DBPs, trace metals or pesticides in surface waters.
- Increase in concentrations of bioaccumulative water quality constituents.
- Increase in public exposure to EMF.
- Increase in public exposure to CHABs.

26.3.1.1 Process and Methods of Review for Public Health

Vectors

Most species of mosquitoes lay their eggs on the surface of stagnant water, although some species use damp soil. A body of standing water represents potential breeding habitat, except areas that are flushed daily by tidal action and that are either too saline or not stagnant long enough to support mosquito larvae to maturity. The increase in the public's risk of exposure to mosquitoes, and thus to vector-borne diseases, is evaluated by describing the project alternatives or potential conditions during construction and operation of the water conveyance facility and compensatory mitigation that could result in more potential mosquito breeding habitat (i.e., surface water areas) and

1 qualitatively evaluating it against the existing amount of potential breeding habitat, taking into
 2 consideration the proximity of densely populated areas relative to potential new breeding habitat in
 3 the study area. A qualitative determination is made as to whether the project alternatives would
 4 result in a substantial⁷ increase in the public's risk of exposure to vector-borne diseases.

5 The findings from Chapter 9 are summarized for each project alternative and a qualitative
 6 determination is made as to whether the public (e.g., recreationists) would experience a substantial
 7 increase in exposure to *Microcystis* and whether there would be significant impacts on drinking
 8 water due to increases in *Microcystis*.

9 **Constituents of Concern and Water Quality**

10 As discussed in Chapter 9, numerical water quality objectives/criteria have been established to
 11 protect beneficial uses surface waters, and therefore represent concentrations or values that should
 12 not be exceeded. Many of these water quality objectives/criteria are protective of public health
 13 where the beneficial use being protected relates to humans (e.g., "municipal and domestic supply").
 14 The analysis in Chapter 9 discusses the different water quality standards evaluated through
 15 modeling and determines whether these standards would be exceeded as a result of the project
 16 alternatives. Accordingly, the analysis in this chapter summarizes the qualitative and quantitative
 17 results presented in Chapter 9 to identify whether the construction and operations of the water
 18 conveyance facilities and compensatory mitigation under all project alternatives would exceed
 19 water quality standards for pesticides that do not bioaccumulate; trace metals of human health and
 20 drinking water concern (i.e., aluminum, arsenic, iron, and manganese); and DBPs via increases in the
 21 concentrations of DOC and bromide. Qualitative assessments were then made to determine whether
 22 construction and operations of the project alternatives would result in significant impacts on
 23 drinking water quality as represented by an exceedance in water quality standards for these
 24 constituents of concern. Drinking water is generally treated for various standard constituents prior
 25 to distribution and use in the drinking water supply.

26 The assessment methods used to determine changes in levels of pesticides that do not
 27 bioaccumulate, trace metals, DOC, and bromide are described in Chapter 9. As discussed in Appendix
 28 9A, for several water quality constituents considered in a screening evaluation, it was determined
 29 that the project alternatives would not result in any significant impacts on the beneficial use of
 30 water in the study area. Two of these constituents, PCBs and pathogens, are of concern to public
 31 health and are discussed in this chapter in Section 26.1, *Environmental Setting*. However, as
 32 described in Appendix 9A, these constituents would not be affected substantially by the project
 33 alternatives; therefore, they are not discussed further in the public health analysis.

34 **Bioaccumulation**

35 For the purpose of the bioaccumulation analysis in this chapter, results of the qualitative
 36 (pesticides) and quantitative (methylmercury) analysis for construction and operations of the
 37 project alternative in Chapter 9 are summarized. A qualitative evaluation is then conducted

⁷ State CEQA Guidelines Section 15064(b) states: "[t]he determination whether a project may have a significant effect on the environment calls for careful judgment on the part of the public agency involved, based to the extent possible on factual and scientific data. An ironclad definition of significant effect is not always possible because the significance of an activity may vary with the setting. For example, an activity which may not be significant in an urban area may be significant in a rural area." Accordingly, the significance of a potential impact will be determined qualitatively, depending on the location of the alternative.

1 regarding the potential impact on public health due to a potential for increases in methylmercury
2 bioaccumulation in fish in the study area. It is assumed any additional bioaccumulation that is
3 detected is a potential effect.

4 The assessment methods used to determine changes in levels of pesticides that do not
5 bioaccumulate, trace metals, DOC, and bromide are described in Chapter 9.

6 **Electromagnetic Fields**

7 EMF from power transmission lines vary continuously as electrical load varies on individual
8 transmission lines. As such, EMF would vary with load during water conveyance facilities operation.
9 When the transmission lines are energized, there would likely be some change in the level of EMF in
10 the environment. The magnitude of the change would fluctuate over time based on load variations.
11 These effects are anticipated to be localized within the immediate proximity of the transmission
12 lines. Exposure to EMF from new transmission lines, substations, and transformers is dependent on
13 the load on the transmission lines and the location of these structures in relation to sensitive
14 receptors (e.g., hospitals, schools, parks) or densely populated urban areas given the strength of a
15 magnetic field decreases dramatically with increasing distance from the source (National Institute of
16 Environmental Health Sciences and National Institutes of Health 2002).

17 For this analysis, residences, schools, hospitals, parks, and fire stations are considered to be
18 sensitive receptors. Parks and schools provide a location for people to congregate, and fire stations
19 and hospitals could have sensitive communications and health equipment that could be affected by
20 EMF interference. Residences and other sensitive receptors located 300 feet or more from power
21 lines are not considered to be at risk of high EMF exposure (National Institute of Environmental
22 Health Sciences and National Institutes of Health 2002). At this distance, EMF exposure from power
23 lines is no different than from typical levels around the home. Therefore, the methodology for
24 determining whether people, specifically sensitive receptors, would be exposed to EMF in the study
25 area due to operation of the project alternatives entails identifying the locations of sensitive
26 receptors within 300 feet of the proposed 69 kV and 230 kV power transmission lines using GIS
27 mapping methods. Also considered in the analysis is the general medical and scientific uncertainty
28 as to the potential health effects of EMF on receptors in proximity to power transmission lines. As
29 discussed in Section 26.1.1.6, *Electromagnetic Fields*, this uncertainty extends to people working in
30 areas with high magnetic fields. Accordingly, the potential for health effects on project construction
31 workers is not considered in this analysis because this population would likely receive lower overall
32 exposure to EMF over time from proposed transmission lines in the study area during construction
33 of the project alternatives than those sensitive receptors residing within 300 feet of the proposed
34 transmission lines.

35 There is one proposed temporary aboveground 230 kV transmission line (0.04 mile long) to serve
36 the Bethany Complex during construction under Alternative 5 only. There are no sensitive receptors
37 within 300 feet of this transmission line. Therefore, exposure of sensitive receptors to EMF due to
38 project construction is not considered in the public health analysis. Most of the power to the intakes,
39 tunnel launch shafts, Southern Forebay, and the Bethany Complex would be 69 kV–capacity or
40 greater, and some of these transmission lines would serve both construction and operations.
41 Because these lines would be permanent, the potential for EMF exposure of sensitive receptors due
42 to proximity to these proposed lines are discussed under *Operations and Maintenance* for Impact
43 PH-4, below. Table 26-7 identifies for each alternative the approximate lengths of proposed
44 permanent aboveground and underground transmission lines, as well as those sensitive receptors
45 within 300 feet of the proposed lines.

1 **Table 26-7. Length of Proposed Permanent 69 kV and 230 kV Transmission Lines (miles) and Proximity to Sensitive Receptors**

Alternative	69 kV Transmission Lines				230 kV Transmission Lines			
	Underground		Aboveground		Underground		Aboveground	
	Length ^a (miles)	Residences (total) or Other Sensitive Receptors within 300 Feet of Proposed Lines	Length ^a (miles)	Residences (total) or Other Sensitive Receptors within 300 Feet of Proposed Lines	Length ^a (miles)	Residences (total) or Other Sensitive Receptors within 300 Feet of Proposed Lines	Length ^a (miles)	Residences (total) or Other Sensitive Receptors within 300 Feet of Proposed Lines
1	23.3	<ul style="list-style-type: none"> • Residences (37) • Cosumnes River Preserve • Stone Lakes National Wildlife Refuge • White Slough Wildlife Area 	3.9	<ul style="list-style-type: none"> • Residences (23) • Cosumnes River Preserve 	0.2	None	8.3	None
2a	23.7	<ul style="list-style-type: none"> • Residences (37) • Cosumnes River Preserve • Stone Lakes National Wildlife Refuge • White Slough Wildlife Area 	3.9	<ul style="list-style-type: none"> • Residences (23) • Cosumnes River Preserve 	0.2	None	8.3	None
2b	20.7	<ul style="list-style-type: none"> • Residences (32) • Cosumnes River Preserve • Stone Lakes National Wildlife Refuge • White Slough Wildlife Area 	3.9	Residences (23) Cosumnes River Preserve	0.2	None	8.3	None

Alternative	69 kV Transmission Lines				230 kV Transmission Lines			
	Underground		Aboveground		Underground		Aboveground	
	Length ^a (miles)	Residences (total) or Other Sensitive Receptors within 300 Feet of Proposed Lines	Length ^a (miles)	Residences (total) or Other Sensitive Receptors within 300 Feet of Proposed Lines	Length ^a (miles)	Residences (total) or Other Sensitive Receptors within 300 Feet of Proposed Lines	Length ^a (miles)	Residences (total) or Other Sensitive Receptors within 300 Feet of Proposed Lines
2c	23.3	<ul style="list-style-type: none"> • Residences (37) • Cosumnes River Preserve • Stone Lakes National Wildlife Refuge • White Slough Wildlife Area 	3.9	<ul style="list-style-type: none"> • Residences (23) • Cosumnes River Preserve 	0.2	None	8.3	None
3	18.7	<ul style="list-style-type: none"> • Residences (7) • Cosumnes River Preserve • Stone Lakes National Wildlife Refuge 	3.9	<ul style="list-style-type: none"> • Residences (23) • Cosumnes River Preserve 	0.2	None	8.3	None
4a	19.1	<ul style="list-style-type: none"> • Residences (7) • Cosumnes River Preserve • Stone Lakes National Wildlife Refuge 	3.9	<ul style="list-style-type: none"> • Residences (23) • Cosumnes River Preserve 	0.2	None	8.3	None
4b	16.1	<ul style="list-style-type: none"> • Residences (2) • Cosumnes River Preserve • Stone Lakes National Wildlife Refuge 	3.9	<ul style="list-style-type: none"> • Residences (23) • Cosumnes River Preserve 	0.2	None	8.3	None
4c	18.7	<ul style="list-style-type: none"> • Residences (7) • Cosumnes River Preserve • Stone Lakes National Wildlife Refuge 	3.9	<ul style="list-style-type: none"> • Residences (23) • Cosumnes River Preserve 	0.2	None	8.3	None

Alternative	69 kV Transmission Lines				230 kV Transmission Lines			
	Underground		Aboveground		Underground		Aboveground	
	Length ^a (miles)	Residences (total) or Other Sensitive Receptors within 300 Feet of Proposed Lines	Length ^a (miles)	Residences (total) or Other Sensitive Receptors within 300 Feet of Proposed Lines	Length ^a (miles)	Residences (total) or Other Sensitive Receptors within 300 Feet of Proposed Lines	Length ^a (miles)	Residences (total) or Other Sensitive Receptors within 300 Feet of Proposed Lines
5	15.2	<ul style="list-style-type: none"> • Residences (7) • Cosumnes River Preserve • Stone Lakes National Wildlife Refuge 	3.9	<ul style="list-style-type: none"> • Residences (23) • Cosumnes River Preserve 	0	N/A	0.3	None

1 kV=kilovolt; N/A = not applicable.

2 ^a Length rounded to nearest tenth of a mile.

1 **Microcystis**

2 As described in Chapter 9, the assessment of water conveyance facility operations on CHABs utilized
 3 Delta Simulation Model II (DSM2)-modeled water temperature, velocity, and residence time. In
 4 addition, potential changes in nutrients and water clarity due to project operations, including
 5 compensatory mitigation, were assessed qualitatively to make determinations regarding whether
 6 the project alternatives could result in substantial changes to one or more of these environmental
 7 factors in Delta waters such that the frequency of magnitude of CHABs in the Delta would be
 8 affected. Additional details regarding the assessment methodology are provided in Appendix 9E,
 9 *Cyanobacteria Harmful Algal Blooms*.

10 **26.3.2 Thresholds of Significance**

11 This impacts analysis assumes that a project alternative would have a significant impact under CEQA
 12 if implementation would result in one of the following conditions.

- 13 • Substantial increase in the public's risk of exposure to vector-borne diseases. For purposes of
 14 this analysis, *substantial increase* would be evaluated qualitatively, depending on the location of
 15 the alternative, in accordance with State CEQA Guidelines Section 15064(b)(1).⁸
- 16 • Exceedance(s) of water quality criteria for constituents of concern such that drinking water
 17 quality may be affected. This analysis is based on the qualitative and quantitative results
 18 presented in Chapter 9 to identify whether the construction and operation of the alternatives
 19 would exceed water quality standards for pesticides that do not bioaccumulate (present use
 20 pesticides for which substantial information is available, namely diazinon, chlorpyrifos,
 21 pyrethroids, and diuron), trace metals of human health and drinking water concern
 22 (i.e., aluminum, arsenic, iron, and manganese), and DBP precursors, DOC, and bromide.
- 23 • Substantial mobilization or substantial increase of constituents known to bioaccumulate. For
 24 purposes of this analysis, an expected increase in bioaccumulation above existing conditions
 25 (levels and locations) in fish in the study area as a result of implementing an alternative would
 26 be considered a potential effect and is discussed qualitatively in terms of the populations
 27 affected and potential public health concerns.
- 28 • Adversely affect public health due to exposing sensitive receptors to new sources of EMF.
 29 Exposure to EMF from new transmission lines is dependent on the location of the transmission
 30 lines in relation to sensitive receptors. For purposes of this analysis, residences, schools,
 31 hospitals, parks, and fire stations are considered sensitive receptors. Residences and other
 32 sensitive receptors located 300 feet or more from power lines are not considered to be at risk of
 33 high EMF exposure.
- 34 • Increase in *Microcystis*, and thus microcystin concentrations, in waterbodies in the study area
 35 such that public health may be adversely affected. This analysis is based on the results of the
 36 qualitative analysis presented in Chapter 9.

⁸ State CEQA Guidelines Section 15064(b)(1): "The determination of whether a project may have a significant effect on the environment calls for careful judgment on the part of the public agency involved, based to the extent possible on scientific and factual data. An ironclad definition of significant effect is not always possible because the significance of an activity may vary with the setting. For example, an activity which may not be significant in an urban area may be significant in a rural area."

26.3.2.1 Evaluation of Mitigation Impacts

CEQA also requires an evaluation of potential impacts caused by the mitigation measures. Following the CEQA conclusion for each impact, the chapter analyzes potential impacts associated with implementing both the Compensatory Mitigation Plan (CMP) and the other mitigation measures required to address with potential impacts caused by the project. Mitigation impacts are considered in combination with project impacts in determining the overall significance of the project. Additional information regarding the analysis of mitigation measure impacts is provided in Chapter 4, *Framework for the Environmental Analysis*.

26.3.3 Impacts and Mitigation Approaches

26.3.3.1 No Project Alternative

As described in Chapter 3, *Description of the Proposed Project and Alternatives*, CEQA Guidelines Section 15126.6 directs that an EIR evaluate a specific alternative of “no project” along with its impact. The No Project Alternative in this Final EIR represents the circumstances under which the project (or project alternative) does not proceed and considers predictable actions, such as projects, plans, and programs, that would be predicted to occur in the foreseeable future if the Delta Conveyance Project is not constructed and operated, which are identified in Appendix 3C, *Defining Existing Conditions, No Project Alternative, and Cumulative Impact Conditions*, Section 3C.3.2, *No Project Alternative Conditions*, including Table 3C-2. This description of the environmental conditions under the No Project Alternative first considers how public health could change over time and then discusses how other predictable actions described in Appendix 3C, Section 3C.3.2.5, *No Project Alternative Assumptions for Water Agency Actions*, could affect public health.

Future Public Health Conditions

Future conditions with respect to water quality changes within the Delta could be expected to primarily be driven by climate change and sea level rise, as described in Chapter 9. There would be little change in DOC, trace metals, and pesticides in the Delta under the No Project Alternative relative to existing conditions. Although no substantial changes in DOC would be expected, there may be changes in the potential for the formation of DBPs in drinking water due to potential increases in bromide concentrations in the western Delta. This change relative to existing conditions would be due in large part to increases in salinity in this area of the Delta that could be expected to occur as a result of climate change and sea level rise. Treatment plants that use the Delta as a source for drinking water already experience highly variable bromide concentrations and, thus, must implement appropriate treatment technologies to ensure compliance with drinking water regulations for disinfection byproducts. In addition, there would be little change in mercury within the Delta under the No Project Alternative relative to existing conditions and therefore no expected substantial change to levels of methylmercury in fish tissue in the Delta. OEHHA standards and fish consumption advisories would continue to be implemented for the consumption of fish, which would help protect people from the overconsumption of fish with increased body burdens of mercury. CHABs would be expected to occur with similar or greater frequency throughout the study area for the No Project Alternative, relative to existing conditions. Increases in water temperature and potentially lower inflows to the Delta in summer months due to climate change would be responsible for more frequent or extensive blooms in the Delta.

Climate change under the No Project Alternative would also be expected to affect the occurrence of vector-borne diseases in the study area relative to existing conditions. With increasing temperatures, it is expected that mosquito abundance, survival, and feeding activity would increase because mosquitoes are ectotherms (i.e., “cold-blooded”) and, as such, rely on external sources of heat for reproduction and survival. Furthermore, the rate of development of the pathogen within the mosquito may also increase with increasing ambient temperatures (Rocklöv and Dubrow 2020:479–480).

To the extent that additional electric transmission lines are constructed and operated in the Delta in close proximity to sensitive receptors, those receptors could be exposed to EMF. Exposure of sensitive receptors to EMF in the Delta likely would not change substantially overall under the No Project Alternative relative to existing conditions given current land use policies and practices. It is also reasonable to assume that utilities would implement routine magnetic field-reduction measures identified in the EMF Design Guidelines to reduce the potential for EMF exposure.

Predictable Actions by Others

A list and description of actions included as part of the No Project Alternative are provided in Appendix 3C, Section 3C.3.2.5. As described in Chapter 4 and Appendix 3C, the No Project Alternative analyses focus on identifying the additional water supply-related actions public water agencies may opt to follow if the Delta Conveyance Project does not occur.

Public water agencies participating in the Delta Conveyance Project have been grouped into four geographic regions. The water agencies within each geographic region would likely pursue a similar suite of water supply projects under the No Project Alternative (Appendix 3C, Section 3C.3.2.5). Although the types of water supply projects considered would vary somewhat by region, projects would generally include water conservation programs, water recycling for non-potable uses, groundwater recovery (brackish water desalination) projects, seawater desalination, and groundwater management.

Water conservation programs could include rebate programs or other incentives for water saving devices, water use restrictions, and water conservation outreach campaigns to educate the public (e.g., direct mail newsletters or community events). Water conservation programs would likely be pursued by all four regions. These types of conservation actions would not result in public health impacts due to exposure to vector-borne diseases, exceedances of water quality criteria for constituents of concern in drinking water, increases in bioaccumulative pesticides or methylmercury in fish, or exposure to EMF or *Microcystis* and cyanotoxins. Because these water conservation actions are intended to reduce use and waste of water, they would not result in standing water (i.e., mosquito habitat), the mobilization or introduction of pollutants to surface or groundwater, require new power transmission lines, or result in changes in river flow (i.e., residence time), water temperature, nutrients or create other conditions conducive to CHABs.

Water recycling projects could be pursued in all four regions. Recycled water is wastewater treated to an acceptable water quality standard at a WWTP and then distributed for use. Water recycling for non-potable use generally requires modifications to existing WWTPs and water distribution systems for treatment and conveyance, respectively. To the extent that ground-disturbing construction activities may be required to modify existing WWTPs, there may be temporary effects on water quality potentially related to runoff and erosion, but these would be localized and would not result in increases in concentrations of trace metals, pesticides, or disinfection byproducts such that drinking water quality is compromised or cause a substantial mobilization of or increase in

1 bioaccumulative water quality constituents. Water ponding, including in unused containers and
2 building wastes, as well as on the ground, at construction sites during construction could increase
3 standing water after rain events and thereby create mosquito habitat, but these inundated areas
4 would likely be relatively small, localized, and temporary and would not negatively affect public
5 health due to vector-borne disease exposure. Because recycled water treatment is relatively energy
6 intensive, upgrades to the electrical system of a WWTP may be required, but upgrades would likely
7 occur within the existing WWTP footprint or right-of-way; therefore, increased public exposure to
8 EMF would not occur. Furthermore, the utilities would implement EMF Design Guidelines for
9 construction of new or upgraded electrical transmission lines and substations. These design
10 guidelines include no-cost and low-cost methods for reducing magnetic fields. It is not anticipated
11 that the recycled water facilities would discharge recycled water into receiving waters because the
12 water would be distributed to users in the service area. Accordingly, operation of these facilities
13 would not result in changes in river flow, water temperature, nutrients or create other conditions
14 conducive to CHABs.

15 The northern and southern coastal regions are most likely to explore implementing groundwater
16 management projects. Construction of groundwater management projects could require excavation
17 and other ground-disturbing activities, but there would be no effects on public health related to
18 exposure to vector-borne diseases, increases in concentrations of trace metals, pesticides or
19 disinfection byproducts such that drinking water quality is compromised, or cause a substantial
20 mobilization of or increase in bioaccumulative water quality constituents for the reasons discussed
21 for construction of water recycling projects. Groundwater management projects may or may not
22 require new power transmission lines to provide power to electric groundwater pumps. However,
23 groundwater recharge projects are not typically located in densely populated areas and therefore if
24 new transmission lines required it is reasonable to assume that there would not be a substantial
25 increase in public exposure to EMF. Groundwater management projects would not affect drinking
26 water quality because drinking water in public water supply systems would continue to be treated
27 to drinking water standards prior to distribution into the drinking water system. Operation of
28 groundwater recharge sites would likely create standing pools of water (e.g., recharge basins),
29 which could create mosquito breeding habitat, an increase in mosquitoes and subsequent exposure
30 of the public to vector-borne diseases. However, local MVCDs would exercise their authority to
31 conduct surveillance for vectors, prevent the occurrence of vectors, and abate production of vectors
32 and project proponents would also be responsible for mosquito abatement (Health & Saf. Code §
33 2060).

34 Water supply desalination involves diverting seawater or brackish water to a desalination facility
35 and removing excess salts or minerals through membrane distillation treatment. Seawater
36 desalination projects would most likely be pursued in the northern and southern coastal regions.
37 The southern coastal regions would likely pursue larger and more desalination projects than the
38 northern coastal region in order to replace the water yield that otherwise would have been received
39 through the Delta Conveyance Project. Brackish water desalination could occur across the northern
40 inland, southern coastal, southern inland regions and in both coastal and inland areas. There would
41 be no adverse construction-related effects on public health related to exposure to vector-borne
42 diseases, increases in concentrations of trace metals, pesticides or disinfection byproducts such that
43 drinking water quality is compromised for the reasons discussed for construction of water recycling
44 projects. Construction of water diversion intakes could mobilize existing bioaccumulative
45 constituents within sediments (e.g., methylmercury), but this would be temporary and localized and
46 would not result in a substantial increase in bioaccumulation in fish and therefore would not affect

public health. Construction effects would not be adverse because the mobilization would occur during a limited time and would be localized around the area of construction. Operation of desalination facilities, including distribution infrastructure, would not create habitat for mosquitoes because it would not create areas of standing water; therefore, there would be no increase in public exposure to vector-borne diseases. Public health would not be affected by adverse changes in drinking water quality because water intended for potable use would be treated to drinking water standards prior to distribution. Similarly, discharge of brine from either seawater or brackish water desalination facilities would be subject to waste discharge requirements of the Regional Water Board to avoid effects from increased salinity. Water desalination is an energy-intensive process, and it is likely that new transmission lines would be constructed and operated. New desalination facilities would require transmission lines for power and, although desalination facilities are not likely to be sited near sensitive receptors, transmission lines would traverse from the new desalination facility to existing electrical facilities providing power to the new lines. Accordingly, there could be an increase in exposure of sensitive receptors to EMF depending on proximity to new transmission lines. It is assumed that utilities would implement routine magnetic field reduction measures identified in the EMF Design Guidelines to reduce the potential for EMF exposure. It is not anticipated that the recycled water facilities would discharge recycled water into receiving waters because the water would be distributed to users in the service area. Accordingly, operation of these facilities would not result in changes in river flow, water temperature, nutrients or create other conditions conducive to CHABs.

New desalination facilities would require transmission lines for power and, although desalination facilities are not likely to be sited near sensitive receptors (e.g., adjacent to a hospital, school, or residential area), transmission lines would traverse from the new desalination facility to existing electrical facilities providing power.

26.3.3.2 Impacts of the Project Alternatives on Public Health

Impact PH-1: Increase in Vector-Borne Diseases

All Project Alternatives

Project Construction

Ponding in construction and staging areas for all alternatives, as well as at sites where preconstruction field investigations are performed, could develop after moderate to heavy precipitation events. Ponding areas that do not dry for several days may create suitable mosquito breeding habitat and thus contribute to mosquito population growth. Stormwater runoff would be diverted to an on-site collection system to be captured, treated, and stored in enclosed trailers for on-site water supplies. Therefore, stormwater would not be allowed to accumulate in large open-shallow ponds at the construction site, which would minimize potential mosquito breeding habitat. Because mosquitoes in Northern California typically breed April–October (Sacramento–Yolo Mosquito and Vector Control District 2008), ponding on the ground or any standing water at construction sites (e.g., in unused containers, construction and demolition debris) in spring or fall, when precipitation is more likely to occur, could temporarily create suitable mosquito breeding habitat, which may temporarily increase the public's exposure to vector-borne diseases in the study area.

Operations and Maintenance

All project alternatives would include operation and maintenance of one sedimentation basin and four sediment drying lagoons at each intake. Both of these project features would introduce new surface water areas in the study area. The total number of sedimentation basins and drying lagoons would vary by alternative. Alternatives 2a and 4a would each have a total of three sedimentation basins and 12 drying lagoons; Alternatives 1, 2c, 3, 4c, and 5 would each have a total of two sedimentation basins and eight drying lagoons; and Alternatives 2b and 4b would each have a total of 1 sedimentation basin and four drying lagoons. The water surface elevation in each sedimentation basin would vary from approximately 3 to 27 feet. Water depth in the sediment drying lagoons would average 10 to 12 feet when in use. The sedimentation basins and drying lagoons of Intake A would be located less than 1 mile south of Clarksburg and less than 1.5 miles west of Elk Grove. The town of Hood would be less than 1 mile south of the sedimentation basins and drying lagoons at Intake B and less than 1.5 miles north of the sedimentation basins and drying lagoons at Intake C.

Water diverted from the Sacramento River through an intake would be collected in a sedimentation basin where suspended sediment would settle. A control structure at the back of each sedimentation basin would hold the water in the basin at a constant water level relative to the river level and allow the diverted flow into the tunnel inlet channel. During the summer months (May through September), the sedimentation basins would be dredged, and the sediment slurry discharged to the drying lagoons where water would drain and be pumped back into the sedimentation basin. Each lagoon would be filled and drained for about 3 days, then the sediment would be dried and removed in about 4 to 5 days; the basin fill and drain/dry sequence would be approximately 7 to 8 days (Delta Conveyance Design and Construction Authority 2022:25). Therefore, water movement through the sedimentation basins and drying lagoons would be constant enough to prevent water from stagnating. As discussed in Section 26.1.1.5, *Vectors*, mosquitoes typically prefer shallow (generally less than 3 feet in depth), stagnant water with little movement for breeding. Water in the sedimentation basins and drying lagoons would generally be too deep and have too much regulated water movement to provide suitable mosquito habitat. On average, water residence time in the sedimentation basins at full depth and minimum intake flow would be approximately 1 day. During the summer, water residence time would be approximately 12 hours. Furthermore, during sediment drying and basin cleaning operations, flow would be stopped completely and the moisture in the sediment would be reduced to a point at which the sediment would not support insect/mosquito larvae production. Minor vegetation management would be conducted on a monthly basis, at minimum, along the side slopes of the basins to keep them free of unwanted vegetative growth. Therefore, sedimentation basins and drying lagoons would not substantially increase suitable mosquito breeding habitat and would not substantially increase the public's exposure to vector-borne diseases.

Under all project alternatives except Alternative 5, a forebay (the Southern Forebay) would be constructed and operated. Located on Byron Tract, the Southern Forebay would have a water surface area of approximately 750 acres under normal operating conditions. Average surface water elevation in the Southern Forebay would be approximately 11.5 feet and would range from approximately 5.5 to 17.5 feet. Although the proposed Southern Forebay would increase surface water within the study area, it is unlikely that the forebay would provide suitable breeding habitat for mosquitoes given that the water would not be stagnant because DWR would manage the forebay to encourage volume turnover and would be too deep to provide suitable mosquito habitat under normal operating conditions. Mosquitoes prefer relatively shallow water (less than 3 feet deep) for egg laying. In drier water year types when flows are reduced, water residence time in the forebay

1 would be expected to increase somewhat. Although the shallow edges of the forebay could provide
2 suitable mosquito breeding habitat if emergent vegetation or other aquatic plants (e.g., pond weed)
3 were allowed to grow, maintenance of the forebay would include biannual removal of aquatic
4 vegetation.

5 The surge basin proposed for Alternative 5 would normally be empty and would only be used during
6 infrequent hydraulic transient-surge events. As such, this facility would not create mosquito
7 breeding habitat.

8 ***CEQA Conclusion—All Project Alternatives***

9 Under all project alternatives, ponding in construction and staging areas (including in unused
10 containers, construction, and demolition debris), as well as at sites where preconstruction field
11 investigations are performed, could develop after moderate to heavy precipitation events and
12 temporarily create areas conducive to mosquito breeding, which may temporarily increase the
13 public's exposure to vector-borne diseases in the study area. However, there would be extensive
14 stormwater facilities at each site where stormwater runoff would be diverted to an on-site collection
15 system to be captured, treated, and stored in enclosed trailers for on-site water supplies. Therefore,
16 stormwater would not be allowed to accumulate in large open-shallow ponds at the construction
17 site, which would minimize potential mosquito breeding habitat. However, remaining smaller
18 puddles of water could continue for several days and could increase potential for mosquito
19 breeding, especially at the larger construction sites for the intakes, tunnel launch shaft sites, and
20 Southern Complex or Bethany Complex. This could increase the public's exposure to vector-borne
21 diseases, which would be a significant impact.

22 Operation of sedimentation basins and drying lagoons under all project alternatives, and operation
23 of the Southern Forebay under all project alternatives except Alternative 5, has the potential to
24 provide habitat for vectors that transmit diseases (e.g., mosquitoes) because new areas of surface
25 water would be introduced in the study area relative to existing conditions. However, the depth,
26 design, and operation of the sedimentation basins and drying lagoons would prevent the
27 development of suitable mosquito habitat. Specifically, water in the basins would be too deep and
28 the regular movement of water through the project facilities would prevent mosquitoes from
29 breeding and multiplying. Similarly, water in the Southern Forebay would generally be circulated
30 regularly because DWR would manage the forebay to encourage volume turnover and, with the
31 exception of shallower areas around the periphery, would be too deep (5.5 to 17.5 feet surface water
32 elevation) to provide suitable mosquito breeding habitat. In drier water year types, when flows are
33 reduced, water residence time in the forebay would increase; however, because mosquitoes prefer
34 relatively shallow water (less than 3 feet deep) for egg laying, substantial breeding habitat in the
35 forebay is not expected. Minor vegetation management would be conducted on a monthly basis, at
36 minimum, along the side slopes of the basins to keep them free of unwanted vegetative growth.
37 Furthermore, although the shallow edges of the forebay could provide suitable mosquito breeding
38 habitat if emergent vegetation or other aquatic plants (e.g., pond weed) were allowed to grow,
39 maintenance of the forebay would include biannual removal of aquatic vegetation. Thus, operation
40 and maintenance of the water conveyance facilities would not be expected to result in the creation
41 of potentially suitable mosquito breeding habitat and thus would not likely increase the public's
42 exposure to vector-borne diseases in the study area relative to existing conditions.

43 Mitigation Measure PH-1a: *Avoid Creating Areas of Standing Water During Preconstruction, Field*
44 *Investigations, and Project Construction* would minimize the potential for any impact on public

health related to increasing suitable vector habitat within the study area during construction and reduce this impact to a less-than-significant level by reducing suitable mosquito habitat at project alternative facilities.

Mitigation Measure PH-1a: Avoid Creating Areas of Standing Water During Preconstruction Field Investigations and Project Construction

1. DWR will eliminate standing water to reduce potentially suitable mosquito breeding areas at field investigation sites and construction sites (including staging areas). Actions will include, but not necessarily be limited to:
 - a. Avoid leaving containers that can accumulate water in an uncovered or upright position. This includes wheelbarrows, drums, buckets, cans, tarps, and other containers. If uncovered containers must remain on-site, create drainage holes.
 - b. Store building materials under shelter/cover that does not collect water.
 - c. Grade all work areas to drain.
 - d. Fill in potholes and other areas where water is likely to accumulate and/or clear pooled, stagnant water regularly.
 - e. Routinely remove garbage and other debris that may collect water.
 - f. Periodically pump out water from trenches, ditches, or other ground areas where water could accumulate for several days and potentially provide mosquito breeding habitat.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F, *Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources*, does not act as mitigation for impacts on public health from project construction or operations, its implementation could result in impacts on public health.

Compensatory mitigation on Bouldin Island and at three ponds east of the Mokelumne River and west of Interstate (I-) 5 would create aquatic habitat potentially suitable for mosquito breeding. Tables 26-8a and 26-8b summarize the change in acreage for aquatic habitat types on Bouldin Island and at I-5 Pond Sites 6, 7, and 8 relative to existing conditions.

Tidal wetland habitat, created as part of the proposed Tidal Habitat Mitigation Framework, would not be expected to contribute suitable mosquito breeding habitat in the study area. Tidal wetland restoration can reduce mosquito populations as tidal fluctuations keep water moving so that mosquitoes do not have standing water in which to breed. Details on the proposed Tidal Habitat Mitigation Framework, as well as the creation and enhancement of aquatic and other habitat types on Bouldin Island and at I-5 pond sites, are provided in Appendix 3F.

Table 26-8a. Change in Aquatic Habitat on Bouldin Island (acres) ^{a, b}

Aquatic Habitat Type	Bouldin Island (Sites B1 and B2)
Agricultural ditch/drain	-13.3
Depression (lake/pond)	10.3
Tidal channel	0
Natural channel	0
Conveyance channel	0
Alkaline seasonal wetland	0
Seasonal wetland	92.2
Nontidal freshwater emergent wetland	49.9
Valley/foothill riparian (forested and scrub shrub wetland)	193.9
Tidal freshwater emergent wetland	0
Vernal pool	0
Total	333.0

^a Acres rounded to the nearest tenths. See Appendix 3F, *Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources*, for more detail.

^b Acreage identified in the table represents the change in acreage of that aquatic habitat type relative to existing conditions.

Table 26-8b. Change in Aquatic Habitat at I-5 Ponds 6, 7, and 8 (acres) ^{a, b}

Aquatic Habitat Type	Pond 6	Ponds 7 and 8
Agricultural ditch	-0.1	-0.3
Nontidal Freshwater Emergent Wetland	37.6	58.6
Nontidal Perennial Aquatic (depression, lake/pond, natural channel)	10.2	-30.0
Other Seasonal Wetlands	0	-0.2
Tidal Freshwater Emergent Wetland	0	0
Tidal Perennial Aquatic (tidal channel)	0	0
Valley/ Foothill Riparian	-31.0	-5.8
Total	16.7	22.3

^a Acres rounded to the nearest tenths. See Appendix 3F, *Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources*, for more detail.

^b Acreage identified in the table represents the change in acreage of that aquatic habitat type relative to existing conditions.

1 A net increase in potentially suitable mosquito breeding habitat as a result of implementing
2 compensatory mitigation would occur on Bouldin Island and at all I-5 pond sites (Tables 26-8a and
3 26-8b). Of the compensatory mitigation sites, I-5 Pond 7 and 8 sites are the closest to a densely
4 populated area (i.e., approximately 5 miles west of Lodi). The I-5 Pond 6 site is less than
5 approximately 7 miles from Lodi, but fewer acres of potentially suitable mosquito breeding habitat
6 would be created/enhanced relative to Ponds 7 and 8 (Figure 26-1). Bouldin Island is less than 10
7 miles from Oakley and Stockton. Table 26-3 outlines the distances traveled from breeding grounds
8 for the mosquito species known to occur in the Delta. These distances range from less than 1 mile to
9 up to 20 or more miles. Therefore, aquatic habitat creation and enhancement restoration at all
10 proposed compensatory mitigation sites on Bouldin Island and at the I-5 pond sites may result in an
11 increase in mosquito breeding habitat, mosquitoes, and public exposure to vector-borne diseases. It
12 should be noted that although there would be a net increase in aquatic habitat, not necessarily all of
13 this habitat would be high-quality mosquito breeding habitat. For example, as described in Section
14 26.1.1.5, *Vectors*, functional tidal marshes do not provide high-quality habitat for all mosquito
15 species, and maintenance and restoration of natural tidal flushing in marshes is effective at limiting
16 mosquito populations. Furthermore, forested and scrub shrub wetlands typically are in areas that
17 have saturated soils, but are not necessarily inundated such that pooling would occur, although the
18 potential for pooling exists.

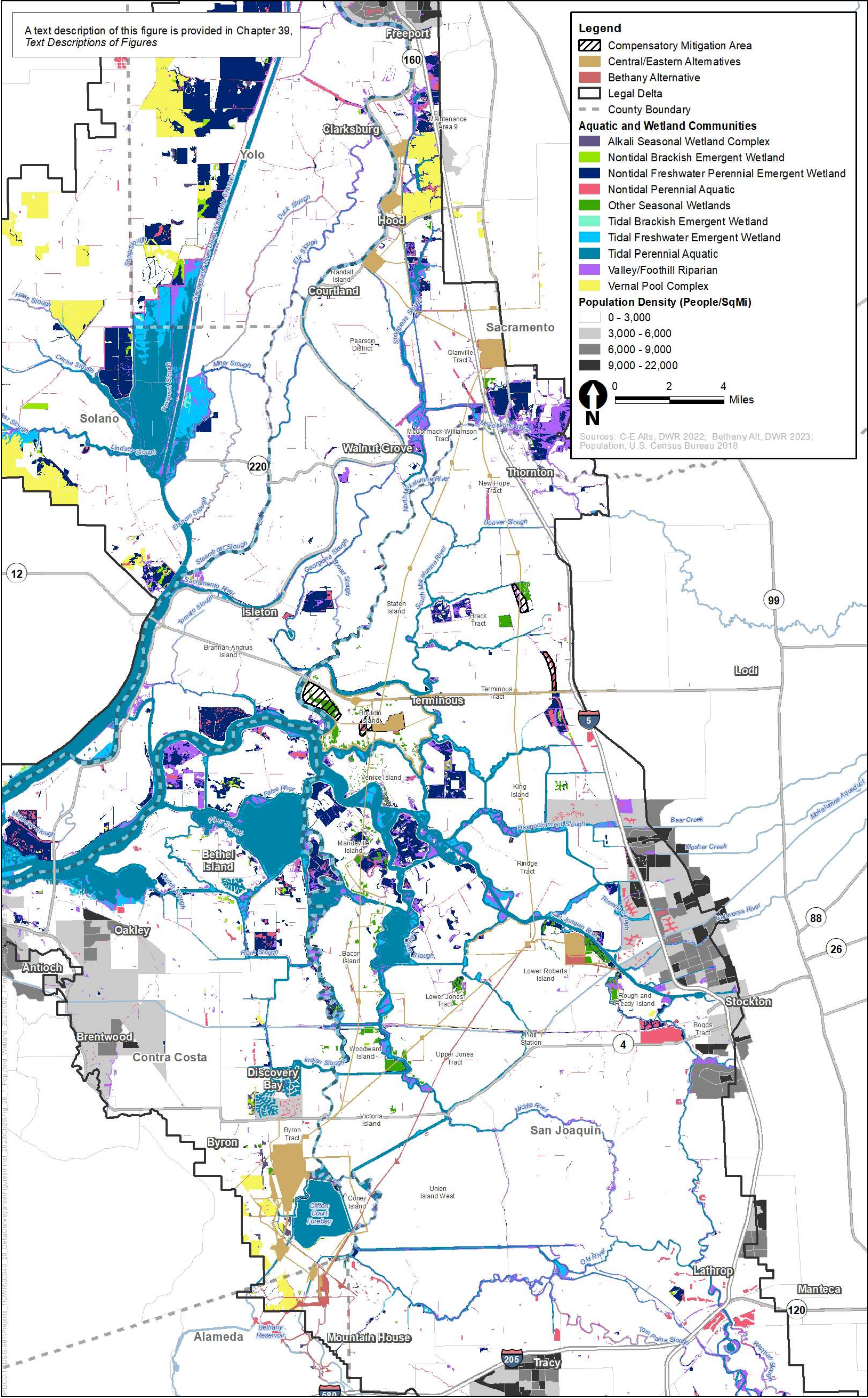


Figure 26-1. Population Density and Wetland Communities

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The project alternatives combined with the CMP would have a potentially significant impact on public health by increasing suitable mosquito breeding habitat within the study area both temporarily and permanently, as discussed above. Mitigation Measure PH-1a: *Avoid Creating Areas of Standing Water During Preconstruction Field Investigations and Project Construction* and Mitigation Measure PH-1b: *Develop and Implement a Mosquito Management Plan for Compensatory Mitigation Sites on Bouldin Island and at I-5 Ponds* would reduce the severity of this impact to a less-than-significant level by managing project facilities to reduce mosquito habitat and implementing a vector control plan in coordination with local MVCDs. Combined with project alternatives, there would be no change in the overall impact conclusion.

Mitigation Measure PH-1b: Develop and Implement a Mosquito Management Plan for Compensatory Mitigation Sites on Bouldin Island and at I-5 Ponds

1. To aid in vector management and control, DWR will develop and implement a mosquito management plan for the compensatory mitigation sites where freshwater marsh, lake/pond, riparian, or seasonal wetland habitat is created/enhanced on Bouldin Island and at the I-5 Ponds. Bouldin Island and the I-5 Ponds are located in San Joaquin County and thus DWR will consult with the San Joaquin County MVCD with respect to habitat creation and enhancement activities at these locations. Consultation will include, but may not be limited to, review of the mosquito management plan and best management practices (BMPs) to be implemented at the compensatory mitigation sites, review of proposed mosquito monitoring efforts at the sites, and assistance with monitoring efforts where feasible. In addition, DWR will consult with the San Joaquin County MVCD during all phases of habitat creation and enhancement (i.e., design, implementation, and operations).
2. The Central Valley Joint Venture's Technical Guide to Best Management Practices for Mosquito Control in Managed Wetlands (Kwasny et al. 2004), the California Department of Public Health's Best Management Practices for Mosquito Control in California (California Department of Public Health and the Mosquito and Vector Control Association of California 2012), and other guidelines will be used to help design appropriate habitat creation and enhancement features to the extent feasible, consistent with the biological goals and objectives of the Delta Conveyance Project.
3. The mosquito management plan will address aquatic habitat design considerations, water management practices, vegetation management, biological controls, and habitat maintenance. BMPs included in the mosquito management plan will include (as applicable), but may not be limited to:
 - a. Implement monitoring and sampling programs to detect early signs of mosquito population problems.
 - b. Implement freshwater habitat management to include water-control-structure management, vegetation management to reduce mosquito production, mosquito predator management, drainage improvements, and coordination with California Department of Fish and Wildlife regarding these strategies and specific techniques to help minimize mosquito production.
 - c. Maintain permanent ponds that increase the diversity of waterfowl yet decrease the introduction of vectors through constant circulation of water, vegetation control, and periodic draining of ponds.

- d. Utilize water sources with mosquito predators (e.g., mosquito-eating fish or invertebrate predators) for flooding.
- e. Manage vegetation routinely; activities such as annual thinning of rushes and cattails and removing excess vegetative debris enables natural predators to hunt mosquito larvae more effectively in permanent wetlands. Vegetation in shallow, temporary wetlands can be mowed when dry.
- f. Time flooding of seasonal wetlands to reduce overlap with peak mosquito activity.
- g. Excavate deep channels or basins to maintain permanent water areas (>2.5 feet deep) within a portion of seasonal managed wetlands. This provides year-round habitat for mosquito predators that can inoculate seasonal wetlands when they are irrigated or flooded.
- h. Provide adequate water control structures for complete drawdown and rapid flooding.
- i. When possible, include independent inlets and outlets in the design of each wetland unit.
- j. Construct or enhance swales so they are sloped from inlet to outlet and allow maximum drawdown.
- k. Use biological agents, such as mosquito fish (*Gambusia affinis*), to limit larval mosquito populations.
- l. Use larvicides and adulticides, as necessary, in compliance with all applicable federal and state regulations (e.g., Clean Water Act, Endangered Species Act). Use only larvicides and adulticides that are currently registered by the California Department of Pesticide Regulation. These pesticides will be applied only by trained personnel and according to label directions.

Other Mitigation Measures

Some mitigation measures would involve the use of heavy equipment such as graders, excavators, dozers, and haul trucks, which would create the potential for ponding after moderate to heavy precipitation events due to ground disturbance. The mitigation measures with potential to result in ponding and associated increase in vector-borne diseases are: Mitigation Measures BIO-2c: *Electrical Power Line Support Placement*; AG-3: *Replacement or Relocation of Affected Infrastructure Supporting Agricultural Properties*; AES-1c: *Implement Best Management Practices in Project Landscaping Plan*; CUL-1b: *Prepare and Implement a Built-Environment Treatment Plan in Consultation with Interested Parties*; and AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP Operational Pumping to Net Zero*. Temporary increases in mosquito breeding habitat and potentially vector-borne diseases resulting from mitigation measures would be similar to construction effects of the project alternatives in certain construction areas and could contribute to vector-borne disease impacts of the project alternatives. Mitigation Measure PH-1a: *Avoid Creating Areas of Standing Water During Preconstruction, Field Investigations, and Project Construction*, would minimize the potential for any impact on public health related to increasing suitable vector habitat by reducing suitable mosquito habitat. Therefore, other mitigation measures are unlikely to increase vector-borne diseases and the impact would not be substantial with mitigation.

Overall, the impact of increased vector-borne diseases from construction of compensatory mitigation and other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant with mitigation.

Impact PH-2: Exceedance(s) of Water Quality Criteria for Constituents of Concern Such That Drinking Water Quality May Be Affected

All Project Alternatives

Project Construction

Ground-disturbing activities as part of field investigations and construction of the project alternatives, or exposure of disturbed sites immediately following field investigations and project construction and prior to stabilization, could result in precipitation-related soil erosion and runoff to surface waterbodies in the study area. Any existing trace metals, pesticides, other contaminants, or organic matter in the soil could incrementally increase concentrations in surface water. Erosion and Sediment Control Plans and Stormwater Pollution Prevention Plans (SWPPP) (Environmental Commitments EC-4a: *Develop and Implement Erosion and Sediment Control Plans* and EC-4b: *Develop and Implement Stormwater Pollution Prevention Plans*, respectively) under all project alternatives for each construction site would minimize the potential for existing trace metals or pesticides in soils at project construction sites to be introduced to adjacent surface water by controlling erosion and runoff to surface water. Erosion and sediment control BMPs implemented as part of EC-4a would include diverting runoff away from steep, denuded slopes, retaining native vegetation to reduce erosion, and slowing runoff and retaining sediment transported by runoff using silt traps, wattles, and berms. BMPs implemented as part EC-4b would include watering soil and covering stockpiles to prevent wind erosion and capturing sediment in detention facilities (refer to Appendix 3B, *Environmental Commitments and Best Management Practices*, for details). Environmental Commitments EC-4a and EC-4b would be implemented before, during, and after construction and would prevent and minimize the introduction of contaminants into surface waters. Accordingly, project construction would not be expected to negatively affect public health from drinking water sources with respect to trace metals, pesticides, or DBP.

Operation and Maintenance

Trace Metals

Operation of the water conveyance facilities would not substantially change concentrations of metals of primarily human health and drinking water concern (i.e., aluminum, arsenic, iron, manganese) relative to existing conditions in Delta waters. Average concentrations for aluminum, arsenic, iron, and manganese in the Sacramento and San Joaquin Rivers are below the applicable water quality criteria for these metals. No mixing of the primary source waters to the Delta (i.e., Sacramento River, San Joaquin River, and San Francisco Bay) could result in concentrations of these trace metals greater than the highest source water concentration and given that the average water concentrations for these metals do not exceed water quality criteria in any of these surface waterbodies, more frequent exceedances of drinking water criteria in the Delta would not occur under the project alternatives. Accordingly, no effect on public health related to the trace metals from drinking water sources is anticipated.

Pesticides

Sources of pesticides in the study area under existing conditions include direct input of surface runoff from agriculture and urbanized areas in the Delta as well as inputs from rivers upstream of the Delta. These sources would not be affected by implementing the project alternatives. There may be use of both terrestrial and aquatic pesticides/herbicides by DWR during operation and maintenance of the water conveyance facilities, and these would be used in accordance with the established DWR policy for pesticide use per the *Water Resources Engineering Memorandum No. 10b* (WREM 10b [California Department of Water Resources 2018]) as well as per the requirements of the Statewide General National Discharge Pollutant Discharge Elimination System Permit for the Discharge of Aquatic Pesticides for Aquatic Weed Control in Waters of the United States for DWR's Aquatic Pesticides Application Plan for State Water Project facilities (Water Quality Order 2013-0002-DWQ) (California Department of Water Resources 2016). The purpose of WREM 10b is to identify staff roles and responsibilities and to ensure that DWR is following safe procedures for all pesticide-related activities by meeting current regulatory requirements and using up-to-date BMPs. As described in Chapter 9, existing pesticide monitoring and control programs implemented for the Sacramento River and San Joaquin River to address past pesticide-related impairments and prevent potential future impairments are also applicable to the Delta. Because of these programs and the limited potential for any of the project alternatives to affect pesticide concentrations, use or discharge to waterbodies in the study area, the potential for pesticide to impact drinking water quality and therefore public health due to the operation of the water conveyance facilities is low.

Disinfection Byproducts

As discussed in Section 26.1.1.1, *Drinking Water*, chlorine used in the drinking water disinfection process reacts with organic carbon and bromide in water supply sources to form DBPs. There are no numeric federal water quality criteria or state water quality objectives for bromide or organic carbon applicable to Delta waters, to meet current drinking water regulations for DBPs.

DSM2 modeling results of DOC for the project alternatives indicate that monthly average DOC concentrations at assessment locations in the study area would change minimally relative to existing conditions for the full simulation period, as described in Chapter 9. Although nominal, concentration increases would be greatest at Contra Costa Pumping Plant #1, Old River at State Route (SR) 4 and Victoria Canal and would range from 0.1 mg/L at Victoria Canal and Old River, to 0.2 mg/L at Contra Costa Pumping Plant #1. At other locations, specifically Banks and Jones Pumping Plants, monthly average DOC concentrations would either remain the same as existing conditions or decrease slightly, depending on the month (see Appendix 9I, *Organic Carbon*). During the drought years assessed, the project alternatives would result in similar small changes in monthly average DOC concentrations at the Delta assessment locations (refer to Appendix 9I, Tables 9I-1-1-A through 9I-11-6-D). Because DOC concentrations are not expected to change substantially, no long-term water quality degradation from DOC is expected to occur. Any minor increases in DOC concentrations that could occur in the Delta would not cause additional treatment operations or facilities for drinking water treatment plants that utilize Delta waters in order to comply with drinking water regulations.

As described in Chapter 9, modeled bromide concentrations at all Delta assessment locations except Banks Pumping Plant would seasonally increase under the project alternatives relative to existing conditions. However, there would be no substantial changes in the frequency that bromide exceeds

300 µg/L⁹ relative to existing conditions. The greatest magnitude increases in monthly average bromide concentrations would occur in the western Delta at times of the year when bromide concentrations are already high (i.e., typically greater than 1,000 µg/L). To what degree changes in bromide concentrations may result in increased formation of DBPs in the study area is uncertain, as discussed in Chapter 9. Given the numerous variables that affect disinfection byproduct formation potential in Delta-diverted waters, including diversion location and water treatment plant processes, it cannot be definitively determined for this assessment. Treatment plants that use the Delta as a source for drinking water already experience highly variable bromide concentrations and thus must implement appropriate treatment technologies to ensure compliance with drinking water regulations for disinfection byproducts. Despite the potential for periodically higher bromide concentrations under the project alternatives relative to existing conditions at specific times and locations, it is expected that water quality would not be substantially degraded at any Delta location with regard to bromide concentrations given the relatively small increases in long-term average concentrations that would be observed at the locations assessed. These incremental increases in annual average bromide concentrations are not expected to be of sufficient magnitude to cause Delta water diverters to exceed drinking water standards for DBPs more often than under existing conditions.

CEQA Conclusion—All Project Alternatives

Ground-disturbing activities as part of field investigations and project construction activities could result in soil erosion and runoff, which may result in the transport of pesticides and trace metals of primarily human health and drinking water concern (i.e., arsenic, aluminum, iron, and manganese) potentially present in soil to nearby surface waters. However, this potential effect on water quality would be temporary and fairly localized to areas of construction. The development and implementation of site-specific Erosion and Sediment Control Plans and SWPPPs (Environmental Commitments EC-4a: *Develop and Implement Erosion and Sediment Control Plans* and EC-4b: *Develop and Implement Stormwater Pollution Prevention Plans*, respectively) under all project alternatives would minimize the potential for this impact by controlling erosion and runoff to surface water. Sources of pesticides in the study area include direct input of surface runoff from agriculture and urbanized areas in the Delta as well as inputs from rivers upstream of the Delta. These sources would not be affected by operation and maintenance of the project alternatives. Average concentrations for trace metals in the Sacramento and San Joaquin Rivers are below the applicable water quality criteria for these metals. No mixing of the primary source waters to the Delta (i.e., Sacramento River, San Joaquin River, and San Francisco Bay) could result in concentrations of these trace metals greater than the highest source water concentration and given that the average water concentrations for these metals do not exceed water quality criteria in any of these surface waterbodies, more frequent exceedances of drinking water criteria in the Delta would not occur under the project alternatives.

Bromide concentrations at all Delta assessment locations, except Banks Pumping Plant, would seasonally increase under the project alternatives, relative to existing conditions, but would not result in substantial changes to the frequency that bromide exceeds 300 µg/L, relative to existing conditions. The greatest magnitude increases in monthly average bromide concentrations would

⁹ As described in Chapter 9, to evaluate the effects of the project alternatives on bromide, the assessment considered work by a panel of three water quality and treatment experts, engaged by the California Urban Water Agencies, which determined that bromide concentrations up to 300 µg/L, and total organic carbon from 4 mg/L to 7 mg/L, is acceptable to provide users adequate flexibility in their choice of treatment method.

1 occur in the western Delta at times of the year when bromide concentrations are already high. The
2 project alternatives would not cause long-term degradation of water quality with regard to bromide
3 at any of the Delta locations assessed.

4 Because there would be no substantial changes to water quality relative to existing conditions with
5 respect to non-bioaccumulative pesticides, trace metals, or DBPs due to construction, or operation
6 and maintenance under any of the project alternatives, there would be a less-than-significant impact
7 on public health from drinking water sources.

8 ***Mitigation Impacts***

9 *Compensatory Mitigation*

10 Although the CMP described in Appendix 3F does not act as mitigation for impacts on public health
11 from project construction or operations, its implementation could result in impacts on public health.

12 Compensatory mitigation implemented on Bouldin Island and at the sites of the I-5 Ponds 6, 7, and 8
13 would not adversely affect water quality through increases in concentrations of trace metals (i.e.,
14 aluminum, arsenic, iron, and manganese) or pesticides. As described in Chapter 9, natural habitats
15 contribute fewer trace metals and pesticides to receiving waters than agricultural or urban areas. In
16 addition, any newly created wetlands or enhanced habitat may also filter stormwater to remove
17 solids and either improve or have no effect on concentrations of trace metals and pesticides relative
18 to existing conditions.

19 Similarly, compensatory mitigation would not adversely affect drinking water quality due to
20 increases in DBPs because this mitigation is not expected to increase bromide or substantially
21 increase organic carbon in surrounding waterbodies. The natural habitats proposed by the
22 compensatory mitigation are not sources of bromide to receiving waters. As described in Chapter 9,
23 soil type, amount and type of vegetation, construction method, and age of wetland are all factors
24 affecting the potential for wetlands to form reactive carbon that could form DBPs. To ensure that the
25 proposed tidal wetlands do not generate additional organic carbon that could affect municipal water
26 supplies utilizing the Delta for source waters, siting of tidal wetlands would take into consideration
27 the location of nearby drinking water supply intakes. DOC is a concern in drainage water from
28 oxidizing peat soils (Fleck et al. 2007:3). However, likely new tidal wetland sites with suitable
29 elevations would have more mineral-based soils, due to either natural geography (Cache Slough and
30 lower Yolo Bypass areas) or design (e.g., build up elevations with reusable tunnel material or dredge
31 spoil). The hydrologic regime that would occur in the new tidal wetlands would create a consistently
32 anoxic environment in the soils, which would minimize conditions that could foster oxidation of soil
33 organic carbon. Therefore, compensatory mitigation would not affect public health due to
34 substantial increases in DBPs in drinking water or trace metals or pesticides in drinking water
35 sources in the study area. As such, potential impacts on public health related to trace metals,
36 pesticides, and DBPs in drinking water due to project alternatives combined with compensatory
37 mitigation would be minimized; combined with project alternatives, there would be no change in the
38 overall impact conclusion.

39 *Other Mitigation Measures*

40 Some mitigation measures would involve the use of heavy equipment such as graders, excavators,
41 dozers, and haul trucks that would have the potential to result in soil erosion and runoff and
42 associated transport of pesticides, trace metals, or other contaminants in soil. These mitigation

measures with potential to result in soil erosion and runoff are Mitigation Measures BIO-2c: *Electrical Power Line Support Placement*; AG-3: *Replacement or Relocation of Affected Infrastructure Supporting Agricultural Properties*; AES-1c: *Implement Best Management Practices in Project Landscaping Plan*; CUL-1b: *Prepare and Implement a Built-Environment Treatment Plan in Consultation with Interested Parties*; and AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP Operational Pumping to Net Zero*.

Potential temporary increases in any existing trace metals, pesticides, other contaminants, or organic matter in surface water from eroded soil, which may affect drinking water quality downstream, resulting from mitigation measures would be similar to construction effects of the project alternatives in certain construction areas and could temporarily contribute to drinking water quality impacts of the project alternatives. Site-specific Erosion and Sediment Control Plans and SWPPPs (Environmental Commitments EC-4a: *Develop and Implement Erosion and Sediment Control Plans* and EC-4b: *Develop and Implement Stormwater Pollution Prevention Plans*, respectively) would minimize the potential for this impact by controlling erosion and runoff to surface water. Average concentrations for trace metals in the Sacramento and San Joaquin Rivers are below the applicable water quality criteria and exceedances of drinking water criteria would not occur. Other mitigation measures would not result in substantial changes to water quality relative to existing conditions with respect to non-bioaccumulative pesticides, trace metals, or DBPs. Therefore, other mitigation measures is unlikely to exceed water quality criteria that may affect drinking water quality, and the impact on drinking water quality would not be substantial.

Overall, the impact of exceeding water quality criteria that may affect drinking water quality from construction of compensatory mitigation and other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant.

Impact PH-3: Substantial Mobilization of or Increase in Constituents Known to Bioaccumulate

All Project Alternatives

Project Construction

Bioaccumulative Pesticides and Methylmercury

Legacy pesticides, such as organochlorines, have low water solubility—they do not readily volatilize and tend to adsorb (bond) to particulates, settle out into the sediment, and not be transported far from the source. Similarly, mercury and methylmercury adsorb to suspended particulate matter and particulates in sediment. If organochlorines or mercury and methylmercury are present in sediment within in-water construction areas, these toxicants would be temporarily disturbed and resuspended in the water column due to in-channel sediment-disturbing construction activities at intake sites (e.g., pile driving and cofferdam installation, dredging at intakes prior to riprap placement) or field investigations. In addition, legacy pesticides and mercury that may be present in soil at construction sites adjacent to surface water in the study area could enter the water column via runoff and erosion. Increases in water column concentrations of bioaccumulative pesticides or methylmercury can ultimately be transferred to fish consumed by humans. Given the temporary nature of any sediment resuspension, potential changes in water column concentrations of legacy pesticides, mercury, or methylmercury during construction of the project alternatives would not increase long-term fish tissue concentrations in the study area.

The development and implementation of Erosion and Sediment Control Plans and SWPPPs (Environmental Commitments EC-4a: *Develop and Implement Erosion and Sediment Control Plans* and EC-4b: *Develop and Implement Stormwater Pollution Prevention Plans*, respectively) under all project alternatives would minimize the potential for legacy pesticides and mercury in soil to be introduced to the water column. BMPs implemented as part of these plans would control erosion and runoff to surface water (Appendix 3B).

Operations and Maintenance

Bioaccumulative Pesticides

Legacy pesticides that are bioaccumulative, such as organochlorines, are not currently in use and the project alternatives would not increase their concentrations in fish. As discussed in Chapter 9, considering that these legacy pesticides are no longer used, their low frequency of detection in source waters of the Sacramento and San Joaquin Rivers, concentrations of legacy pesticides would not be affected measurably by operation of the water conveyance facilities under all project alternatives. Maintenance dredging of sediment around the intake and pumping plant structures and potential emergency dredging at the fish screens (case-by-case basis) would result in the temporary resuspension of sediments, which could reintroduce legacy pesticides to the water column. However, this would only occur periodically as needed, and sediment resuspension would be temporary and fairly localized. Because of the limited potential for operation and maintenance of the project alternatives to affect legacy pesticide concentrations waterbodies in the study area, the potential for bioaccumulative pesticides to increase in fish tissue relative to existing conditions and indirectly affect public health through consumption of those fish is low.

Methylmercury

Modeling results indicate that the water column concentration of total mercury and methylmercury would differ little from existing concentrations at the 11 Delta assessment locations modeled (Chapter 9, Tables 9-33 and 9-34). Total mercury concentrations under the project alternatives would be well below the California Toxics Rule criterion (50 nanograms per liter) for protection of human health from consumption of water and organisms. Modeled fish tissue concentrations exceed the methylmercury water quality objective for fish tissue under both existing conditions and all project alternatives. Fish tissue modeling results indicate that there would be a nominal increase in average fish tissue methylmercury concentrations (no more than 0.01 milligrams per kilogram (mg/kg) wet weight as averages over full simulation period) at all modeled locations (Chapter 9, Table 9-35). As indicated in Chapter 9, all modeled fish tissue concentrations exceed the methylmercury water quality objective of 0.24 mg/kg wet weight (350 millimeter largemouth bass) under existing conditions. Based on the small changes in total mercury and aqueous and fish tissue methylmercury concentrations at all Delta assessment locations, the project alternatives would not contribute to measurable water quality degradation with respect to mercury and methylmercury (i.e., the existing mercury/methylmercury impairment in Delta waters would not be made measurably worse). As such, operation of the project alternatives would not increase public health risks due to the consumption of fish in the study area.

CEQA Conclusion—All Project Alternatives

Intermittent and short-term construction-related activities (as would occur for in-river construction) under all project alternatives, or in-channel activities as part of field investigations,

would not be anticipated to result in changes in concentrations of bioaccumulative pesticides, mercury, or methylmercury of sufficient magnitude or duration to contribute to long-term bioaccumulation processes. The development and implementation of Erosion and Sediment Control Plans and SWPPPs (Environmental Commitments EC-4a: *Develop and Implement Erosion and Sediment Control Plans* and EC-4b: *Develop and Implement Stormwater Pollution Prevention Plans*, respectively) would help ensure that construction activities would not substantially increase or substantially mobilize legacy organochlorine pesticides or methylmercury during construction.

Given that legacy pesticides are no longer used, are infrequently detected in source waters of the Sacramento and San Joaquin Rivers, concentrations of legacy pesticides would not be affected measurably by operation of the water conveyance facilities under all project alternatives. Maintenance dredging of sediment around the intake structures would result in the temporary resuspension of sediments, which could reintroduce legacy pesticides to the water column, but this would only occur periodically, and sediment resuspension would be temporary and fairly localized. Thus, operation and maintenance of the water conveyance facilities under all project alternatives would not result in an increase in bioaccumulation of legacy pesticides in fish, and public health would not be affected. Changes in long-term methylmercury concentrations that may occur in waterbodies of the study area related to operation of the proposed water conveyance facilities would not differ substantially from existing conditions. Fish tissue methylmercury concentrations under all project alternatives would not differ substantially from existing conditions. As such, operation of the proposed water conveyance facilities under the project alternatives would not contribute to measurable water quality degradation with respect to mercury and methylmercury, and thus would not increase existing health risks related to the consumption of fish in the study area. OEHHA standards and fish consumption advisories would continue to be implemented for the consumption of study area fish, which would help protect people from the overconsumption of fish with increased body burdens of mercury. This impact would be less than significant because construction and operation of project alternatives would not increase bioaccumulation of pesticides and methylmercury in fish that could affect human health.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on public health from project construction or operations, its implementation could result in impacts on public health.

Compensatory mitigation implemented on Bouldin Island and at the sites of the I-5 Ponds 6, 7, and 8 would not negatively affect water quality through increases in concentrations of pesticides. As described in Chapter 9, natural habitats contribute fewer pesticides to receiving waters than agricultural or urban areas. In addition, any newly created wetlands or enhanced habitat may also filter stormwater to remove solids and either improve or have no effect on pesticide concentrations relative to existing conditions.

Conditions that are conducive to mercury methylation and uptake from water into fish tissues may increase, relative to existing conditions, in localized areas of the Delta as part of the creation of new freshwater-emergent perennial wetlands, seasonal wetlands, and tidal habitats. Mercury methylation occurs under anoxic conditions in sediments, flooded shoreline soils and, to a lesser degree, in the water column. Increased methylmercury is also associated with wetting and drying cycles. Accordingly, the CMP could result in increased production, mobilization, and bioavailability

1 of methylmercury. An increase in methylmercury bioavailability could result in a corresponding
2 increase in bioaccumulation in fish tissue, biomagnification through the food chain, and human
3 exposure.

4 The freshwater emergent perennial wetlands and seasonal wetlands would be located on Bouldin
5 Island and would not be hydrodynamically connected with adjacent Delta waters. As part of
6 management of the new wetlands, water may be discharged from the wetlands to adjacent Delta
7 waterways through existing drains or outfalls. As part of adaptive management, monitoring of the
8 discharge would be conducted and the discharges potentially modified (e.g., to a detention basin)
9 should monitoring results show the wetland discharges to be a net exporter of methylmercury to
10 Delta waters. Thus, the wetlands to be created on Bouldin Island would not contribute to
11 measurable increases in methylmercury concentrations in fish in the Delta.

12 Location(s) and size(s) of the new tidal habitats would generally be in the northern and western
13 portions of the Delta and would be selected in accordance with the Tidal Habitat Mitigation
14 Framework in Appendix 3F. The new tidal habitats would be hydrodynamically connected to the
15 Delta and conditions that are conducive to increased mercury methylation and uptake from water
16 into fish tissues may occur within the new tidal habitats. Although there are uncertainties related to
17 the potential for increases in methylmercury concentrations in new tidal habitats, as described in
18 Chapter 9 (Impact WQ-6: *Effects on Mercury Resulting from Facility Operations and Maintenance*),
19 measurable increases in levels of methylmercury concentrations in waters and fish within and near
20 the new tidal habitats could potentially occur. OEHHA standards and fish consumption advisories
21 would continue to be implemented for the consumption of study area fish, which would help protect
22 people from the overconsumption of fish with increased body burdens of mercury. Accordingly, this
23 impact would be less than significant. In addition, as described in Chapter 9, Mitigation Measure
24 WQ-6: *Develop and Implement a Mercury Management and Monitoring Plan* would be implemented
25 with the goal to minimize generation of methylmercury within new tidal habitat, which would
26 further reduce the potential for an increase in methylmercury in fish tissue of study area fish.
27 Therefore, the CMP combined with the project alternatives would not substantially mobilize or
28 substantially increase the public's exposure to constituents known to bioaccumulate, and would not
29 change the overall impact conclusion.

30 Other Mitigation Measures

31 Some mitigation measures would involve the use of heavy equipment such as graders, excavators,
32 dozers, and haul trucks that would have the potential to result in the mobilization of or an increase
33 in constituents known to bioaccumulate due to soil disturbance and runoff, or sediment disturbance
34 if these constituents are present. The mitigation measures with potential to result in
35 bioaccumulation are: Mitigation Measures BIO-2c: *Electrical Power Line Support Placement*; AG-3:
36 *Replacement or Relocation of Affected Infrastructure Supporting Agricultural Properties*; AES-1c:
37 *Implement Best Management Practices in Project Landscaping Plan*; CUL-1b: *Prepare and Implement a*
38 *Built-Environment Treatment Plan in Consultation with Interested Parties*; and AQ-9: *Develop and*
39 *Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP*
40 *Operational Pumping to Net Zero*. Temporary increases in the mobilization of or an increase in
41 constituents known to bioaccumulate resulting from mitigation measures would be similar to
42 construction effects of the project alternatives in certain construction areas and could contribute to
43 bioaccumulation impacts of the project alternatives. Site-specific Erosion and Sediment Control
44 Plans and SWPPPs (Environmental Commitments EC-4a: *Develop and Implement Erosion and*
45 *Sediment Control Plans* and EC-4b: *Develop and Implement Stormwater Pollution Prevention Plans*,

respectively) would help ensure that mitigation measures would not substantially increase or substantially mobilize legacy organochlorine pesticides or methylmercury during construction. Given the temporary nature of any sediment resuspension, potential changes in water column concentrations of legacy pesticides, mercury, or methylmercury resulting from other mitigation measures would not likely increase long-term fish tissue concentrations in the study area. Therefore, other mitigation measures are unlikely to result in an increase in bioaccumulative constituents in surface waters in the study area, and the impact of bioaccumulation on public health would not be substantial.

Overall, the impact of mobilization or increase in constituents known to bioaccumulate from construction of compensatory mitigation and other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant.

Impact PH-4: Adversely Affect Public Health Due to Exposing Sensitive Receptors to New Sources of EMF

All Project Alternatives

Operations and Maintenance

Approximately 719 miles of existing transmission lines are located within the study area. Table 26-7 identifies the lengths of the proposed permanent 69 kV and 230 kV transmission lines for all project alternatives as well as the sensitive receptors that would be located within 300 feet of these proposed transmission lines.

Although new transmission lines generating new sources of EMF would be constructed for all project alternatives, the proposed permanent aboveground and underground transmission lines would be located in relatively sparsely populated areas (Figure 26-2). As shown in Table 26-7, from 2 (Alternative 4b) to 37 residences (Alternatives 1, 2a, and 2c), and up to three wildlife preserve areas would be within 300 feet of a proposed permanent underground 69 kV transmission line, depending on the project alternative. Under all alternatives there would be a proposed permanent aboveground 69 kV line installed on existing towers, and the Cosumnes River Preserve, as well as 23 residences, would be within 300 feet of this proposed line. There would be no sensitive receptors located within 300 feet of the proposed permanent aboveground and underground 230 kV transmission lines.

Generally, visitors to wildlife preserve areas and parks come for walks, birdwatching, water recreation, and hunting for a limited time. As such, it is unlikely that large groups of people would be staying in these areas, and therefore any EMF exposure would be limited. Up to 37 residences are located within 300 feet of proposed permanent transmission lines, depending on project alternative. Although there may be general public concern about exposure to EMF, there are no state or federal standards (health-based or otherwise) to limit occupational or residential exposure to EMF and, furthermore, there is currently no medical or scientific consensus that EMF exposure poses a health risk. The location and design of proposed transmission lines and substations would be in accordance with EMF Design Guidelines (California Public Utilities Commission 2006b) to minimize potential exposure of sensitive receptors to EMF due to operation of project alternatives.

CEQA Conclusion—All Project Alternatives

The permanent aboveground and underground 69 kV and 230 kV transmission lines proposed for construction and operation of the water conveyance facilities for all project alternatives would be located in generally sparsely populated areas away from most existing potentially sensitive receptors. However, depending on project alternative, 2 to 37 residences and up to three wildlife preserve areas would be within 300 feet of a proposed permanent underground 69 kV transmission line, and 23 residences and the Cosumnes River Preserve would be within 300 feet of a proposed permanent aboveground 69 kV transmission line. There would be no sensitive receptors within 300 feet of any proposed permanent aboveground or underground 230 kV transmission lines. Because visitors to wildlife preserve areas generally come for walks and other recreational activities, it is unlikely that large groups of people would be staying in these areas within 300 feet of any proposed transmission line, so any EMF exposure would be limited. There are no state or federal standards (health-based or otherwise) to limit occupational or residential exposure to EMF, and there is no medical or scientific consensus that EMF exposure poses a health risk. Furthermore, the location and design of proposed transmission lines and power facilities would be in accordance with EMF Design Guidelines (California Public Utilities Commission 2006b) to minimize potential exposure of sensitive receptors to EMF due to operation of project alternatives. As such, this impact would be less than significant.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on public health from project construction or operations, its implementation could result in impacts on public health.

No transmission lines would be constructed or operated as part of compensatory mitigation. Therefore, compensatory mitigation would not create a new source of EMF in the study area relative to existing conditions. Therefore, impacts related to new sources of EMF on public health due to the project alternatives, combined with the CMP, would not change the overall impact conclusion.

Other Mitigation Measures

Other mitigation measures proposed would not result in generation of EMF because none of the mitigation measures propose constructing and operating electrical transmission lines in the study area. Therefore, mitigation measures would not result in a potential impact on public health related to EMF exposure.

Overall, the impact of affecting public health due to exposure to new sources of EMF from construction of compensatory mitigation and implementation of other mitigation measures, combined with project alternatives, would not change the less than significant impact conclusion.

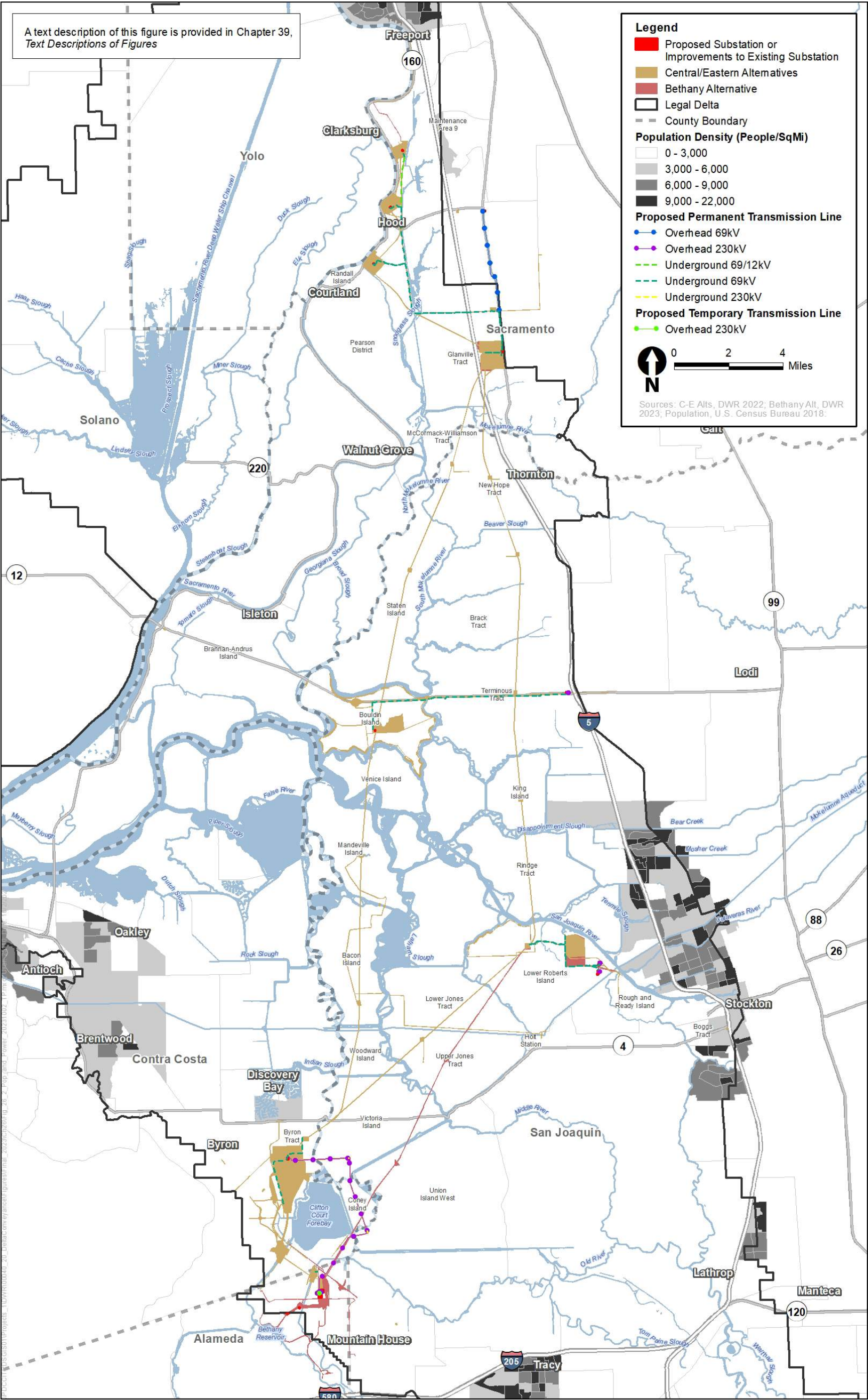


Figure 26-2. Population Density and Proposed Transmission Lines

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Impact PH-5: Impact Public Health Due to an Increase in *Microcystis* Bloom Formation

All Project Alternatives

The five factors that affect the development of CHABs in Delta are water temperature, channel velocities and associated turbulence/mixing, hydraulic residence time, nutrients, and water clarity. As discussed in Chapter 9 (Impact WQ-14: *Effects on Cyanobacteria Harmful Algal Blooms Resulting from Facility Operations and Maintenance*), the project alternatives would not affect these factors in the northern, southern, western, or eastern Delta to such a degree that the frequency or magnitude of CHABs in these areas of the Delta would be affected relative to existing conditions. However, based on DSM2 modeling, the project alternatives would be expected to increase residence times somewhat in the open-water areas of the central Delta relative to existing conditions. Because water temperature, turbulence and mixing, nutrient levels, and water clarity and associated irradiance are key to the initiation of blooms and subsequent growth, and because these factors would not be affected by the project alternatives, the project alternatives would not be expected to cause more frequent CHABs anywhere in the Delta, relative to existing conditions.

The modeled 1- to 2-day increase in hydraulic residence time in the central portion of the Delta, specifically Discovery Bay, relative to existing conditions, may contribute to more *Microcystis* cell and colony production and accumulation/aggregation at this location in July, although this is uncertain, as discussed in Chapter 9. The project alternatives would not affect water temperature, nutrients, turbulence and mixing, water clarity, or residence time in the central Delta sufficiently to cause substantially increased frequency or magnitude of CHABs in the central Delta, including Discovery Bay. Accordingly, the project alternatives are not expected to substantially increase microcystin or any other cyanotoxins in the Delta, relative to existing conditions at the Delta assessment locations.

CEQA Conclusion—All Project Alternatives

The frequency and magnitude of CHABs in the study area would not increase relative to existing conditions under the project alternatives because operation of the water conveyance facilities would not cause the key factors potentially associated with CHABs (i.e., temperature, residence time, nutrients, water velocities and associated turbulence and mixing, and water clarity and associated irradiance) to change in a manner that would increase the frequency or magnitude of CHABs in the Delta. Accordingly, concentrations of cyanotoxins within the study area would not be expected to substantially increase relative to existing conditions due to operation of the water conveyance facilities and therefore there would be no increased potential for public health to be affected by exposure to cyanotoxins. This impact would be less than significant.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on public health from project construction or operations, its implementation could result in impacts on public health.

The creation of valley/foothill riparian, freshwater emergent perennial wetland, and seasonal wetland, lake/pond habitat types from compensatory mitigation would not affect CHAB formation within the Delta relative to existing conditions because they would be located within Bouldin Island and I-5 ponds and thus would not be hydrodynamically connected with Delta channels.

As part of compensatory mitigation, the creation of tidal habitats in the North Delta Habitat Arc (i.e., the region from Cache Slough to Suisun Marsh) that would be hydrodynamically connected to Delta channels, could create some new areas that are conducive to CHABs. There is some uncertainty related to the design of the wetlands (e.g., depth, amount of aquatic vegetation, and exact location). However, design of the tidal habitat would consider hydrologic regime and channel morphology (backwater areas with low velocities and high residence time can create conditions that foster CHABs) to help ensure potential adverse effects related to CHABs are minimized. As such, newly created tidal habitats would have daily tidal flushing to ensure no substantial increase in residence time, relative to existing conditions. Although tidal habitats would be designed to reduce potential for CHAB formation, it is possible that along the edges of the new tidal habitat, there could be small areas of increased residence time, elevated water temperature, reduced water turbulence and mixing, and turbidity (which affects irradiance). Depending on the vegetation in the tidal habitat, there could be some increased nutrient concentrations (from decomposing vegetation). However, the presence of vegetation would generally decrease the potential for CHAB formation as plants would likely outcompete cyanobacteria for nutrients and sunlight.

As discussed in Chapter 9, although there are some characteristics of the newly created tidal habitats that could increase residence time and water temperatures along the margins, the CMP is not expected to cause substantial additional *Microcystis* or other cyanobacteria production for the following reasons: (1) tidal restoration sites would be sited in a region where conditions are not conducive to CHAB formation; (2) the design of the tidal habitats would be such that there would be daily hydrologic exchange, which would ensure that there would not be substantially increased residence times compared to adjacent habitats; and (3) if the tidal habitat were to be located in Cache Slough, the region would continue to be fed with waters that are relatively nutrient poor and not conducive to substantial cyanobacteria formation. Similarly, if the tidal habitat were to be located in the Suisun Marsh region, salinities would continue to be high enough to prevent substantial growth and aggregation of cyanobacteria. Accordingly, impacts on public health due to potential exposure to cyanotoxins as a result of increases in CHABs, due to the project alternatives combined with the CMP, would be less than significant.

Other Mitigation Measures

Other mitigation measures proposed would not have impacts on public health due to potential exposure to CHABs because none of the mitigation measures would create conditions that would be conducive to the formation of CHABs. Therefore, there would be no impact.

Overall, impacts to public health related to increased *Microcystis* bloom formation and cyanotoxins due to compensatory mitigation and other mitigation measures, combined with project alternatives would not change the impact conclusion of less than significant.

26.3.4 Cumulative Analysis

This cumulative impact analysis considers past, present, and probable future projects in the study area that could affect the same resources and, where relevant, occur within the same timeframe as the project. The impacts of the project, as they relate to public health, considered in connection with the potential impacts of projects that may occur in the study area, could be cumulatively significant. It is expected that some changes related to public health would take place, even though it is assumed that probable future projects would include typical design and construction practices to avoid or minimize potential impacts.

When the effects of the project are considered in combination with the effects of projects listed in Table 26-9, the cumulative impacts on public health are potentially significant. The specific plans, policies, programs, and projects are identified below for each impact category based on the potential to contribute to an impact due to the Delta Conveyance Project that could be deemed cumulatively considerable. The potential for cumulative impacts on public health is described for potential effects related to the construction and operation of the water conveyance facilities and compensatory mitigation under the project.

Table 26-9. Cumulative Impacts on Public Health from Plans, Policies, and Programs

Program/Project	Agency	Status	Description of Program/Project	Impacts on Public Health
North Delta Flood Control and Ecosystem Restoration Project	DWR	Final EIR complete	Project implements flood control and ecosystem restoration benefits in the north Delta.	Potential to increase the amount of breeding habitat for mosquitoes and thus increase the local populations of mosquitoes. Accordingly, within 10 miles of McCormack-Williamson Tract, there would be the potential to increase the public's exposure to mosquitoes and therefore potentially vector-borne disease.
Suisun Marsh Habitat Management, Preservation, and Restoration Plan	CDFW, USFWS, Reclamation, DWR, and Suisun Resource Conservation District	Final EIS/EIR 2011	The plan is intended to balance the benefits of tidal wetland restoration with other habitat uses in Suisun Marsh by evaluating alternatives that provide a politically acceptable change in marsh-wide land uses, such as salt marsh harvest mouse habitat, managed wetlands, public use, and upland habitat.	No impact on public health from vector-borne diseases or mobilization of constituents known to bioaccumulate during construction and operation.
Cache Slough Area Restoration	DWR and CDFW	Ongoing and future actions	Enhancement and restoration of existing and potential open-water, marsh, floodplain, and riparian habitat in northern Delta.	Potential incremental increase in methylmercury formation and contribution to Delta load

Program/Project	Agency	Status	Description of Program/Project	Impacts on Public Health
Dutch Slough Tidal Marsh Restoration Project (EcoRestore Project)	DWR	Planning phase	The Dutch Slough Tidal Marsh Restoration Project, located near Oakley in Eastern Contra Costa County, would restore wetland and uplands, and provide public access to the 1,166-acre Dutch Slough property owned DWR. The property is composed of three parcels separated by narrow man-made sloughs.	Reduce levels of mosquito production in areas where seasonal wetland areas and unmanaged nontidal freshwater marsh are reduced. Increase mosquito production as a result of nontidal open-water management options, which would increase exposure of humans to mosquitoes and potentially vector-borne diseases. Potential incremental increase in methylmercury formation and contribution to Delta load.
American Basin Fish Screen and Habitat Improvement Project	Reclamation, CDFW, and Natomas Central Mutual Water Company	Ongoing	This project involves consolidation of diversion facilities; removal of decommissioned facilities; aquatic and riparian habitat restoration; and installing fish screens in the Sacramento River. Total project footprint encompasses about 124 acres east of the Yolo Bypass. Permanent conversion of 70 acres of farmland (including 60 acres of rice) during Phases I and II.	No impact on public health is expected from vector-borne diseases and mobilization of constituents known to bioaccumulate during or after conversion.
California Water Action Plan	CNRA, CalEPA, and CDFA	Ongoing and future	Identifies key actions for the next 1 to 5 years that address urgent needs and provide the foundation for the sustainable management of California's water resources.	Actions implemented may affect seasonal and long-term water quality conditions in the Delta.
Bay-Delta Water Quality Control Plan Update	State Water Board	Ongoing and future	The State Water Board is updating the Bay-Delta Water Quality Control Plan in four phases: Phase I: Modifying water quality objectives (i.e., establishing minimum flows) on the Lower San Joaquin River and Stanislaus, Tuolumne, and Merced Rivers to protect the beneficial use of fish and wildlife and modifying the water quality objectives in the southern Delta to protect the beneficial use of agriculture; Phase II: Evaluating and potentially amending existing water quality objectives that protect beneficial uses and the program of implementation to achieve those objectives. Water quality objectives that could be	To the extent that modifications in surface water flow patterns, increase minimum instream flows, and increase minimum Delta outflows, this would benefit water quality in the Delta.

Program/Project	Agency	Status	Description of Program/Project	Impacts on Public Health
			amended include Delta outflow criteria; Phase III: Requires a water rights proceeding to determine changes to existing water rights to achieve the objectives identified in Phase I and Phase II. Phase III will likely not occur until after Phase IV is complete or close to complete; Phase IV: Evaluating and potentially establishing water quality criteria and flow objectives that protect beneficial uses on tributaries to the Sacramento River.	
Drought Contingency Plan (includes Emergency Drought Barriers project)	Reclamation, DWR, and State Water Board	Completed for 2015; reasonably foreseeable to occur in future years with drought	Modification of Bay-Delta Water Quality Objectives (e.g., Delta outflow and electrical conductivity requirements) and requirements from 2008/2009 SWP/CVP BiOps to balance supplying human needs, repelling saltwater in the Delta, and providing for cold water needs of Chinook salmon.	Reduced Delta outflow may increase the potential for negative effects from flow-related stressors (e.g., <i>Microcystis</i>).
San Joaquin River Restoration Program	Reclamation, USFWS, NMFS, DWR, and CDFW	Final Program EIS/EIR 2012	The program would restore and maintain fish populations in “good condition” in the main stem of the 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.	There is the potential for vector-borne diseases to adversely affect public health as operation of this program could result in an increase in adult mosquito populations.
Central Valley Diuron TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of diuron pesticide.
Central Valley Diazinon and Chlorpyrifos TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of diazinon and chlorpyrifos pesticides.
Sacramento and Feather Rivers Diazinon TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of diazinon pesticides.
Sacramento–San Joaquin Delta Diazinon and Chlorpyrifos TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of diazinon and chlorpyrifos pesticides.
Central Valley Pyrethroid Pesticide TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of pesticides.

Program/Project	Agency	Status	Description of Program/Project	Impacts on Public Health
Central Valley Organochlorine Pesticide TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of legacy organochlorine pesticides.
Cache Creek, Bear Creek, Sulphur Creek, and Harley Gulch Mercury TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of mercury and methylmercury formation, and thus bioaccumulation in fish and consequent potential effects on public health.
Clear Lake Mercury TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of mercury and methylmercury formation, and thus bioaccumulation in fish and consequent potential effects on public health.
Sacramento–San Joaquin Delta Methylmercury TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of mercury and methylmercury formation, and thus bioaccumulation in fish and consequent potential effects on public health.

CalEPA = California Environmental Protection Agency; CDFW = California Department of Fish and Wildlife; CNRA = California Natural Resources Agency; CVP = Central Valley Project; DWR = California Department of Water Resources; EIR = Environmental Impact Report; EIS = Environmental Impact Statement; NMFS = National Marine Fisheries Service; Reclamation = Bureau of Reclamation; State Water Board = State Water Resources Control Board; SWP = State Water Project; TMDL = total maximum daily load; USFWS = U.S. Fish and Wildlife Service.

26.3.4.1 Cumulative Impacts of the No Project Alternative

The No Project Alternative considers projects, plans, and programs that would be predicted to occur under foreseeable conditions if the project were not approved and project objectives were not met, and also included climate change and sea level rise. In combination with the past, present, and probable future projects in the study area (Table 26-9), the No Project Alternative could have a cumulative impact on public health in the study area. The No Project Alternative could result in adverse impacts on public health by increasing the public's risk of exposure to vector-borne diseases; lowering drinking water quality due to exceedances of water quality criteria for constituents of concern; increasing bioaccumulation of persistent toxicants (e.g., mercury) in fish consumed by people; exposing sensitive receptors (e.g., hospitals, schools, parks) to EMF from new transmission lines; and exposing the public to microcystins as a result of CHABs.

As described in Chapter 9, some water quality constituents in the study area are at levels under existing conditions that cause occasional adverse effects to beneficial uses, including mercury, OC, and CHABs, and under the cumulative condition with the No Project Alternative, these constituents are expected to remain at levels that will cause some impact to beneficial uses. It is expected that potential cumulative impacts on public health related to mercury bioaccumulation in fish in the study area from both the No Project Alternative and past, present, and probable future projects could be avoided because OEHHHA standards and fish consumption advisories would continue to be implemented for the consumption of study area fish. This would help protect people from the overconsumption of fish with increased body burdens of mercury so that the impact would not be cumulatively significant. Potential increases in OC would not be expected to affect public health by

causing an increase in DBPs in drinking water because under the federal Stage 1 Disinfectants and Disinfection Byproducts Rule, municipal drinking water treatment facilities are required to remove specific percentages of TOC in source waters through enhanced treatment methods unless the drinking water treatment system can meet alternative criteria. Therefore, this impact would not be cumulatively significant. Increases in surface water temperatures in the Delta under the No Project Alternative due to climate change may result in earlier occurrences of *Microcystis* blooms in the Delta. In addition, warmer water temperatures could increase bloom duration and magnitude. This, in combination with past, present, and probable future projects, would result in a cumulatively significant impact on public health due to potential exposure to increased cyanotoxins in the study area.

Climate change is expected to influence the seasonal patterns of mosquito reproduction and thus of vector-borne diseases. Warmer temperatures associated with climate change can accelerate mosquito development, biting rates, and disease incubation within mosquitoes (U.S. Environmental Protection Agency 2021). Therefore, the No Project Alternative combined with past, present, and probably future projects would result in a cumulatively significant impact on public health due to potential increased exposure to vector-borne diseases.

Some projects under the No Project Alternative and identified in Table 26-9 may require constructing and operating power transmission lines. These transmission lines may be sited within 300 feet of sensitive receptors and thus operation of these transmission lines could expose sensitive receptors in the study area to EMF. However, there are no state or federal standards (health-based or otherwise) to limit exposure to EMF, and there is no medical or scientific consensus that EMF exposure poses a health risk. Furthermore, it is reasonable to assume that project proponents would locate and design proposed transmission lines in accordance with EMF Design Guidelines to minimize potential exposure of sensitive receptors to EMF due to operation of electrical transmission lines. Accordingly, this cumulative impact would be less than significant.

26.3.4.2 Cumulative Impacts of the Project Alternatives

Increase in Vector-Borne Diseases

Substantial vector habitat is present throughout the study area, and the cumulative projects could result in an increase in potential mosquito habitat (e.g., more standing shallow water). Although programs to prevent mosquitoes from breeding and multiplying are in place throughout the study area, the incremental contribution of aquatic habitat restoration as part of compensatory mitigation to the cumulative effect on public health could be cumulatively considerable and significant. Mitigation Measure PH-1b: *Develop and Implement a Mosquito Management Plan for Compensatory Mitigation Sites on Bouldin Island and at I-5 Ponds*, which would help control mosquitoes and reduce the potential for an increase in mosquito breeding habitat due to compensatory mitigation related to aquatic habitat on Bouldin Island and at I-5 ponds, would reduce this cumulative impact to less than significant.

Exceedance(s) of Water Quality Criteria for Constituents of Concern Such That Drinking Water Quality May be Affected

As described in Section 26.1.1.1, *Drinking Water*, the primary sources of trace metals to the Delta include acid mine drainage from abandoned and inactive mines, agriculture, WWTP discharges, and urban runoff. Ongoing efforts to control acid mine drainage into the Sacramento River system and

1 increasingly stringent regulations in the future are expected. Regulatory controls on and monitoring
2 of agricultural runoff, WWTP discharges, and urban runoff are anticipated to prevent trace metal
3 concentration under the cumulative condition from becoming substantially worse than existing
4 conditions. Furthermore, the project would not present new or substantially changed sources of
5 trace metals into the Delta. As such, the project, including compensatory mitigation, combined with
6 potential effects of other cumulative projects would not affect trace metal levels in the Delta, and
7 therefore there would be a less-than-significant cumulative impact with regard to trace metals.

8 Pesticide use within and upstream of the Delta is changing continuously. Although factors such as
9 TMDLs and future development of more target-specific and less-toxic pesticides will ultimately
10 influence the cumulative condition for pesticides, forecasting whether these various efforts will
11 ultimately be successful at resolving current pesticide-related impairments requires considerable
12 speculation. As such, it is conservatively assumed that the cumulative condition would be significant
13 with respect to pesticides in the Delta. The project would not contribute considerably to the
14 significant cumulative condition for pesticides in the study area. This is because the changes in the
15 source water fractions to the Delta (i.e., Sacramento River, San Joaquin River, San Francisco Bay
16 water, eastside tributaries, and Delta agriculture water) resulting from the project would not
17 substantially alter the pesticide concentrations in the Delta consistently over time in a manner that
18 would substantially alter the long-term risk of impacts on water quality. Similarly, the CMP would
19 not substantially affect pesticide concentrations in the Delta. As such, any incremental contribution
20 of the project to the significant cumulative conditions with regards to pesticides in the Delta would
21 not be cumulatively considerable.

22 The cumulative condition for bromide and OC in the Delta is considered significant relative to
23 existing conditions due to anticipated future increases in these constituents in the Delta. For
24 bromide, the primary driver of these increases would be seawater intrusion associated with climate
25 change and sea level rise. Nonpoint- and point-source loadings of OC from growing urbanized areas
26 of the watershed are expected to increase in the future.

27 Modeling results (Appendix 9D, *Bromide*) indicate that long-term average bromide concentrations
28 with the project would be similar to existing conditions at most Delta locations and months.
29 Concentrations at Banks Pumping Plant would decrease, relative to existing conditions. Bromide
30 increases that would occur due to the project would not be of sufficient frequency, magnitude, and
31 geographic extent to directly cause impacts to beneficial uses or contribute considerably to
32 anticipated future bromide levels in the western Delta. Likewise, the CMP would not substantially
33 affect, or affect at all, bromide levels in the Delta. The incremental contribution of the project,
34 including compensatory mitigation, to the significant cumulative condition for OC in the Delta would
35 not be cumulatively considerably based on modeling results (Appendix 9I, Attachment 9I.1, *Organic*
36 *Carbon, No Project Alternative Modeling Results*), which show little effect of the project on long-term
37 average DOC concentrations. Thus, the project, including compensatory mitigation, would not
38 contribute considerably to the formation of DBPs in Delta-diverted drinking water supplies.

39 **Substantial Mobilization of or Increase in Constituents Known to Bioaccumulate**

40 Numerous regulatory efforts have been implemented to control and reduce mercury loading to the
41 Delta, which include a Delta mercury TMDL and its implementation strategies, increased restrictions
42 on point-source discharges such as from WWTPs, greater restrictions on suction dredging in Delta
43 tributary watersheds, and continued clean-up actions on mine drainage in the upper watersheds.
44 The Sacramento–San Joaquin Delta Estuary TMDL for methylmercury is intended to reduce

1 agricultural drainage, tributary inputs, and point and nonpoint source discharges of mercury and
2 methylmercury in the Delta to meet fish tissue objectives and is supported by the Central Valley
3 RWQCB Delta Mercury Exposure Reduction Program. The State Water Resources Control Board is
4 also developing a statewide mercury control program for reservoirs and a Central Valley mercury
5 control program for rivers. Despite these regulatory programs, a key challenge surrounds the pool
6 of mercury deposited in the sediments of the Delta, which cannot be readily or rapidly reduced
7 despite efforts to reduce loads in Delta tributaries, and which serves as a source for continued
8 methylation and bioaccumulation of methylmercury by Delta biota. Accordingly, the existing
9 cumulative condition for mercury/methylmercury in the Delta is considered significant.

10 Other projects shown in Table 26-9 could affect constituents known to bioaccumulate, such as
11 methylmercury. These projects are not anticipated to substantially increase methylmercury
12 concentrations in the study area because they are not anticipated to have actions that would
13 mobilize such a constituent. Once operational, the habitat restoration projects could result in an
14 increase of methylmercury in the study area as a result of biogeochemical processes and sediment
15 conditions established in restored aquatic habitat types conducive to mercury methylation.
16 However, it is expected that these projects either have evaluated or would evaluate the potential for
17 methylmercury production and would implement measures to monitor and adaptively manage
18 methylmercury production. Therefore, the habitat restoration projects that would occur under
19 cumulative conditions are not likely to negatively affect public health.

20 Modeling results (Appendix 9H) indicate that long-term average mercury concentrations with the
21 project would be similar to existing conditions at most Delta locations. Any changes in Delta fish
22 tissue methylmercury concentrations from facility operations would likely not be measurable.
23 Accordingly, facility operations under the project would not substantially alter the cumulative
24 condition for mercury/methylmercury and the impairment in the Delta or contribute considerably
25 to significant cumulative mercury/methylmercury condition. However, the CMP would result in
26 additional wetland habitat in the Delta. Wetlands have the potential to methylate mercury at higher
27 rates than most other aquatic habitats. Thus, the creation of the compensatory mitigation wetlands
28 could contribute to additional mercury methylation and bioaccumulation methylmercury in Delta
29 fish. However, OEHHA standards and fish consumption advisories would continue to be
30 implemented for the consumption of study area fish, which would help protect people from the
31 overconsumption of fish with increased body burdens of mercury. As such, the incremental
32 contribution of the compensatory mitigation component of the project would not contribute
33 considerably to the significant cumulative impact on public health due to potential increases in
34 bioaccumulation of methylmercury in fish in the Delta. In addition, Mitigation Measure WQ-6:
35 *Develop and Implement a Mercury Management and Monitoring Plan* would be implemented with the
36 goal to minimize generation of methylmercury within compensatory mitigation sites, which would
37 further reduce the potential for an increase in methylmercury in fish tissue.

38 **Adversely Affect Public Health Due to Exposing Sensitive Receptors to New Sources of EMF**

39 Past, present, and reasonably foreseeable future projects have resulted and will likely result in the
40 development and operation of power transmission lines in the study area, which have or will
41 potentially expose existing populations and sensitive receptors to EMF. There would be up to 37
42 residences (depending on project alternative) within 300 feet of a proposed permanent
43 transmission line. Although there may be general public concern about exposure to EMF, there are
44 no state or federal standards (health-based or otherwise) to limit occupational or residential
45 exposure to EMF. Furthermore, although existing populations and sensitive receptors are exposed to

1 EMF, the medical and scientific communities generally agree that evidence from available research
2 has not demonstrated that EMF exposure creates a health risk, although research is ongoing.
3 Therefore, the project combined with other cumulative projects would result in a less-than-
4 significant cumulative impact on public health due to new sources of EMF. The siting and design of
5 proposed transmission lines and substations for the project would be done in accordance with EMF
6 Design Guidelines (California Public Utilities Commission 2006b) to minimize potential exposure of
7 sensitive receptors to EMF due to operation of the project.

8 **Impact Public Health Due to an Increase in *Microcystis* Bloom Formation**

9 Future climate change will result in reduced Delta inflows and increased average Delta water
10 temperatures during the summer and early fall months, as discussed in Chapter 9. High water
11 temperatures, particularly those above 25°C (77°F) give cyanobacteria a competitive advantage
12 over other algae. As such, *Microcystis* and other cyanobacteria typically produce more biovolume
13 and cell abundance at elevated water temperatures. Increased water temperatures could lead to
14 earlier attainment of the water temperature threshold of 19°C (66.2°F) required to initiate
15 *Microcystis* blooms in the Delta; thus, earlier occurrences of blooms, relative to existing conditions.
16 Warmer water temperatures could also increase bloom duration and magnitude, relative to existing
17 conditions.

18 The other key environmental factors that affect *Microcystis* and other cyanobacteria production—
19 nutrient levels, channel velocities and associated turbulence and mixing, and water clarity and
20 associated irradiance—are not expected to change substantially in the future, relative to existing
21 conditions. Increased residence time and higher water temperatures are the two most important
22 drivers of past and present problem-level CHABs in the Delta. Because water temperatures, and
23 possibly residence times in some portions of the Delta, are expected to increase in the future due
24 primarily to sea level rise and climate change (which will favor CHABs), the future cumulative
25 condition for *Microcystis* (and thus microcystin concentrations), as well as other cyanobacterial
26 species, would be significant in the Delta.

27 The project alternatives would not substantially alter Delta water temperatures, nutrient levels,
28 channel velocities and associated turbulence and mixing, water clarity and associated irradiance, or
29 residence times, relative to existing conditions. Modeled residence times would increase somewhat
30 (i.e., by up to 32 hours) under the project alternatives in the northern, eastern, and southern Delta,
31 but these increases would not be sufficiently large to result in greater magnitude of cyanobacteria
32 blooms through the Delta. Residence times in the open-water areas of Discovery Bay would increase
33 by up to 2 days, where residence times for existing conditions were on the order of several weeks.
34 Multi-week-long residence times occur annually in Discovery Bay under existing conditions and
35 such long residence times would continue for the future cumulative condition, albeit potentially
36 increasing by several days. Discovery Bay, characterized by long residence times, would support
37 substantial accumulation of cyanobacteria cells under both existing and project conditions.
38 Consequently, these project alternatives' individual contributions to the significant cumulative
39 condition for CHABs in the Delta would not be cumulatively considerable and, thus, would not be
40 significant.

41 The compensatory mitigation tidal wetlands to be constructed in the North Delta Habitat Arc could
42 cause small areas of increased residence times, reduced water turbulence and mixing (which affects
43 irradiance), increased nutrient concentrations, and slightly elevated water temperatures. However,
44 tidal wetland design would consider the hydrologic regime and channel morphology to ensure

1 backwater areas with low velocities and high residence times do not develop. Cyanobacteria are
2 ubiquitous within the Delta as part of the overall phytoplankton community and will continue to be
3 present, particularly along the channel margins at the compensatory mitigation sites. Even if some
4 additional CHABs form along the margins of the tidal habitats, the additional cyanobacterial biomass
5 would not be sufficient to have a cumulatively considerable or significant contribution to the
6 significant cumulative condition for CHABs in the Delta.

30.1 Introduction

Climate is the average weather over many years, measured most often in terms of temperature, precipitation, and wind. For example, the climate of California’s Central Valley is a Mediterranean climate, which is hot and dry during the summer and cool and damp in winter, with the majority of precipitation falling as rain in the winter months. Climate is unique to a particular location and changes on timescales of decades to centuries or millennia.

Climate change generally refers to “statistically significant variations of the mean state of the climate or of its variability, typically persisting for decades or longer” (Intergovernmental Panel on Climate Change 2001:87). Although the climate can change, and has changed, in the past in response to natural drivers, recent climate change has been more rapid than previous episodes of climate change and has been unequivocally linked to increasing concentrations of greenhouse gases (GHGs) in Earth’s lower atmosphere and the rapid timescale on which these gases have accumulated (Intergovernmental Panel on Climate Change 2021:SPM-5, TS-60). The major causes of this rapid loading of GHGs into the atmosphere include the burning of fossil fuels since the beginning of the Industrial Revolution, agricultural practices, increases in livestock grazing, and deforestation. More background information on GHG emissions is provided in Chapter 23, *Air Quality and Greenhouse Gases*, Section 23.1.3, *Global Climate Change*.

Higher concentrations of heat-trapping GHGs in the atmosphere result in increasing global surface temperatures, a phenomenon commonly referred to as *global warming* or *climate change*. Higher atmospheric GHG concentrations and global surface temperatures in turn result in changes to Earth’s climate system, including rainfall patterns, extreme weather events, ocean temperature and acidity, the amount of spring snow cover in the Northern Hemisphere, atmospheric water content, and global sea level rise (Intergovernmental Panel on Climate Change 2021:SPM-5, SPM-19, 2-5–7). Some of the above changes will result in specific impacts at the state and local levels.

30.1.1 Purpose

The objective for this chapter is to evaluate how observed trends and projected future conditions show the need for the proposed project and how climate change could influence the ability of the project to fulfill its intended purpose. More information on the analysis of project-generated GHGs can be found in Chapter 23, *Air Quality and Greenhouse Gases*. To understand this, this chapter analyzes three fundamental questions relating to climate change:

1. How is climate change projected to affect the study area?
2. How might the project’s impacts on operations and resources in the study area be affected by climate change (i.e., are future changes in climate likely to exacerbate project impacts or operations)?
3. How might the project affect the resiliency of the study area or its resources to climate change?

This chapter is organized differently from the other resource chapters in this Final Environmental Impact Report (EIR) because analyzing how climate change is projected to affect the study area, how anticipated resource impacts from the project may be affected by climate change, and how project alternatives may improve the study area's resiliency and adaptability to climate change are fundamentally different analyses than those presented in other resource chapters. Whereas other chapters are organized to identify existing conditions as of issuance of the Notice of Preparation (NOP) in 2020, one of the functions of this chapter is to analyze and disclose the future conditions of the study area under climate change. The study area for this chapter includes areas upstream of the Delta region, the Delta region, and State Water Project (SWP)/Central Valley Project (CVP) export service areas. The project alternatives do not affect areas upstream of the Delta region; however, both the SWP and CVP water delivery systems rely on runoff and reservoir releases in areas upstream of the Delta. Both water delivery systems may be affected by changes in Delta salinity levels due to climate change, regardless of the project alternative.

Section 30.2.3, *Climate Change Trends and Associated Impacts on the Study Area*, helps to address Question 1 by noting recent trends, climate change projections to 2100, and expected climate impacts in the study area.

Question 2 is addressed in Section 30.4, *Potential Impacts of Alternatives*. Most resource chapters evaluate how the project would affect the specific resource in question compared to existing conditions at the time of the NOP (January 2020) to evaluate the effects of project alternatives without the confounding effects of future climate change. Resource analyses also compare the No Project Alternative in the future to existing resource conditions, including reasonably foreseeable changes in existing conditions and changes that would be predicted to occur in the foreseeable future (i.e., including climate change) if the project were not approved, as further described in Appendix 3C, *Defining Existing Conditions, No Project Alternative, and Cumulative Impact Conditions*. Resources that consider hydrologic modeling primarily focus on conditions in 2040; assumptions and further detail on the No Project Alternative 2040 scenario are found in Appendix 3C and Appendix 5A, *Modeling Technical Appendix, Section B, Hydrology and Systems Operations Modeling*. Appendix 4A, *Consideration of 2070 Conditions*, provides a qualitative discussion of longer-term operational impacts based on trends and conditions for water demand and supply in California. Appendix 30A, *CalSim 3 Results Sensitivity to 2040 Climate Change and Sea Level Projections*, summarizes results under additional 2040 climate scenarios to understand anticipated changes in variables relevant to project operations under a broader range of climate scenarios. The project alternatives are evaluated using a projection of future climate that includes changes in temperature, precipitation, and hydrology and sea level rise.

This chapter also addresses Question 3 in Section 30.4.3, *Resilience and Adaptation Benefits*. In this context, *resiliency* and *adaptability* mean the ability of the study area and its resources to remain stable or flexibly change as the effects of climate change increase.

The resiliency and adaptation discussion focuses on the major impacts of climate change in the study area and the clear and measurable ways that the project alternatives will ameliorate these impacts or add flexibility to the system so that the SWP can continue providing water supply benefits with sufficient water quality and supporting ecosystem conditions that maintain or enhance aquatic and terrestrial plant and animal species. No single project and, indeed, none of the project alternatives would be able to completely counteract all of the impacts of climate change; however, as discussed in Section 30.4.3, the project alternatives provide important added resilience and

adaptability to many of the expected changes. Impacts for which the project alternatives provide a benefit that is minimal or not documentable are not discussed in this chapter.

Table 30-1 describes the differences between this chapter and the other resource chapters with respect to climate change discussion. The differences between these two comparisons allow readers to determine the incremental effects attributable to climate change as distinct from the impacts of the project alternatives.

Table 30-1. Comparison of Climate Change Chapter to Other Resource Chapters

Topic	Chapter 30: <i>Climate Change</i>	Other Resource Chapters
What is covered	Focuses on effects of climate change; also compares a climate-changed future without the project alternatives to a climate-changed future with the project alternatives. Evaluates how the project will affect the resiliency of the study area or its resources to climate change. References analyses of project operations were performed for the 2040 and 2100 timeframes and draw from Appendix 5A, <i>Modeling Technical Appendix</i> , Section B, <i>Hydrology and Systems Operations Modeling</i> . References design analysis, performed at 2040 for construction and 2100 for facility design, including intakes and conveyance facilities.	Focus on comparisons of alternatives at the 2020 timeframe to Existing Conditions (i.e., the “environmental setting” as it exists at the time of issuance of the NOP). This comparison excludes any impacts resulting from climate change. Includes a discussion of the No Project Alternative that describes expected future conditions resulting from a continuation of existing policies and programs by federal, state, and local agencies in the absence of the project alternatives that are likely to be in place by 2040, including related climate change impacts in respective analyses. Select resources include appendices providing modeled quantitative comparisons for the No Project Alternative against the project alternatives at the 2040 and 2070 timeframe. A qualitative discussion at the 2100 timeframe (for relevant resources).
Limitations	Uses peer-reviewed literature and best available science to identify likely climate impacts in the study area and evaluate resiliency.	Do not specifically contemplate the extent to which project alternatives would contribute to the resiliency and adaptability of the study area to the effects of climate change.

NOP = Notice of Preparation.

As noted in CEQA Guidelines Section 15064.4, the lead agency must determine: (1) whether GHGs may be generated by a proposed project and, if so, quantify or estimate the GHG emissions by type and source; and (2) whether the project’s incremental contribution to climate change is cumulatively considerable. This is addressed in Chapter 23 with the discussion of Impact AQ-9: *Result in Impacts on Global Climate Change from Construction and O&M*, Mitigation Measure AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce Construction and Net CVP Operational Pumping Emissions to Net Zero*, and ultimately results in no cumulative impacts of the project’s GHG emissions on global climate change. See Appendix 23E, *Assessment Form for Consistency with GHG Emissions Reduction Plan*, for the California Department of Water Resources (DWR’s) assessment form to document a DWR CEQA project’s consistency with the DWR *Greenhouse Gas Emissions Reduction Plan*.

30.1.2 Organization

This chapter presents the following: (1) basic background on scientific efforts to evaluate the degree and impacts of future climate changes (a detailed background discussion on climate change is provided in Appendix 5A, *Modeling Technical Appendix*); (2) a discussion of observed climatological changes over the past several decades and expected future changes during the rest of this century globally, in California, and for the study area; (3) an evaluation of how the project's impacts on resources in the study area will be affected by climate change; and (4) an evaluation of the resiliency and adaptability of the study area to the major expected impacts of climate change.

30.1.3 Climate Change Background

Scientific measurements have shown that changes in the global climate system are already occurring. These changes include rising global average surface temperatures, rising ocean temperatures, changes in precipitation patterns, changes in ocean salinity, ocean acidification, glacier shrinking, decreased Arctic sea-ice extent, rising global sea levels, and increased intensity and frequency of extreme events such as heat waves and heavy precipitation events (Intergovernmental Panel on Climate Change 2021:1-50–1-51, 2-7; [California Natural Resources Agency et al. 2020:14–15](#)).

Studies on climate change impacts conducted by the Intergovernmental Panel on Climate Change (IPCC), the U.S. Global Change Research Program (USGCRP), the Governor's Office of Planning and Research (OPR), the California Energy Commission (CEC), the California Natural Resources Agency (CNRA), agencies in the State of California (e.g., DWR), the DWR Interagency Ecological Program (IEP), and the U.S. Department of the Interior Bureau of Reclamation (Reclamation) are referenced throughout this chapter. Particularly relevant studies to the study area include the Delta Stewardship Council's report, *Delta Adapts: Creating a Climate Resilient Future* (Delta Stewardship Council 2021) and DWR's vulnerability assessment in the *Climate Action Plan Phase III: Climate Change Adaptation Plan* (California Department of Water Resources 2020a).

The IPCC was established by the United Nations Environment Programme and the World Meteorological Organization to provide the world with a clear scientific view of the current state of knowledge regarding climate change and its potential environmental and socioeconomic impacts (Intergovernmental Panel on Climate Change 2012:i). IPCC, an organization of more than 800 scientists from around the world, regularly publishes summary documents that analyze and consolidate all recent peer-reviewed scientific literature, providing a consensus of the state of the science. Thus, IPCC is viewed by governments, policymakers, and scientists as the leading international body on the science of climate change, and its summaries are considered the best available science. IPCC documents address changes at the global and super-regional scales. The *Sixth Assessment Report of the Intergovernmental Panel on Climate Change: Climate Change 2021: The Physical Science Basis* (AR6 Report) (Intergovernmental Panel on Climate Change 2021) is the most recent synthesis report and the one cited here (along with various special reports).

The USGCRP was established by a U.S. Presidential Initiative in 1989 and mandated by Congress in the Global Change Research Act of 1990 (15 USC § 2921 *et seq.*). It consists of 13 U.S. federal agencies that “conduct or use research on global change and its impacts to society.” USGCRP's congressional mandate is to develop and coordinate “a comprehensive and integrated United States research program which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change.” As part of meeting this

mandate, USGCRP develops National Climate Assessments that “analyze the impacts of global change in the United States,” and each assessment undergoes extensive external peer review to serve as an “authoritative” and “policy neutral” resource (U.S. Global Change Research Program n.d.).

OPR, CEC, and CNRA coordinate development of statewide climate assessments, including *California’s Fourth Climate Change Assessment* (Fourth Assessment), published in 2018. The Fourth Assessment presents climate science and impact and adaptation analyses specific to the state, regional, or local levels and includes information and recommendations to inform vulnerability assessments and adaptation strategy development for sectors such as water resources and management in California (California Governor’s Office of Planning and Research et al. 2018a). All research contributing to the Fourth Assessment was peer-reviewed.

30.2 Affected Environment and Resources

The study area is characterized by hot, dry summers and cool, rainy winters. From 1981–2010, average monthly temperatures in Sacramento ranged from 41.0 degrees Fahrenheit (°F) (5 degrees Celsius [°C]) in December and January to 94.1°F (34.5°C) in July, with average monthly rainfall ranging from a low of 0.02 inches (0.05 centimeters) in July to a high of 3.90 inches (9.9 centimeters) in February (Western Regional Climate Center 2021). Average air temperatures in the mountainous regions of the watershed are typically 5°F to 10°F (3°C to 6°C) lower than the temperature on the valley floor.

Although the snow lines vary by storm event, portions of the Sacramento, San Joaquin, Mokelumne, and Cosumnes River watersheds are above the snow line; consequently, much of their respective runoff into the Delta is from snowmelt. Snow in higher elevations serves as an effective type of natural storage because typically it melts gradually during the spring and summer.

Annual precipitation in the Sacramento River watershed ranges from 80 to 90 inches (as liquid water) (203 to 229 centimeters) of primarily snowfall in the mountainous regions, to 41 inches (104 centimeters) of rain in Redding and 19 inches (48 centimeters) in Sacramento. Average annual precipitation for the entire watershed is approximately 36 inches (91 centimeters). Most precipitation occurs between November and April, with little or no precipitation falling between May and October (Stockholm Environment Institute 2003:6). Precipitation that falls as rain in the study area can run off into the rivers (and eventually into the Delta), infiltrate into the soils (recharging the groundwater system), or evapotranspire. Factors such as spring temperatures and the nature of precipitation (i.e., rain/snow elevations in storms) during the October to April period play an important role in runoff timing.

Sandy and peaty soils are found in the Delta region. These soils were developed by the formation of mineral soils near the channels during flood conditions and organic soils on marsh island interiors because plant residues accumulated faster than they could decompose. Prior to the mid-1800s, the Delta was a vast marsh and floodplain, under which peat soils developed to a thickness of up to 65 feet (20 meters) in the central Delta (Whipple et al. 2012:125). In addition to peat, the Delta soils are composed of mineral sediments from rivers (U.S. Geological Survey 2013:3). More information on this topic can be found in Chapter 11, *Soils*.

The study area historically has been affected by periodic extreme precipitation events. The majority of these historical events have likely been caused by atmospheric phenomena called *atmospheric*

rivers (Dettinger 2011:518–519)—narrow corridors of water vapor transported in the lower atmosphere that traverse long swaths of Earth’s surface (Ralph and Dettinger 2011:265). These storms can deliver large amounts of precipitation to California in a short period of time. In addition, these storms tend to be warm (originating in the tropics), which results in higher snowlines and larger portions of the watershed contributing to direct runoff. More detailed information on surface water and climate and meteorological conditions in the study area is provided in Chapter 5, *Surface Water*, and Chapter 23, *Air Quality and Greenhouse Gases*.

Because this chapter discusses how the project alternatives affect the resiliency and adaptability of the study area to the effects of climate change, this section also discusses expected changes to the affected environment. The following background sections provide brief descriptions of: (1) recent trends in key climate metrics, such as temperature, precipitation, and sea level; and (2) projections of how the climate will change between now and 2100. Although the project is designed with a 100-year lifespan, an end-of-century time horizon was chosen for discussion of climate change trends in this chapter because it represents the latest time horizon for a range of best available sea level rise scenarios (California Ocean Protection Council 2017:8).

In the subsections that follow, this information is summarized at the global scale, at the state level, and for the study area. Projections of future climate change are based on: (1) the level of GHGs already in the atmosphere; (2) the current rate at which human activity releases GHGs to the atmosphere; and (3) the projected future rate of GHG emissions, which in turn relies on predictions of future population, global economic growth, future available energy sources, and regulations. Consequently, future projections of climate change typically are displayed as a range, with the lower end representing a lower expectation of the amount of change, and the higher end representing a higher expectation for the degree of change.

30.2.1 Global Climate Change Trends

30.2.1.1 Recent Trends in Climate

The IPCC has found observed changes to be unprecedented: “Global surface temperature has increased faster since 1970 than in any other 50-year period over at least the last 2,000 years” (Intergovernmental Panel on Climate Change 2021:SPM-8). Atmospheric and ocean warming, reduced snow and ice, and sea level rise have been observed (Intergovernmental Panel on Climate Change 2021:1-50–1-51). Global average surface temperatures from 2011 to 2020 are 1.96°F (1.09°C) higher than those from 1850 to 1900 (Intergovernmental Panel on Climate Change 2021:SPM-5). Furthermore, the period from 1983 to 2012 was very likely the warmest 30-year period in the Northern Hemisphere over the last 800 years (Intergovernmental Panel on Climate Change 2021:2-34).¹

Global mean sea levels rose by approximately 7.87 inches (0.2 meters) from 1901 to 2018 and have been rising at a higher rate since the mid-nineteenth century compared to the average rate in the two millennia prior, increasing to an average rate of 0.15 inches (3.7 millimeters) per year during 2006 to 2018 (Intergovernmental Panel on Climate Change 2021:SPM-6). Melting glaciers and ice

¹ The IPCC used the term *very likely* to indicate the assessed likelihood of the outcome or result, based on an evaluation of underlying evidence and agreement. *Very likely* probability indicates 90%–100% likelihood of this outcome or result (Intergovernmental Panel on Climate Change 2021:SPM-4).

1 sheets have been the main contributors to twenty-first century global mean sea level rise, as well as
2 thermal expansion of oceans (Intergovernmental Panel on Climate Change 2021:SPM-11, 7-128).

3 The AR6 Report identifies observed changes in the climate system, causes of climate change, impacts
4 of climate change, and changes in extreme events. In addition to warming surface temperatures and
5 rising sea levels, the AR6 Report identified the following observed changes in the climate system:
6 ocean warming; changes in precipitation, with trends varying by region; changes in ocean surface
7 salinity; ocean acidification; mass loss in the Greenland and Antarctic ice sheets; global glacier
8 shrinking; decreased extent of spring snow cover in the Northern Hemisphere; increased
9 permafrost temperatures in most regions; and changes in sea-ice extent (e.g., decreased annual
10 mean Arctic sea-ice extent and regional differences in extent of change in Antarctica)
11 (Intergovernmental Panel on Climate Change 2021:SPM-5–SPM-6, SPM-11).

12 The AR6 Report also describes impacts of changes in climate on natural and human systems,
13 including altering hydrological systems and shifting geographic range, migration patterns, seasonal
14 patterns, abundances, and interaction of species. Some impacts on human systems have also been
15 attributed to climate change, including the negative impacts of climate change on crop yields and
16 fisheries (due to ocean acidification), which have adverse effects on food security
17 (Intergovernmental Panel on Climate Change 2021:1-69–1-70, 5-56).

18 Furthermore, the AR6 Report states that since 1950, changes in extreme weather and climate events
19 have been observed, including increases in the frequency of warm temperature extremes, extreme
20 high sea levels, and the number of heavy precipitation events (Intergovernmental Panel on Climate
21 Change 2021:SPM-8). Additionally, globally, the number of warm days and nights has increased, and
22 heat waves have become more frequent, along with increased intense tropical cyclone activity
23 (Intergovernmental Panel on Climate Change 2021:TS-67, TS-82).

24 The IPCC also found that measurements have shown a decline in the extent of mountain glaciers;
25 increased atmospheric water vapor content; increased precipitation in most of North America, the
26 southeastern portion of South America, northwestern Australia, and northern and central Eurasia;
27 drying conditions in most of Africa, the Mediterranean, the Middle East, eastern Australia, central
28 South America, and parts of East Asia and Canada; strengthening in mid-latitude westerly winds;
29 more intense and frequent drought conditions in some regions; and decreased frost days and
30 increased frequency and duration of extreme heat events (since the 1950s) (Intergovernmental
31 Panel on Climate Change 2021:8-34, 12-31, 12-78, 12-96, 12-105, SPM-19).

32 **30.2.1.2 Twenty-First Century Climate Change Projections**

33 A variety of projected climate changes may occur during the twenty-first century. Climate models
34 indicate that global average surface temperature will increase by approximately 1.2°F to 1.4°F
35 (0.65°C to 0.75°C) for the period from 2021 to 2040, compared to the period from 1995 to 2014,
36 with similar changes across the five shared socioeconomic pathway (SSP) scenarios used for climate
37 model simulations. The SSP5-8.5 modeling trajectory represents a very high GHG concentration
38 trajectory if no concerted policy efforts are undertaken to reduce GHGs; the SSP2-4.5 modeling
39 scenario represents an intermediate GHG concentration trajectory. GHG concentration trajectories
40 vary depending on socioeconomic assumptions and climate mitigation levels (Intergovernmental
41 Panel on Climate Change 2021:SPM-14–SPM-15).

42 The SSP scenarios begin to affect the magnitude of projected changes in climate significantly by
43 midcentury, with increasing divergence among scenarios in 2100 and beyond. The IPCC finds that

compared to 1850–1900 levels, end-of-century (i.e., 2081–2100) conditions may be notably different, with global surface temperature likely to be higher by approximately 5.0°F (1.8°C) or 8.1°F (4.5°C), depending on the scenario studied (e.g., SSP2-4.5 or SSP5-8.5). Warming will vary by region, more rapid warming will continue to occur in the high-latitude Arctic region compared to the global mean, warming over land will be greater than warming over oceans, and there will be global average warming for all modeling scenarios. Hot temperature extremes are projected to become more frequent and cold extremes less frequent over most land areas on seasonal and daily timescales for all modeling scenarios. Heat waves are projected to increase in frequency and duration, although cold winter extremes will continue to occur on occasion (Intergovernmental Panel on Climate Change 2021:TS-61, TS-66, TS-82).

Changes in precipitation, ocean temperatures and acidity, Arctic sea ice and near-surface permafrost extent, glacier volume, and sea levels are also likely to occur for all SSP modeling scenarios (Intergovernmental Panel on Climate Change 2021:SPM-22, TS-143). Changes in precipitation may vary by region, with many high-latitude regions, mid-latitude wet regions, and the equatorial Pacific likely to see increased mean precipitation and many subtropical regions likely to see decreased mean precipitation by end of century under all SSP modeling scenarios. Additionally, increased frequency and intensity of extreme precipitation events is likely, depending on regional conditions, such as monsoons and mid-latitude storms (Intergovernmental Panel on Climate Change 2021:SPM-9, SPM-18).

Ocean warming and global ocean acidification will continue over the century for all SSP scenarios. Surface ocean pH is projected to decrease for all SSP scenarios. Arctic sea ice is projected to decrease, as is the extent of permafrost and mountain and polar glaciers across scenarios (Intergovernmental Panel on Climate Change 2021:SPM-15, SPM-22).

Global average sea levels are projected to continue to rise through the twenty-first century and at a faster rate compared to historical rates. Compared to 1995 to 2014, end-of-century global mean sea level rise is likely to be 1.4 to 2.5 feet (0.44 to 0.76 meters) under the intermediate SSP2-4.5 modeling scenario and 2.07 to 3.3 feet (0.63 to 1.01 meters) under the SSP5-8.5 scenario, although there will be variation by region.² By 2100, sea levels will very likely rise in more than approximately 95% of the ocean area,³ and almost 70% of the global coastline is projected to see a change in sea level “within ±20% of the global mean increase” (Intergovernmental Panel on Climate Change 2021:SPM-21, SPM-25).

The IPCC projected additional changes to the global climate system, including reduced global snow cover; increased thaw depth in permafrost regions; decreased sea ice with potential full disappearance in summer months; increased frequency of heat waves, droughts, and heavy precipitation events; increased intensity of tropical cyclone events; and northward movement of extra-tropical storm tracks (Intergovernmental Panel on Climate Change 2021:TS-67, TS-71, TS-76, TS-82, TS-134).

² The Intergovernmental Panel on Climate Change used the term *likely* to indicate the assessed likelihood of the outcome or result, based on an evaluation of underlying evidence and agreement. *Likely* probability indicates 66–100% likelihood of this outcome or result (Intergovernmental Panel on Climate Change 2021:SPM-4).

³ The Intergovernmental Panel on Climate Change used the term *very likely* to indicate the assessed likelihood of the outcome or result, based on an evaluation of underlying evidence and agreement. *Very likely* probability indicates 90%–100% likelihood of this outcome or result (Intergovernmental Panel on Climate Change 2021:SPM-4).

30.2.2 Climate Change Trends in California

This section reviews the current understanding of potential climate change in California as established by recent scientific and peer-reviewed publications, including the *California's Fourth Climate Change Assessment* and the *Fourth National Climate Assessment*. These assessments use projections from downscaled Coupled Model Intercomparison Project Phase 5 (CMIP5) Global Climate Models using Representative Concentration Pathway (RCP) GHG trajectories, rather than the SSPs described above. Downscaled projections for California using CMIP6 Global Climate Models and SSPs are in development and will be used in future state and federal climate assessments. California has experienced warming during the twentieth century, and annual maximum temperatures are projected to increase by 5.6°F (3.1°C) for RCP 4.5 and 8.8°F (4.9°C) for RCP 8.5 throughout the state by 2100 (California Governor's Office of Planning and Research et al. 2018a:23). Overall precipitation is projected to continue to be variable, and annual precipitation may increase broadly in the north and decrease in the southernmost regions of California (California Governor's Office of Planning and Research et al. 2018a:25). These wetter conditions in the northern regions are expected to be more notable under the RCP 8.5 GHG concentration trajectory compared to the RCP 4.5 trajectory, particularly in the central California coast, due to the increased heavy precipitation extremes (Scripps Institution of Oceanography 2018:22). Some basins overall—and some areas within basins—are projected to become wetter, some are projected to become drier, and some have approximately equal chances of becoming drier or wetter (California Governor's Office of Planning and Research et al. 2018a:25; Bureau of Reclamation 2021:335–349). Projected changes in precipitation are less consistent across climate models and characterized by greater uncertainty compared to projected changes in temperature. Although changes in annual precipitation are projected to be small in many regions throughout California, extreme heavy precipitation events and dry spells are projected to increase significantly throughout the state (California Governor's Office of Planning and Research et al. 2018a:22, 26).

Warming trends appear to have led to a shift in cool season precipitation toward more rain and less snow, which has caused increased rainfall-runoff volume during the cool season accompanied by less snowpack and spring snow water accumulation in some Western United States locations (Scripps Institution of Oceanography 2018:51; California Governor's Office of Planning and Research et al. 2018a:26). Hydrologic analyses-based future climate projections, using RCPs 4.5 and 8.5 and a yearly timeframe, suggest that warming and associated loss of snowpack will persist over much of the Western United States. However, there are some geographic contrasts. Snowpack losses are projected to be greatest where the baseline climate is closer to freezing thresholds (e.g., lower-lying valley areas and lower-altitude mountain ranges). It also appears that in some high elevation regions there is a chance that snowpack actually could increase during the twenty-first century because winter precipitation increases are projected (Bureau of Reclamation 2021:ES-iii). This increase in snowpack in some areas may occur during rain-snow storms due to an increase in mixed precipitation types and increased precipitation (California Energy Commission 2018a:40).

One of the technical reports in California's Fourth Climate Change Assessment is *Mean and Extreme Climate Change Impacts on the State Water Project* (California Department of Water Resources 2018a). This report used the CalSim 3.0 water resources planning model to assess risks of midcentury impacts of shifting hydrology, warming temperatures, and rising sea levels on the SWP. It also presents key findings on impacts to the SWP system by midcentury under both the RCP 8.5 and RCP 4.5 modeling scenarios.

The technical report *Climate Change Risk Faced by the California Central Valley Water Resource System* is also included in the Fourth Assessment and was prepared by DWR (2018b). This report assesses water supply vulnerability to midcentury climate impacts of changing temperatures and precipitation, using a stress-test strategy and Global Climate Model-based probability estimates, under RCPs 4.5 and 8.5. It uses the 1,100-year record of Sacramento and San Joaquin River flows, assessing extreme droughts and floods and variability. The report presents key findings on changing temperatures and precipitation levels that could affect system performance, finding likely declines in system performance of supply, storage, and Delta outflow with increasing temperatures (California Department of Water Resources 2018b:iii).

30.2.2.1 Recent Trends in Climate

Over the last 100+ years, temperatures have been warming and sea levels have been rising. Long-term observations have not shown significant trends of California being wetter or drier overall, but rather recent trends have observed general increases in annual, winter, and spring precipitation variability that indicate an increasing frequency of precipitation extremes—heavy precipitation and drought (He and Gautam 2016:11, 17). Over the last 60+ years, snowpack has been declining, there have been some downward trends (mostly not significant) in marine layer clouds, and there have been no significant trends in frequency and intensity of Santa Ana winds (California Governor's Office of Planning and Research et al. 2018a:22). Over the last 30+ years, acres burned by wildfire have been increasing, for which both biophysical factors (e.g., temperature, moisture, wind, vegetation) and rapid population growth near wildland areas are attributed as causes (California Governor's Office of Planning and Research et al. 2018a:22).

California experiences significant precipitation variability across seasons, between annual, monthly, and daily precipitation totals, and in multi-year dry and wet cycles; notably, extreme precipitation events significantly affect annual variability. This climate is exemplified by recent, unusually wet years (e.g., 2005, 2011, 2017) and droughts (e.g., 2012–2016). Winter storms caused by atmospheric river events—modeled by the USGS ARkStorm scenario (U.S. Geological Survey 2021a) and often referred to as *ARkStorms*—can create heavy precipitation when they encounter mountain ranges along the coast and are capable of creating widespread, severe flooding. ARkStorms can also contribute to snowpack when occurring in the colder months. Many of California's water resources depend on snowpack from atmospheric rivers each year (California Governor's Office of Planning and Research et al. 2018a:24–26).

30.2.2.2 Twenty-First Century Climate Change Projections for California

In brief, projected trends of climate impacts anticipate future temperature warming, sea level rise, snowpack decline, and increasing intensity of heavy precipitation events, frequency of drought, and acres burned by wildfire. The direction of future change in annual precipitation, frequency and intensity of Santa Ana winds, and marine layer clouds is unknown (California Governor's Office of Planning and Research et al. 2018a:22).

Trends and associated impacts will vary by region, and it will become increasingly critical for water managers to use climate science and projections to plan as historical hydrological information stops serving as a “trustworthy guide” (California Natural Resources Agency et al. 2020:14–15).

As described in the 2020 California Water Resilience Portfolio (California Natural Resources Agency et al. 2020:14–15), these trends may affect California water resources in various ways, including those listed below.

- Increased risk of intense storms and flooding, rising sea levels, and storm surges, making coastal communities vulnerable to coastal flooding and seawater intrusion. Water resources in the San Francisco Bay Area and Sacramento–San Joaquin Delta may be adversely affected, for example, by increased salinity.
- Decreased snowpack in areas such as the Cascade and Sierra Nevada ranges may lead to increased “flashy winter runoff and flood risks” and lower spring and summer stream flow (California Natural Resources Agency et al. 2020:14–15). Additionally, more intense drought particularly may affect areas dependent on surface water flows and may affect water resources (e.g., degrading water quality in estuaries). Updated water infrastructure and management—for example, to capture water in high-flow periods to mitigate impacts in dry periods—will be key to managing increased variability of water bursts and prolonged periods of dry conditions.
- Increased wildfire risk in fire-prone areas heightens the risk of catastrophic fire impacts on water supply and quality.
- Decreased water quality in estuaries during droughts.
- Increased saltwater intrusion in the San Francisco Bay Area and the Sacramento–San Joaquin Delta as sea level rises.

Compared to 1960–2005 observations, annual average maximum daily temperatures across California are projected to increase by between 4.4°F and 5.8°F (2.4°C and 3.2°C) by 2050 and between 5.6°F and 8.8°F (3.1°C and 4.9°C) by 2100, depending on the GHG concentration trajectory assumed (California Governor’s Office of Planning and Research et al. 2018a:22–23). Warming will not be uniform across the state (California Natural Resources Agency et al. 2020:14–15).

Broadly, California is expected to experience a longer dry season and increased numbers of dry days and dry years and more frequent heavy precipitation and flood events, although future total precipitation projections remain uncertain (California Governor’s Office of Planning and Research et al. 2018a:19). The modeling for this study relies on an ensemble of climate projection scenarios to account for a range of climate change outcomes; however, it does not explicitly resolve or investigate precipitation extremes. Precipitation projections in California show regional variation, with models indicating Northern California may become wetter and Southern California may become drier, although, compared to annual precipitation variability, these trends are relatively small. Atmospheric rivers are projected to become stronger and carry more moisture in a warmer climate, which may lead to increased extreme precipitation. Additionally, the likelihood of a “prolonged ‘mega-drought’” occurring in the twenty-first century in the Southwestern United States is increasing, as is the likelihood of a “mega-flood” occurring in California (California Governor’s Office of Planning and Research et al. 2018a:24–27). Global changes, such as a decrease in Arctic sea ice, may affect future precipitation in California, as well; further research is needed to understand this potential link (California Governor’s Office of Planning and Research et al. 2018a:24–27).

Snowpack in the Nevada and California mountains that serves as a natural reservoir and key source of surface and groundwater may decline substantially under future climate conditions, in part because warmer temperatures may lead to a smaller percentage of precipitation falling as snow and

a greater percentage of precipitation falling as rain (California Governor’s Office of Planning and Research et al. 2018a:26–28).

Warmer air temperatures may increase soil moisture loss and lead to drier soils, affecting both drought events and seasonal dryness; seasonal impacts will vary (e.g., earlier soil drying in the spring may lead to prolonged summer dryness).

Wildfire risks in California are already increasing due to changes in climate (e.g., warmer air temperatures) and other factors (e.g., changes in land use, such as development along the wildland–urban interface). Scientists are still working to determine how winds that often play a significant role in amplifying fire weather conditions in California—such as the Santa Ana, Sundowner, and Diablo winds—may respond to climate change. The complexity of wildfire drivers also leads to a range in results of future projections, from “modest changes” to “relatively large increases in wildfire regimes” compared to historical conditions; projections by the California Energy Commission (2018b:19, 21), which do not incorporate potential changes in wind regimes, project a significant increase in large fire events by end of century under the RCP 8.5 modeling scenario (California Governor’s Office of Planning and Research et al. 2018a:28–30).

It is “virtually certain” that substantial sea level rise will occur by the end of the century, although the rate and degree of increase remain uncertain (e.g., at the San Francisco Bay, the 50th percentile change in projected sea level rise by 2100 under the RCP 8.5 modeling scenario is 2.5 feet, but it is 1.6 feet under the RCP 2.6 modeling scenario) (California Natural Resources Agency and Ocean Protection Council 2018:57). Erosion caused by flooding from coastal wave events and sea level rise may affect large areas and lead to substantial property damage. The U.S. Geological Survey’s (USGS’s) Coastal Storm Modeling System (CoSMoS) model simulations along the Southern California coastline estimated widespread beach erosion by end of century, assuming “limited human intervention” and sea level rise scenarios from 3 to 6.6 feet (0.9 to 2 meters) (California Governor’s Office of Planning and Research et al. 2018a:31–33).

30.2.3 Climate Change Trends and Associated Impacts on the Study Area

30.2.3.1 Climate Change Trends in the Study Area

Looking comparatively at existing conditions (2020) and projected 2040 conditions, scenarios were chosen to assess impacts of the project alternatives, considering expected impacts of climate change and sea level rise and changes in land use, population, and water demand (Appendix 5A, *Modeling Technical Appendix*). Global model projections generated under RCPs 4.5 and 8.5 are used. These were selected because of their relevance to DWR’s programs and planning and as representative of broader climate projections. Historical events and future climate projections with this basis support precipitation and temperature data used for the 2040 scenario. The most feasible models were chosen for historical data and projected outcomes based on changing factors, including temperature and precipitation changing hydrologic conditions, sea level rise, water temperature and quality, and salmonid populations.

As shown in Table 30-2, average daily maximum temperatures, temperature extremes, flood risks, and wildfire risks are all expected to increase in the study area by 2100 or earlier.

1 It is important to note that the character of precipitation within the Sacramento and San Joaquin
2 River Basins is projected to change under warming conditions, resulting in more frequent rainfall
3 events and less frequent snowfall events (He et al. 2019:11). Increased warming is projected to
4 diminish the accumulation of snow during the cool season (i.e., late autumn through early spring)
5 and the availability of snowmelt to sustain runoff during the warm season (i.e., late spring through
6 early autumn). Warming may lead to more rainfall runoff during the cool season, rather than
7 snowpack accumulation. Consequently, this change in runoff pattern leads to increases in December
8 through March runoff and decreases in April through July runoff.

9 Recent modeling indicates that sea level at the San Francisco (Golden Gate) tide gage may increase
10 by as much as 1.8 feet (0.55 meters; H++ scenario, which is an extreme modeling scenario resulting
11 from loss of the West Antarctic ice sheet) by 2040 and 10.2 feet (3.11 meters; H++ scenario) by 2100
12 (California Natural Resources Agency and Ocean Protection Council 2018:18). It is expected that
13 more land in the study area will be subject to inundation by 2100, in comparison to current
14 conditions. Potential changes in inundation zones (i.e., tidal regime) may affect the salinity and
15 suitable habitat for species in the Delta.

16 Table 30-2 reflects climate projections (for all variables except sea level rise) provided in regional
17 reports developed as part of the Fourth Assessment by OPR, CEC, and CNRA: Sacramento Valley
18 (California Governor's Office of Planning and Research et al. 2018b:18–20), San Francisco Bay Area
19 (California Governor's Office of Planning and Research et al. 2018c:14, 17, 31, 61), San Joaquin
20 Valley (California Governor's Office of Planning and Research et al. 2018d:7–8), Central Coast
21 (California Governor's Office of Planning and Research et al. 2018e:7, 13–17, 25, 31, 39), Los Angeles
22 (California Governor's Office of Planning and Research et al. 2018f:6, 10–14, 18, 54, 61), San Diego
23 (California Governor's Office of Planning and Research et al. 2018g:10, 19, 21, 27–29, 39, 74), Sierra
24 Nevada (California Governor's Office of Planning and Research et al. 2018h:5, 15, 18, 28, 46), and
25 Inland Deserts (California Governor's Office of Planning and Research et al. 2018i:14, 18, 21, 23, 29).
26 The Delta Stewardship Council's *Delta Adapts: Creating a Climate Resilient Future* (2021:3-13, 5-8) is
27 used to supplement some information. Sea level rise projections referenced are those developed for
28 the 2018 update to the *State of California Sea-Level Rise Guidance*; data is provided for
29 representative tide gages in each region (California Natural Resources Agency and Ocean Protection
30 Council 2018:18, 63, 72, 78). Regions for which sea level rise data is not provided are indicated with
31 a “–” symbol.

1 **Table 30-2. Climate Change Projections for the Study Area ^a**

Study Area Region	Average Daily Max. Temperature ^b	Temperature Extremes ^c	Precipitation	Sea Level Rise ^d	Flood Risk	Wildfire Risk	Other Impacts
Sacramento Valley Region	Likely ^e to increase by 10°F (5.6°C)*†	Average number of extreme heat days (above 104°F [40°C]) increases from 4 to 40 per year in midtown Sacramento*†	Dry and wet extremes increase	Sea level rise in the San Francisco Bay Area will increase flood potential and salinity of Sacramento–San Joaquin Delta waters	More flood potential in Delta	Heightened risk of catastrophic wildfire	Streamflow shifts from spring to winter, more runoff, and less groundwater recharge
San Francisco Bay Area Region	Likely to increase by 7.2°F (4.0°C)*†	Average number of extreme heat days (over 85°F [29.4°C]) to potentially increase by 90*†	Dry and wet extremes increase	San Francisco tide gage: 1.8 feet (0.5 meters) to 10.2 feet (3.1 meters)	More flood potential	Frequent and sometimes large wildfire	Winter storms more intense; a once-in-20-year storm will become a one-in-7-year or more frequent storm
San Joaquin Valley Region	Likely to increase by 10°F (5.6°C)*†	Average number of extreme heat days (above 101.6°F [38.7°C]) increases from 4 to 46 per year*†	Dry and wet extremes increase	–	More flood potential in Delta	Longer fire season, increase in wildfire frequency, expansion in fire-prone areas	Salinity intrudes deeper into Delta; stream flows shift from spring to winter; more runoff and less groundwater recharge
Central Coast Region	Likely to increase by 7.5°F (4.2°C)*†	Average number of extreme heat days (above 87.5°F–90.1°F [30.8°C–32.3°C], depending on the county) increases from 4.3 to 20–50 per year*††	Dry and wet extremes increase	Port San Luis tide gage: 1.6 feet (0.5 meters) to 9.9 feet (3.0 meters)	More flood potential, particularly coastal flooding	Frequent and sometimes large wildfires continue, with heightened post-fire impacts	Sediment from wildfires intrudes flows
Los Angeles Region	Likely to increase by 8.4°F (4.7°C)*†	Average number of extreme heat days (over 90°F [32.2°C]) increases from less than 15 to up to 90 at Los Angeles International Airport*†	Dry and wet extremes increase	Los Angeles tide gage: 1.7 feet (0.5 meters) to 9.9 feet (3.1 meters)	More flood potential, particularly coastal flooding	Increase in wildfire frequency, expansion in fire-prone areas	More stormwater runoff and less groundwater recharge, possible changes in Santa Ana winds

Study Area Region	Average Daily Max. Temperature ^b	Temperature Extremes ^c	Precipitation	Sea Level Rise ^d	Flood Risk	Wildfire Risk	Other Impacts
San Diego Region	Likely to increase by 7°F–9°F (3.6°C–5°C) *†	Average hottest day per year increase by 10°F (5.5°C)*†	Dry and wet extremes increase	San Diego tide gage: 1.8 feet (0.5 meters) to 10.2 feet (3.1 meters)	More flood potential	Increase in wildfire frequency, expansion in fire-prone areas	Changes in Santa Ana winds, sediment from wildfires intrudes flows
Sierra Nevada Region	Average temperature likely to increase by 6°F–10°F (3.3–5.6°C)*†	–	Dry and wet extremes increase	–	More flood potential	Increase in wildfire frequency and size, expansion in fire-prone areas	Higher rain-to-snow ratio, earlier snowmelt, less snowpack
Inland Deserts Region	Likely to increase by 14°F (7.8°C)*†	Average number of extreme heat days (over 112°F [44.4°C]) goes from 10 to more than 80 per year*†	Dry and wet extremes increase	–	More flood potential, particularly flash floods	Increase in wildfire frequency	More runoff, diminished inflows into and increased salinity of Salton Sea

Sources: California Governor’s Office of Planning and Research et al. 2018b:18–20; 2018c:14, 17, 31, 61; 2018d:7–8; 2018e:7, 13–17, 25, 31, 39; 2018f:6, 10–14, 18, 54, 61; 2018g:10, 19, 21, 27–29, 39, 74; 2018h:5, 15, 18, 28, 46; 2018i:14, 18, 21, 23, 29; Delta Stewardship Council 2021:3-13, 5-8; California Natural Resources Agency and Ocean Protection Council 2018:18, 63, 72, 78.

°C = degrees Celsius; °F = degrees Fahrenheit.

^a * Indicates “under RCP8.5”; † indicates “by 2100.” Temperature data shown in the table are probabilistic projections developed for RCP scenario 8.5 assuming an end-of-century (i.e., 2100) timeline (see second and third columns from left). Sea level rise changes shown (see fifth column from left) are projections developed for the H++ scenario, which does not have an associated likelihood of occurrence.

^b Information available in the Fourth Assessment region reports varies by region; average daily maximum temperature is provided for all regions except the Sierra Nevada region, which has the average projected change in temperature (i.e., not average daily maximum).

^c Information available in the Fourth Assessment region reports varies by region; average number of extreme heat days is provided for all regions except San Diego, which has average hottest day instead.

^d Sea level rise projections referenced are those developed for the *State of California Sea-Level Rise Guidance: 2018 Update* (California Natural Resources Agency and Ocean Protection Council 2018). Projections provided are for the H++ scenario, a single scenario for extreme sea level rise, not a probabilistic projection; it does not have an associated likelihood of occurrence but is recommended for consideration in significant, long-term decisions (California Natural Resources Agency and Ocean Protection Council 2018:12). For example, sea level rise at the San Diego tide gage for the H++ scenario is 1.8 feet in 2040 and 10.2 feet in 2100, shown as 1.8 feet (0.5 meters) to 10.2 feet (3.1 meters) in the table above.

^e The IPCC used this term to indicate the assessed likelihood of the outcome or result, based on an evaluation of underlying evidence and agreement. “Likely” probability indicates 66%–100% likelihood of this outcome or result (Intergovernmental Panel on Climate Change 2021:SPM-4).

^f This range covers the average number of days with maximum temperatures above the threshold for five counties (i.e., Santa Cruz, San Benito, Monterey, San Luis Obispo, and Santa Barbara); for values at each location, see *California’s Fourth Climate Change Assessment: Central Coast Region Report* (California Governor’s Office of Planning and Research et al. 2018e:15).

30.2.3.2 Climate Change Impacts in the Study Area

Water temperatures, precipitation, and runoff, sea level rise, flooding, and drought climate change impacts are explored in more detail in the subsections that follow because they are common climate impacts within the study area among the resource topics covered in this Final EIR.

Water Temperatures

Increased water temperatures affect aquatic organisms and habitats biologically, physically, and chemically. These impacts may be seen in changing maximum dissolved oxygen saturation levels (i.e., the highest amount of oxygen water can dissolve) and primary productivity, nutrient and chemical cycling, and organism metabolism, growth, and reproductive and mortality rates (IEP MAST 2015:32). Reduced dissolved oxygen levels may have adverse effects on fish spawning in the form of reduced egg survival and may reduce the habitat zone (i.e., reduce abundance) of fish that are sensitive to higher temperatures, such as delta smelt (*Hypomesus transpacificus*). Salmonid egg survival and population productivity also may be affected by higher temperature levels, which can limit sufficient oxygen levels, increase disease prevalence, and interfere with synchrony of natural systems like migration (National Oceanic and Atmospheric Administration 2018:4, 25, 31, 37).

Higher water temperatures can affect fish habitat, and there are some existing management strategies to maintain the desired water temperature; however, projected critically dry years resulting from climate change would make it more difficult to meet water temperature requirements for suitable aquatic habitat for sensitive species. Water temperatures in the lower American River are influenced primarily by the timing, magnitude, and temperature of water releases from Folsom and Nimbus Dams and are currently managed according to the Water Temperature Objectives established in the 2006 Flow Management Standard (Bureau of Reclamation et al. 2006:2–7). Reclamation manages flows to meet a 65°F (18.3°C) water temperature objective in the lower American River for steelhead incubation and rearing during the late spring and summer; however, critically dry years and low reservoir storages could make flow and temperature management more difficult under future climate conditions.

Precipitation and Runoff

The geographic variation and unpredictability in precipitation that California receives make it challenging to manage the available runoff that can be diverted or captured in storage to meet urban and agricultural water needs. In California, winter precipitation and spring snowmelt are captured in surface water reservoirs to provide flood protection and water supply. In general, peak runoff times are projected to be earlier for watersheds in the study area according to climate projections. The peak is projected to shift 1 month earlier from March to February by the late twenty-first century for the Sacramento Four Rivers (i.e., the Sacramento River and its tributaries [the Feather, Yuba, and American Rivers]) under both RCP 4.5 and RCP 8.5 modeling scenarios. Sacramento Valley watersheds are expected to peak earlier (except for Sacramento River above Bend Bridge), by midcentury (He et al. 2019:9). The San Joaquin Four Rivers (i.e., the San Joaquin River and its tributaries [the Stanislaus, Tuolumne, and Merced Rivers]) and San Joaquin Valley watersheds are projected to remain unchanged in May in both future periods under both RCP 4.5 and RCP 8.5 modeling scenarios; however, the Stanislaus River is projected to have an earlier peak during late century under the RCP 8.5 modeling scenario (He et al. 2019:11).

Snowmelt is an important part of water systems in the study area. Due to elevation differences, Sacramento Valley watersheds generally have higher temperatures and are less affected by snow compared to San Joaquin Valley watersheds. Specifically, more runoff is from snowmelt for San Joaquin Valley watersheds (He et al. 2019:13). As mentioned in Chapter 6, *Water Supply*, snowmelt contributes the largest portion of the flows in the Stanislaus River, with the highest runoff occurring in the months of April, May, and June. With inadequate runoff and pattern changes of snowmelt runoff resulting from climate change, CalSim 3 model results show (although infrequently) simulated occurrences of extremely low storage conditions at SWP and CVP reservoirs during critical drought periods when storage is at *dead pool* levels (i.e., when the water level is so low that it cannot drain by gravity through the dam's outlets). Instances may also occur in the simulation results in which flow conditions fall short of minimum flow criteria, salinity conditions may exceed salinity standards, diversion conditions fall short of allocated diversion amounts, and operating agreements are not met (as described in Chapter 6). High temperatures and lower precipitation levels would result in a rapid drop of carryover storage and performance levels for Folsom, Oroville, and Trinity Reservoirs; however, Shasta Reservoir could be slightly more resilient due to its uniquely high inflow of groundwater baseflow, rather than snowmelt (California Department of Water Resources 2018b:21–22; State Water Resources Control Board 2018:15). As noted in Appendix 5A, *Modeling Technical Appendix*, modeling results are limited and include an inherent degree of uncertainty, likely within 5%. During real-life operations, operators would use real-time adjustments in operation to satisfy regulatory, legal, and contractual requirements given the current conditions and hydrologic constraints.

Sea Level Rise

The potential effects of anticipated sea level rise on the study area were evaluated based on detailed modeling simulations as described in Appendix 5A, *Modeling Technical Appendix*. When considering potential sea level rise impacts, special consideration must be given to the following three interrelated elements.

- **Inundation.** Changes in sea levels and Delta inflows have the potential to cause more temporary or permanent inundation (e.g., permanent inundation due to higher sea levels, temporary inundation due to higher inflows associated with higher sea levels and increased precipitation variability) (Delta Stewardship Council 2021:5-52–5-55).
- **Salinity Gradient.** The location of the gradient between saline, brackish, and fresh water in the San Francisco Bay and Delta will be affected by sea level rise. As sea levels rise, the salinity gradient will shift farther upriver. The position of the daily average salinity gradient in the San Francisco Estuary is called “X2,” which is the distance in kilometers upstream of the Golden Gate Bridge of the 2 parts per thousand (ppt) isohaline based on the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (Bay–Delta WQCP) (State Water Resources Control Board 1995). The X2 position is highly variable due to daily tidal movement. Outflow objectives identified in the Bay–Delta WQCP manage the X2 position to control salinity intrusion into the Delta. The daily average X2 position provides an index of the upstream extent of saltwater intrusion as a consequence of sea level rise. Under State Water Resources Control Board (State Water Board) Water Right Decision 1641 (D-1641), SWP and CVP operators are responsible for maintaining the X2 location, as specified in the 1995 Water Quality Control Plan (State Water Resources Control Board 1995).
- **Tidal Variations.** Changes in sea level will influence natural tidal variations along the California coast and within the San Francisco Bay and Delta. Edge species that rely on existing variations

between wet and dry conditions may become permanently inundated or otherwise experience inhospitable environmental changes. Sea level rise and heightened coastal storms have a combined effect on storm surges, particularly for coastal regions (California Governor’s Office of Planning and Research et al. 2018a:54).

Inland Flooding

Historical patterns of precipitation have been used by the U.S. Army Corps of Engineers (USACE) and DWR to develop reservoir storage criteria to reduce flood potential in watersheds. Assumptions for snowfall and rainfall patterns have been made for the project to reflect climate change that is anticipated to increase surface water runoff from rainfall in the winter and early spring and decrease runoff from snowmelt in the late spring and early summer, as described in Chapter 5, *Surface Water*, and Chapter 6, *Water Supply*.

Flooding occurring from increased precipitation, sea level rise, and more intense storm events threatens California’s critical infrastructure and populations. The increasing proportion of precipitation falling as rain, rather than snow, throughout California regions will exacerbate winter floods (California Department of Water Resources 2018b:3). Major sea ports on the West Coast are already flooding because of sea level rise and storms, and this trend will continue. For example, an area of 0.89 square miles (2.28 square kilometers) within the Port of San Francisco is expected to be flooded in the two decades before the end of the century (California Governor’s Office of Planning and Research et al. 2018a:54). The San Francisco Bay Area is already experiencing flooding, in part due to atmospheric rivers, which are expected to increase with rising temperatures (California Governor’s Office of Planning and Research et al. 2018c:87). Sea level rise will increase the potential for flooding in the Delta, particularly during high-tide events (California Governor’s Office of Planning and Research et al. 2018b:33). North of Delta reservoirs will not have the capacity to hold runoff from early snow melting and increased precipitation and instead will be released as flood water and become Delta outflow (California Department of Water Resources 2018a:40–41). Throughout the Sacramento Valley region, growing storm intensity will create conditions that increase the likelihood of and shorten the timeline before inland mega-floods—such as one like the 1862 “Great Flood” (California Governor’s Office of Planning and Research et al. 2018b:19, 34). The San Joaquin Valley region also is projected to experience a higher frequency of mega-flooding (California Governor’s Office of Planning and Research et al. 2018d:6).

Drought

The study area experiences periodic droughts. The Sacramento and San Joaquin 8 Rivers Index, the Sacramento 4 Rivers Index, and the San Joaquin 4 Rivers Index were included in a study evaluating drought using streamflow-based indices, looking for “deficits” (i.e., any negative difference between the annual flow and the long-term mean annual flow) from 1906 to 2012, which included six significant deficit spells: 1928 (an 8-year deficit), 1944 (a 7-year deficit), 1976 (a 2-year deficit), 1987 (a 6-year deficit), 2007 (a 4-year deficit), and 2012 (a 4-year deficit) (Bureau of Reclamation 2014:25, 28). The majority of these six drought periods had runoff levels that were classified as “dry” or “critical” under the Sacramento and San Joaquin Valley Water Year Indices, which had important agricultural consequences given the level of agricultural production in the Central Valley (California Department of Water Resources 2018a:12; U.S. Geological Survey 2021b). On April 21, 2021, Governor Newsom announced a state of emergency due to acute water supply shortages in northern and central areas of California; as of July 2021, the state of emergency includes 50 counties

(California Governor’s Office of Planning and Research 2021). The duration of the dry spell is unknown, but it is highly likely to persist until the next rainy season in October (National Weather Service 2021). By 2050, extreme Delta drought conditions are projected to occur five to seven times more frequently (Delta Stewardship Council 2021:5-62). During midcentury droughts, Delta exports are projected to reduce to half of the quantity compared to historical droughts exports (California Department of Water Resources 2018a:41). Over the next several decades, dry years will become drier (California Governor’s Office of Planning and Research et al. 2018a:19). Meanwhile, in the southwest regions, the likelihood of a long-lasting “mega-drought” is becoming greater (California Governor’s Office of Planning and Research et al. 2018a:24).

30.2.4 Application of California Climate Projections to Alternatives Analysis

Over the last 14 years, the Delta Conveyance Project and its predecessor projects that have proposed new north Delta intakes were extensively studied using a range of projected climate change futures under CMIP3 and CMIP5, including extreme scenarios. In addition, DWR and the Delta Stewardship Council conducted comprehensive climate change studies to understand the potential impacts on the overall SWP and CVP system; these studies considered increased interannual variability and potential increased drought frequency. Based on these extensive analyses, climate change is expected to significantly affect the overall SWP and CVP operations, upstream tributaries, and the Delta. The degree of effects on the SWP and CVP would vary, based on the assumed climate change projection for any future time horizon. However, irrespective of the effects on the overall SWP and CVP operations, key climate change effects that need to be addressed for proposed new intakes in the north Delta include shifts in timing and quantity of flows, increasingly variable hydrology, increased water levels, and potentially greater salinity intrusion. This CEQA analysis appropriately considered these climate change effects and disclosed how the proposed intakes would perform under the projected future changes.

Future temperature, precipitation, and sea level rise conditions were simulated for the project alternatives using CalSim 3 for use in the project’s integrated operational analysis. These simulations were used to understand the impact of climate change on a range of project operations, including impacts on water supply (e.g., storage, deliveries, project operations) and water quality (e.g., salinity changes). As noted in Appendix 5A, *Modeling Technical Appendix*, Section F, *Sea Level Rise and Delta Water Quality Modeling*, the simulations were used to understand salinity changes and to analyze the response of water quality in seven sea level rise scenarios ranging in severity of sea level rise assumptions, including a base condition with no sea level rise, compared to recent historical conditions.

For this analysis, the CalSim 3 model was run with inputs based on year 2040 (climate period 2026–2055) anticipated conditions, as described in Appendix 5A. Ten CMIP5 global climate models and two GHG concentration scenarios (RCP 4.5 and RCP 8.5) were used to develop 20 climate model projections. These projections were then downscaled using the Localized Constructed Analogs method to develop the 2040 (2026–2055) central tendency climate change scenario, based on temperature and precipitation projections from the 20-model ensemble. Generally consistent with the Bay Delta Conservation Plan/California WaterFix Analysis, Water Storage Investment Program Application, Sustainable Groundwater Management Act, Reinitiation of Consultation on the Long-Term Operations of SWP and CVP (ROC on LTO), and the SWP Incidental Take Permit (ITP), a

quantile mapping approach was used to adjust historical daily temperature and precipitation time series based on the climate projections.

As described in Appendix 5A, under the climate change scenario for the DWR Climate Change Technical Advisory Group (CCTAG) 2040 future conditions, compared to the reference period (1981–2010), average temperature is projected to increase by at least 2.88°F (1.6°C) in all major watersheds in the Sacramento and San Joaquin River Basins. The highest temperature increases in the Sacramento River Basin are projected to occur in the Sacramento River (3.24°F, or 1.8°C) and Feather River (3.42°F, or 1.9°C) watersheds. All major San Joaquin River Basin watersheds are expected to increase by 3.24°F (1.8°C).

Overall, all major watersheds are projected to be wetter, with average precipitation increases from 2.7% to 4.8%. Sacramento River Basin is projected to experience a higher increase in long-term average precipitation than the San Joaquin River Basin.

Watershed total runoff is projected to increase in all major basins except for the San Joaquin River Basin, where runoff is projected to decrease by 1%. Generally, in reviewing basins from north to south, relative change to runoff is projected to decrease, as evapotranspiration losses overcome precipitation increases. As compared to historical runoff, increased precipitation under 2040 CCTAG is projected to lead to a higher peak in SAC-4 peak runoff. The 2040 CCTAG SJR-4 peak runoff volume and timing are projected to remain similar to historical runoff. In both basins, runoff is projected to increase in winter and decrease in spring or summer. Increased winter temperatures are projected to lead to a higher portion of precipitation that directly results in runoff, as opposed to snowpack. Similarly, with decreased snowpack, runoff during the summer, when the majority of runoff is snowmelt, is projected to decrease.

The project's primary operational analysis also used the extreme risk aversion scenario (H++) at the San Francisco tide gage for 2040 (1.8 feet) at the point when the project would become operational (Appendix 5A, Section B, *Hydrology and Systems Operations Modeling*). Through the project's facility design analysis, intakes and conveyance facilities are being designed to maintain functionality under the H++ scenario at 2100 or 10.2 feet; construction design was assessed under the H++ scenario at 2040 or 1.8 feet (0.55 meters; California Department of Water Resources 2020b:2). Potential effects of projected sea level rise on water quality were assessed using the Bay-Delta Semi-implicit Cross-scale Hydrosience Integrated System Model. An upper boundary for sea level projections analysis is based on anticipated conditions in 2100; the range of sea level rise projections, which are applied in the design of the intake locations, for year 2100 are 6.9 to 10.2 feet (2.10 to 3.11 meters), corresponding to Medium High (0.5% probability) and H++ risk aversion scenarios, respectively. The H++ scenario represents an extreme risk aversion scenario that assumes rapid ice mass loss from the West Antarctic ice sheet and accelerated global sea level rise (California Ocean Protection Council 2017:24). In its *State of California Sea-Level Rise Guidance 2018 Update*, the California Ocean Protection Council recommends the H++ scenario for use on projects that could affect critical infrastructure or critical natural systems (California Natural Resources Agency and Ocean Protection Council 2018:24). Although no current guidance exists for the use of specific climate scenarios under CEQA, per California Ocean Protection Council guidance, the H++ scenario is relevant to high-stakes, long-term decisions and for projects with a lifespan beyond 2050 that have a low risk tolerance. This extreme scenario was included given the potential for nonlinear acceleration of sea level rise driven by positive feedbacks of ice-sheet dynamics during the second half of the century. The probability of the H++ scenario occurring is unknown. See Appendix 5A for further detail.

Two additional climate scenarios were generated for the 2026–2055 climate period, which include a 2040 Central Tendency (CT) climate scenario with 0.5 foot of sea level rise and a 2040 Median climate scenario with 1.8 feet of sea level rise. These additional scenarios help to depict the possible hydrological outputs under a broader range of climate effects. The 2040 CT climate scenario depends on CCTAG projection models most appropriate for California water resources evaluation and planning. The 2040 Median climate scenario was generated from the 10 general circulation models—RCP models that are closest to the median of the 64 climate projections in terms of the annual temperature, annual streamflow, and variability in streamflow. In the 2040 Median climate scenario, decreases in summer streamflow are more prominent. More information on these scenarios and the differences between them is provided in Appendix 30A, *CalSim 3 Results Sensitivity to 2040 Climate Change and Sea Level Projections*.

30.3 Applicable Laws, Regulations, and Programs

The applicable laws, regulations, and programs considered in the evaluation of climate change are indicated in this section or the impact analysis, as appropriate. Applicable laws, regulations and programs associated with state and federal agencies that have a review or potential approval responsibility have also been considered in the development CEQA impact thresholds or are otherwise considered in the assessment of environmental impacts. A listing of some of the agencies and their respective potential review and approval responsibilities, in addition to those under CEQA, is provided in Chapter 1, *Introduction*, Table 1-1. A listing of some of the federal agencies and their respective potential review, approval, and other responsibilities, in addition to those under NEPA, is provided in Chapter 1, Table 1-2.

The Council on Environmental Quality (2016) has prepared draft guidance on how federal agencies should consider the effects of climate change in their evaluation proposals: *Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews*. Consistent with the draft guidance, this chapter evaluates the relationship of climate change effects to the proposed project and alternatives. The project is therefore compatible with the Council on Environmental Quality guidance on climate change. Furthermore, DWR requires that all projects that go through the CEQA/EIR process document and complete additional information and analysis of climate change in all EIRs in which DWR acts as the lead agency. This chapter evaluates the impacts of climate change on the project and adaptation benefits provided by the project in accordance with the guidance provided in DWR's *Climate Action Plan Phase 2: Climate Change Analysis Guidance* (2018c).

30.4 Potential Impacts of Alternatives

30.4.1 Impacts of the No Project Alternative with Climate Change

Based on climate trends on the study area, as described in Section 30.2.3.1, *Climate Change Trends in the Study Area*, reduced runoff volume and changes in evapotranspiration in the warm season (April–July) due to climate change may decrease the amount of water in channels and associated infrastructure. However, increases in rain-on-snow events, earlier snowmelt, and increased

1 frequency and severity of flood events that are expected during the cool season (December–March)
2 may exacerbate challenges related to channel and reservoir capacity limits or risks associated with
3 runoff or flood flows. Higher water levels under sea level rise and changes in erosion and
4 sedimentation may compound these effects.

5 The Delta currently faces significant risks from levee failure, partially due to factors that contribute
6 to flooding within the Delta, as described in Chapter 10, *Geology and Seismicity*. Additionally, the
7 Delta faces long-term progressive risks of levee failures and diminishing operational efficiency and
8 supply reliability from sea level rise and changes in Delta inflow hydrology driven by climate change
9 (Delta Stewardship Council 2021:2-9, 5-46, 5-55–5-59). Continuation of existing management and
10 operation of the Delta will increasingly expose Delta water users and those that depend on water
11 exported from the Delta to risks of water supply interruption and diminishing water supply
12 reliability over time.

13 Delta levees are critical for maintaining flow through the Delta and protecting marsh habitat (Delta
14 Stewardship Council 2021:2-1). The Delta levee system is vulnerable to sea level rise, increased
15 runoff from the Sierra Nevada, and associated flooding (Delta Stewardship Council 2021:2-9, 3-9;
16 California Department of Water Resources 2017:2-4). Higher sea levels will also push ocean waters
17 into fresher waters in the Delta and increase flood potential in areas around the Delta (California
18 Governor’s Office of Planning and Research et al. 2018b:20).

19 Sea level rise-driven saltwater intrusion in the Delta may have a variety of effects on soil,
20 groundwater, or infrastructure, particularly affecting water quality for diversions and Delta tidal
21 wetland habitat. Rising groundwater levels and sea levels in the San Francisco Bay Area are
22 associated with increased subsurface salinity; some of this groundwater is used as drinking water
23 (California Governor’s Office of Planning and Research et al. 2018c:45). Climate change and sea level
24 rise will continue to make it increasingly difficult for the projects to meet water quality, outflow, and
25 other regulations, such as State Water Board D-1641 agricultural water quality and controlling
26 standards, given that water storage volumes may be reduced, thus impeding releases.

27 Under the No Project Alternative, warmer water temperatures are also expected to decrease
28 suitable summer habitat of delta smelt, a federally listed threatened species and state-listed
29 endangered species, because waters in the lower Delta may be too saline and lack enough food for
30 the species, whereas fresh water in the upper Delta may be too warm (National Research Council
31 2012:167–168). Warming of streams and rivers also facilitates colonization by invasive species that
32 may compete with native species for habitat (Garcia et al. 2018:10993). Growth of nonnative,
33 invasive aquatic plants, such as the water hyacinth (*Eichhornia crassipes*) and Brazilian waterweed
34 (*Egeria densa*), has reduced habitat quality and value for many native fishes and raises concerns
35 about the plants’ ability to clog waterways (as described in further detail in Chapter 12, *Fish and*
36 *Aquatic Resources*). Given that these plants can clog diversion points and contribute to water quality
37 issues, growth of invasive macrophytes presents maintenance and operational problems for water
38 users. Growth of these invasive plants generally is facilitated by warmer temperatures and inhibited
39 by colder conditions (U.S. Fish and Wildlife Service 2018:6–11), and climate change is projected to
40 increase temperatures around the Delta. Interventions that could be taken to mitigate vulnerability
41 of fish and wildlife to climate effects could include habitat restoration and water flow management
42 to provide greater access to habitat (Delta Stewardship Council 2021:5-50). These actions would
43 have corresponding tradeoffs because less water would remain in the reservoirs for other uses.
44 Reduced instream water availability would result in difficulty meeting regulatory standards, given
45 negative effects on upstream aquatic species, including coldwater pool resources, that are critical for

1 salmonid rearing. Reduced water availability also could affect reliability for agricultural, municipal,
2 and industrial water supplies and result in associated loss in productivity or other economic costs.

3 Average annual SWP deliveries would decrease under the No Project Alternative for the long-term
4 average of water years, dry water years, and critical water years due to increasing regulatory and
5 environmental needs and changes to precipitation and temperature, which affect rates of runoff,
6 surface water evaporation, and potential evapotranspiration. Long-term average annual deliveries
7 and dry and critical water years deliveries would decrease 7% and 10%, respectively, as described
8 in further detail in Chapter 6, *Water Supply*, Table 6-2.

9 It can be assumed that, in the absence of the Delta Conveyance Project, participating water agencies
10 would seek to bolster water reliability through other projects, which are described in Appendix 3C,
11 Section 3C.3.2.5, *No Project Alternative Assumptions for Water Agency Actions*. However, other water
12 reliability projects are related to making local supplies more reliable and not related to restoring
13 and protecting SWP supplies. Additionally, under the No Project Alternative, projects that are part of
14 EcoRestore would continue to be implemented.⁴ The Delta Adapts adaptation plan will also include
15 strategies to address the effects of climate change in the Delta and provide local governments with
16 information to incorporate climate change into future Delta actions and investments. Collectively,
17 these projects support adaptation to climate change and have the potential to mitigate some of the
18 effects of climate change on water reliability discussed here, including sea level rise, flooding, and
19 precipitation variability.

20 **30.4.2 Impacts of the Project Alternatives with Climate Change**

21 The project is designed to operate within future hydrological conditions resulting from climate
22 change, thereby accounting for those effects of climate change on project alternatives. The project
23 design considers changing water surface elevations—water surface elevations where the project
24 would increase in comparison to the No Project Alternative. However, under analysis of the project
25 alternatives at 2040 and 2072, DWR determined that changing water elevations do not affect project
26 operations (see Appendix 7A, *Flood Protection 2040/2072 Analysis*, for further detail). Although a
27 variety of changes in climate described above, including changes in temperature, hydrology, and
28 wildfire risk, may affect the Delta region, the future climate modeling developed for this assessment
29 focuses on projected sea level rise and hydrologic changes (e.g., temperature and precipitation-
30 driven shifts in surface water, groundwater, runoff) because they present the most pressing threats
31 to project operations and design (See Appendix 5A, Section B, *Hydrology and Systems Operations*
32 *Modeling*, for further detail).

33 The proposed intake areas will experience sea level rise and be designed to operate at water surface
34 elevations that include climate change and sea level rise effects at year 2100 (California Department
35 of Water Resources 2020b:3). However, intakes in the north Delta were found to *not* be vulnerable
36 to future salinity intrusion conditions evaluated under the H++ scenario at year 2100 (10.2 feet or
37 3.11 meters) (Appendix 5A, *Modeling Technical Appendix*, Section F, *Sea Level Rise and Delta Water*
38 *Quality Modeling*); the mixing processes between saltwater and fresh water that may be exacerbated
39 under sea level rise do not appear to progress far above the confluence of Sacramento River, Cache
40 Slough, and Steamboat Slough 14 to 16 miles downstream from the proposed new intake locations.
41 Changing flooding trends, increasing water temperature, and seasonally reduced precipitation and

⁴ EcoRestore is a multi-agency initiative started in 2015 to improve or create at least 30,000 acres of critical habitat for native fish and wildlife species in California's Central Valley.

1 drought (unrelated to the effects of the project alternatives) could result in decreased species
2 populations and quality of species habitat in the study area. In response to decreased species
3 populations and habitat, additional restoration actions could be implemented to support
4 populations of native species populations. Appendix 5A and Appendix 6A, *Water Supply 2040*
5 *Analysis*, provide the detailed results from the climate change sensitivity analysis.

6 The project alternatives potentially would have negative impacts on critical fish habitat and special-
7 status species. These include construction- and operation-related effects. Construction-related
8 impacts include noise from pile driving and temporary and permanent loss of habitat from the
9 aquatic portions of the construction footprint, for example. Operational impacts include factors such
10 as less Sacramento River flow downstream of the proposed north Delta intakes, resulting in changed
11 north Delta hydrodynamics that may reduce through-Delta survival of juvenile Chinook salmon
12 (*Oncorhynchus tshawytscha*) due to flow-survival relationships that may reduce salmon rearing
13 habitat because of a potential decrease in the inundation of riparian and wetland bench habitat,
14 depending on the alternative, season, and location (further described in Chapter 12, *Fish and Aquatic*
15 *Resources*). As noted in Section 30.2, *Affected Environment and Resources*, and Chapter 12, climate
16 change also presents challenges to fish, fish habitat, and food availability, resulting in the potential
17 for the project impacts on species to compound with those driven by climate change. Because
18 riverine habitat is anticipated to continue to be stressed and vulnerable under climate change
19 (California Natural Resources Agency et al. 2020:12), operations that affect flows to tidal and
20 channel habitat could have both exacerbating and mitigating effects, given changes to flow and
21 wetted areas from climate change, depending on timing and volume of those flows. However, the
22 impact of operations and maintenance of the project alternatives would be less than significant with
23 the restoration of tidal and channel habitat. Compensatory mitigation considers impacts of sea level
24 rise on species' habitat (Appendix 3F, *Compensatory Mitigation Plan for Special-Status Species and*
25 *Aquatic Resources*). Appendix 12C, *Fish and Aquatic Resources 2040 Analysis*, compares the No
26 Project Alternative under the 2040 scenario to the project alternatives at 2040 using modeling tools
27 and methods appropriate for the evaluation of impacts on fish and aquatic resources. In Appendix
28 12C, modeling for the No Project Alternative at 2040 and project alternatives at 2040 incorporates
29 assumptions regarding changes to hydrology and sea level rise as a result of climate change and
30 shows that the relative difference between the project alternatives and No Project Alternative at
31 2040 is generally similar to the difference between the project alternatives and existing conditions
32 at 2020 discussed in Chapter 12.

33 As described in Chapter 7, *Flood Protection*, and Appendix 7A, *Flood Protection 2040/2072 Analysis*,
34 the project would involve no change in flood management operations in the SWP/CVP system, based
35 on the 2-D steady-state Sacramento River system Hydrologic Engineering Center River Analysis
36 System (HEC-RAS) analysis, which incorporates climate change (as described above); reservoirs
37 upstream of the Delta would continue to operate to their permitted flood rule curves, and river
38 flows would not change significantly with respect to channel capacity. Permanent project features
39 would be designed to accommodate the 200-year flood event with climate change induced
40 hydrology and sea level rise for year 2100 (i.e., 10.2 feet at the San Francisco Bay gage). The impact
41 of the project on water surface elevation upstream or downstream of north Delta intakes under
42 2072 conditions would be similar to 2022 conditions, and the project would not affect the level of
43 flood protection afforded by the federal levees near the intakes in the study area. Therefore, project
44 alternatives would not result in an increase in flood risk (i.e., levee overtopping) or reduce flexibility
45 for flood management in the Delta when compared to existing conditions.

In order to represent the broad range of potential future climate and sea level rise conditions, Alternative 5 and No Project Alternative were analyzed under three different representations of climate change and sea level rise projections at 2040 (the 2026–2055 climate period). The first is the 2040 Central Tendency (CT) climate scenario with 1.8 feet of sea level rise, which is the same scenario analyzed in the 2040 appendices to the Final EIR, for example, Appendix 5B, *Surface Water 2040 Analysis*. Two additional 2040 climate change and sea level rise scenarios were also used for comparison. These are a 2040 CT climate scenario with 0.5 foot of sea level rise and a 2040 Median climate scenario with 1.8 feet of sea level rise.

Analysis of these three 2040 scenarios for the No Project Alternative showed at least some climate sensitivity of SWP and CVP reservoir storages, river flows, Delta exports, salinity, and X2 position. Storage is generally higher in the 2040 CT with 0.5-foot sea level rise scenario and lower in the 2040 Median with 1.8-foot sea level rise scenario compared to the 2040 CT with 1.8-foot sea level rise scenario. River flows and Delta outflow also varied between the two 2040 CT scenarios and the 2040 Median scenario, with flows often lower in the 2040 Median scenario, except in May to July on the American River where flows are higher. These flows were not affected by sea level rise. Compared to the 2040 CT with 1.8-foot sea level rise scenario, exports are higher in the 2040 CT with 0.5-foot sea level rise scenario and lower in the 2040 Median with 1.8-foot sea level rise scenario. X2 position during winter and spring and salinity during summer and fall also vary according to the climate scenario, with the 2040 Median with 1.8-foot sea level rise scenario having the most eastward X2 positions and highest salinities, and the 2040 CT with 0.5-foot sea level rise scenario having the most westward X2 positions and lowest salinities.

Climate change sensitivity was generally similar in Alternative 5 as in the No Project Alternative for the factors described above. Differences between Alternative 5 and the No Project Alternative were also generally similar in the three climate scenarios. Compared to the No Project Alternative, in all three climate scenarios, Alternative 5 has (1) either equivalent or slightly increased reservoir storages in drier conditions, especially in September, (2) equivalent flows, (3) an approximately 1 kilometer eastward shift of X2 from December through March, and (4) slightly higher salinities during the September through January period. Exports increase similarly under Alternative 5 in all three climate scenarios, but NDD annual exports are slightly higher in the 2040 CT with 0.5-foot sea level rise scenario (mostly in the wettest years) and are lower in the 2040 Median with 1.8-foot sea level rise scenario, compared to the 2040 CT with 1.8-foot sea level rise scenario.

Generally, these sensitivities to climate change are consistent with prior review of climate projections for related variables, and the project is designed to account for the range of results. More information about the sensitivity analysis for Alternative 5 can be found in Appendix 30A, *CalSim 3 Results Sensitivity to 2040 Climate Change and Sea Level Projections*.

30.4.3 Resilience and Adaptation Benefits

Under Assembly Bill 2800, state agencies must take climate change into account in planning, design, construction, operation, and maintenance (Pub. Resources Code § 71155). The project is being built with consideration of climate change by designing to modeled conditions and thus is expected to have a low level of risk for direct climate change effects such as sea level rise. For example, the project design analysis considers the extreme risk aversion sea level rise scenario of 10.2 feet at 2100 to prevent seawater intrusion at the intakes. However, compounding effects of climate change, including increasing stress on supply to meet demand under warmer temperatures, or increasing need for water releases to maintain water quality requirements, may affect the long-term reliability

1 of Delta exports (Delta Stewardship Council 2021:5-55–5-58). For information on climate models
2 and scenarios used, see Section 30.2.4, *Application of California Climate Projections to Alternatives*
3 *Analysis*, and Appendix 5A, *Modeling Technical Appendix*.

4 This project supports statewide adaptation needs articulated in the *California Water Resiliency*
5 *Portfolio* (California Natural Resources Agency et al. 2020) to diversify local supplies and prepare for
6 hotter conditions and more intense floods and droughts by increasing the average annual SWP
7 deliveries for the long-term average, dry, and critical water years (Chapter 6, *Water Supply*).

8 The project may make California's water system more resilient to changes in snowmelt and runoff
9 patterns by helping to capture and move excess flows from locations in the state where runoff is
10 projected to increase (e.g., some locations in the Sacramento and San Joaquin Valleys) to locations
11 that may otherwise face reduced water availability and reduced carryover storage to supply water
12 during dry months (California Department of Water Resources 2018c:17–19; Appendix 5A). DWR
13 considers capture and conveyance in the Delta as important potential adaptations to mitigate these
14 system losses in its *Climate Action Plan Phase III: Climate Change Adaptation Plan* (California
15 Department of Water Resources 2020a:29).

16 Project alternatives would increase resiliency in managing combined effects of sea level rise and
17 changes in upstream hydrology, including changes to runoff patterns from earlier snowmelt and
18 precipitation (see Section 30.2.3, *Climate Change Trends and Associated Impacts on the Study Area*).
19 The alternatives provide an alternative diversion point in the north Delta for Delta exports,
20 augmenting the ability to capture excess flows and improve operational flexibility to enable
21 increased SWP deliveries during long-term average, dry, and critically dry water years (see Chapter
22 6, *Water Supply*). This increased flexibility would allow managers in the SWP/CVP system more
23 options for adaptively managing resources to optimize benefits across water uses and provide more
24 reliable water supplies that would benefit areas receiving deliveries (see Chapter 6, *Water Supply*).

25 Furthermore, the project alternatives are expected to provide the future benefit of allowing
26 continued water deliveries and operational flexibility, should catastrophic failure from seismic
27 activity or other disasters temporarily disrupt routing or quality of surface water supplies (see
28 Chapter 3, *Description of the Proposed Project and Alternatives*).

**SUPERIOR COURT OF THE STATE OF CALIFORNIA
COUNTY OF SACRAMENTO**

Department 36

Judge: Hon. Stephen P. Acquisto

Related Case Nos. 24WM000006; 24WM000008; 24WM000009;
24WM000010; 24WM000011; 24WM000014; 24WM000012;
24WM000017; 24WM000062; 24WM000076

**DECLARATION OF
CAROLYN BUCKMAN
IN SUPPORT OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES'
EX PARTE APPLICATION**

1 1. I, CAROLYN BUCKMAN, make this declaration in support of the California
2 Department of Water Resources' (DWR) Ex Parte Application for Modification or Stay of the
3 Preliminary Injunction (Ex Parte Application). The following statements are based upon my
4 personal knowledge and upon my review of records kept by DWR in the ordinary course of its
5 business practice. I have personal knowledge of the manner in which DWR's records are kept.
6 Each of the records upon which I rely was made in the ordinary course of business at or near the
7 time of the act, condition, or event. The sources of information at the time of preparation are such
8 that I believe the records to be trustworthy, and if called as a witness, I would and could testify
9 competently thereto.

10 2. I have a Bachelor's degree in Environmental Engineering, a Bachelor's degree in
11 Urban Planning, and a Master's degree in Environmental Engineering from the Massachusetts
12 Institute of Technology. I am a licensed Professional Engineer in civil engineering in the state of
13 California.

14 3. I am currently DWR's Environmental Program Manager for Delta Conveyance
15 Office (DCO), responsible for DCO environmental planning and permitting, and I have been in
16 that role for 5 years. As the Environmental Program Manager – and Assistant Deputy Director for
17 DWR – my work includes analyzing and evaluating the State Water Project future reliability and
18 alternatives associated with Delta Conveyance. Prior to working for DWR, I was in the private
19 sector for 21 years working on feasibility studies and environmental compliance for large water
20 and habitat restoration projects. My professional background, knowledge and experience includes
21 an understanding of how water is stored and delivered in California, the importance of needing
22 safe and reliable sources of water, and how crucial water is for California's environment,
23 economy, and public health. In addition, as part of my job, I regularly review published papers
24 and articles, technical reports from DWR's engineers and technical teams, government reports
25 and data, all of which are relevant to the subject matters of this declaration.

26 4. If the court modifies or stays the injunction, the Delta Conveyance Design and
27 Construction Authority (DCA) has informed me that, to the extent feasible, DCA would, if
28 approved by DWR, perform the geotechnical investigations listed below between 2024 and 2026

as part of the continued planning and design of the Delta Conveyance Project (DCP) (hereafter referred to as “2024-2026 Proposed Geotechnical Activities”):

Activity Type	2024-2026 Proposed Geotechnical Activities
Soil borings	230 (~15 to 250 feet in depth)
Cone Penetration Tests (CPTs)	15 (~50 to 250 feet in depth)
Water Quality Testing at Select Soil Boring Sites	31 (~15 to 250 feet in depth)

The scope of the activities is described in paragraph 10 of the Finney Declaration in Support of DWR’s Ex Parte Application as well as paragraphs 7 through 11 and 13 through 16 of the Finney Declaration in Opposition to All Petitioners’ Motions for Preliminary Injunction.

5. On July 22, 2024, on behalf of DWR, I authorized DCA to proceed with the 2024-2026 Proposed Geotechnical Activities if the court modifies or stays the injunction.

6. A portion of the geotechnical activities included in the 2024-2026 Proposed Geotechnical Activities are currently subject to voluntary temporary entry permits (TEPs) or are located on DWR-owned property. Attached as **Exhibit A** is a map of the geotechnical activities that either are subject to temporary entry permits voluntarily entered by landowners to date or are located on DWR-owned property. Assuming the existing TEPs do not expire before DCA can proceed with the geotechnical activities identified in Exhibit A, no further entry authorization by property owners is required to complete the geotechnical activities identified in Exhibit A.

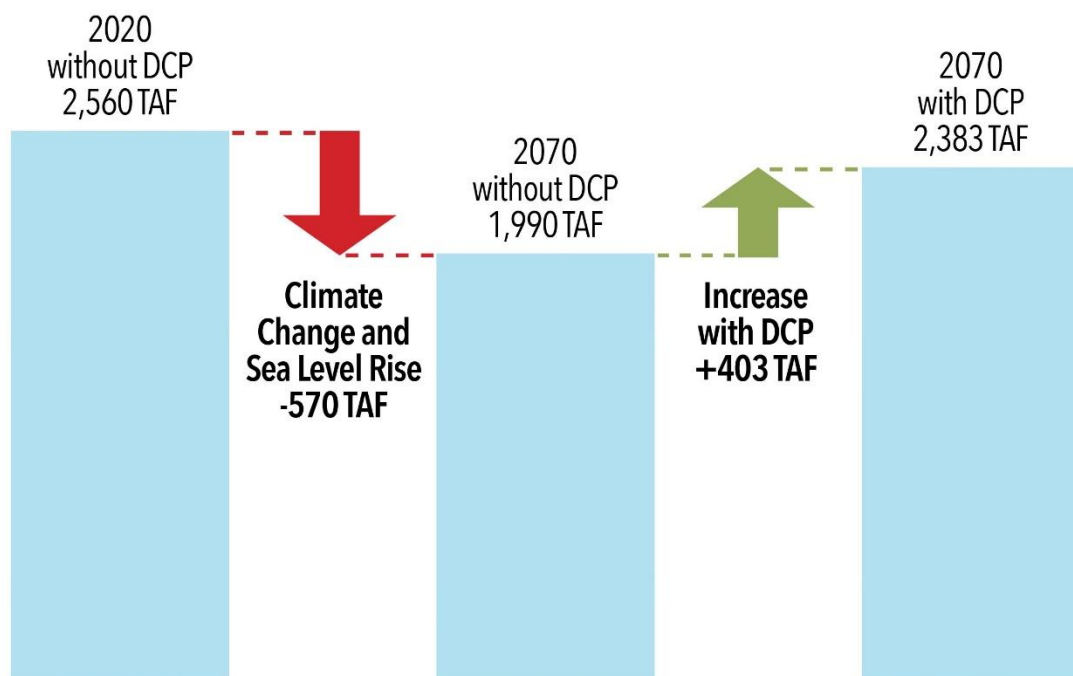
7. The remainder of the 2024-2026 Proposed Geotechnical Activities are not currently subject to a TEP and may require court-ordered entries for DCA to complete the work if the court modifies or stays the injunction. Attached as **Exhibit B** is a map of the geotechnical activities that, assuming additional landowners do not enter TEPs, will require court-ordered entries.

8. In my professional experiences, I have developed a firm understanding about how important the DCP is for California and how it will improve California’s future water security, if timely constructed.

1 9. DWR is the owner and operator of the State Water Project (SWP). I understand
2 that the SWP is an important water supply for California and provides clean, safe, and affordable
3 water for 27 million people, including nearly 7 million disadvantaged community members, and
4 irrigating 750,000 acres of farmland. It is my understanding that the water supplied by the SWP
5 sustains the world's eighth largest economy. I further understand that approximately 2/3 of
6 California's water originates in the Sierra Nevada Mountains and 50% of California's water
7 supply flows through the Delta and is delivered to 3 out of 5 Californians. In my professional
8 work, I have learned that SWP water is responsible for \$400 billion in contributions to
9 California's economy. (See **Exhibit C**, titled Delta Conveyance Project - Modernizing
10 California's Water Infrastructure - 2024 Fast Facts and is publicly available on DWR's website at
11 [https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Delta-Conveyance/Public-](https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Delta-Conveyance/Public-Information/DCP_Fast-Facts_Final.pdf)
12 [Information/DCP_Fast-Facts_Final.pdf](https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Delta-Conveyance/Public-Information/DCP_Fast-Facts_Final.pdf) (last accessed July 22, 2024); see also **Exhibit D**, titled
13 Facts About the Economic Value of the Delta Conveyance Project and is publicly available on
14 DWR's website at [https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Delta-](https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Delta-Conveyance/Public-Information/DCP_Economic-Value-Brochure_2024_Final.pdf)
15 [Conveyance/Public-Information/DCP_Economic-Value-Brochure_2024_Final.pdf](https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Delta-Conveyance/Public-Information/DCP_Economic-Value-Brochure_2024_Final.pdf) (last accessed
16 July 22, 2024).

17 10. Based on my professional background, knowledge and experience in the field of
18 water resource management in California, this State faces a future of water instability, with more
19 unpredictable rain, less snow, and more frequent extreme events like drought and flooding. I have
20 learned that these changes will reduce the ability of the SWP's current infrastructure to capture
21 water, especially because there will be less snow and snowmelt available. (*Ibid.*) See Exhibit D,
22 which includes the graphic below illustrating modeled reductions in SWP water supplies in
23 consideration of current infrastructure as compared to modeled reductions with DCP:
24
25
26
27
28

State Water Project Deliveries:



11. Based on the knowledge that I have gained in my professional work for DWR, I have learned that the DCP is critically important to the State because it will protect against future declines in water security caused by climate driven weather extremes and sea level rise. For example, I have knowledge that DWR conducted 2040 and 2070 model runs that take into account climate change and sea level rise. See **Exhibit E** attached hereto and attached to the Declaration of Graham Bradner in Support of DWR's Ex Parte Application for Modification or Stay of Preliminary Injunction, titled Benefit-Cost Analysis of the Delta Conveyance Project. Berkeley Research Group, which is publicly available on DWR's website at https://water.ca.gov/-/media/DWR%20Website/Web%20Pages/Programs/Delta%20Conveyance/Public%20Information/DCP%20Benefit-Cost%20Analysis%202024-05-13__ADA.pdf (last accessed July 22, 2024). Based on my understanding of that modeling, without revisions to the SWP, annual average SWP exports will decrease, as compared to 2020, by 246,000 acre-feet under the 2040 scenario, and

1 570,000 acre-feet under the 2070 scenario. However, I also learned that with the DCP, the
2 decline could be avoided under the 2040 scenario and the decline could be reduced to 167,000
3 acre-feet, under the 2070 scenario. (*Id.*, at p. 24 [Table 2. Scenarios Considered in Sensitivity
4 Analyses].)

5 12. The understanding I have gained through my professional work at DWR, is that
6 even in a “critical” hydrologic water year like 2021–2022,¹ there would be opportunities for DCP
7 to capture additional supplies following two storm events. Specifically, assuming the DCP had
8 been in place and operating in compliance with regulatory standards for protection of fisheries
9 and water quality objectives, my understanding of the modeling is that it demonstrates that the
10 SWP would have been able to capture an additional 236,000 acre-feet, which is enough water for
11 roughly 850,000 households for one year. (See **Exhibit C**, summarizing DWR’s recent DCP
12 modeling results.)

13 13. Similarly, assuming the DCP had been in place and operating in compliance with
14 regulatory standards for protection of fisheries and water quality objectives, my understanding of
15 the modeling is that it demonstrates that from January 1, 2024 through May 9, 2024, the DCP
16 would have been able to capture and convey 909,000 acre-feet of water that was otherwise lost,
17 enough water for over 9.5 million people, or nearly 3.1 million households, for a full year. (*Ibid.*)

18 14. Using my background, knowledge, and experience, my interpretation of DWR’s
19 modeling is that the DCP would allow the SWP to efficiently capture, move and store water when
20 it is available, especially from storm events. My understanding from the data is that increased
21 flow in the winter months and increased short-duration flashy winter rainstorms as a result of
22 climate change cannot be captured to the historic extent in our upstream reservoirs or at the
23 existing facilities in the south Delta due to physical and regulatory constraints.

24 15. Based on the data that I have reviewed, the SWP provides a foundation for local
25 water supply and resiliency programs. My work, consistent with California’s portfolio approach

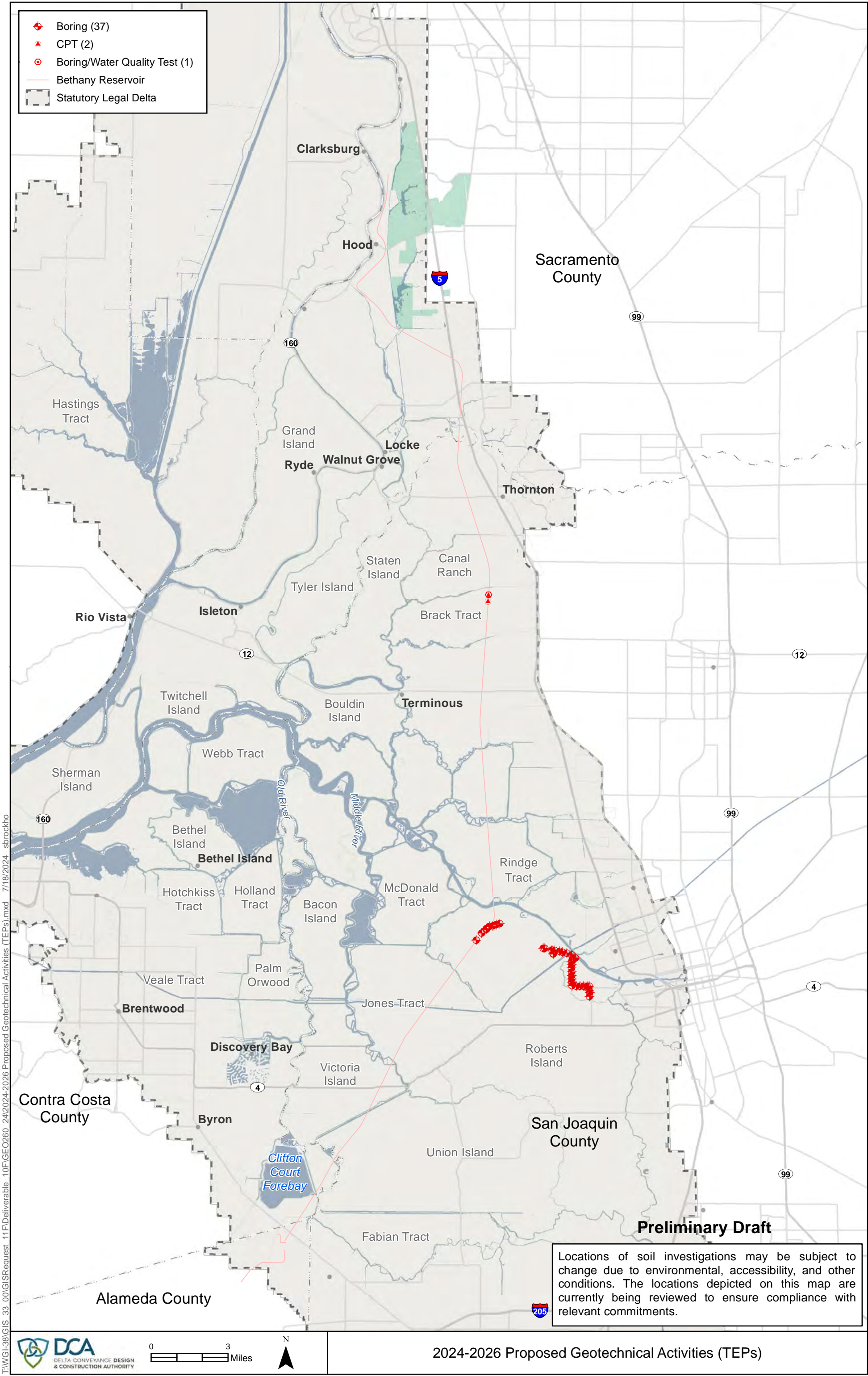
26 ¹ DWR calculates the unimpaired flows of the Sacramento, American, Feather, and Yuba Rivers,
27 key river systems that help determine the annual SWP supply availability. This index, generally
28 referred to as the “Sacramento River Index” is used to determine the water year type classification
and is broken down into five categories, “Wet”, “Above Normal”, “Below Normal”, “Dry,” and
“Critical.”

1 to water security, includes planning a future for California that protects the SWP from growing
2 risks related to climate change and to mitigate risks of a catastrophic levee failure to protect
3 California's water supply and its economy. Based on my work for DWR and the data that I have
4 reviewed, I have learned that the DCP is an essential part of California's broad portfolio approach
5 to respond to climate change and sea level rise and, as a result, is a project of statewide
6 importance and is critical to maintaining the reliability of the SWP.

7 I declare under the penalty of perjury under the laws of the State of California that the
8 foregoing is true and correct. Executed at Sacramento, California, this 23rd day of July, 2024.

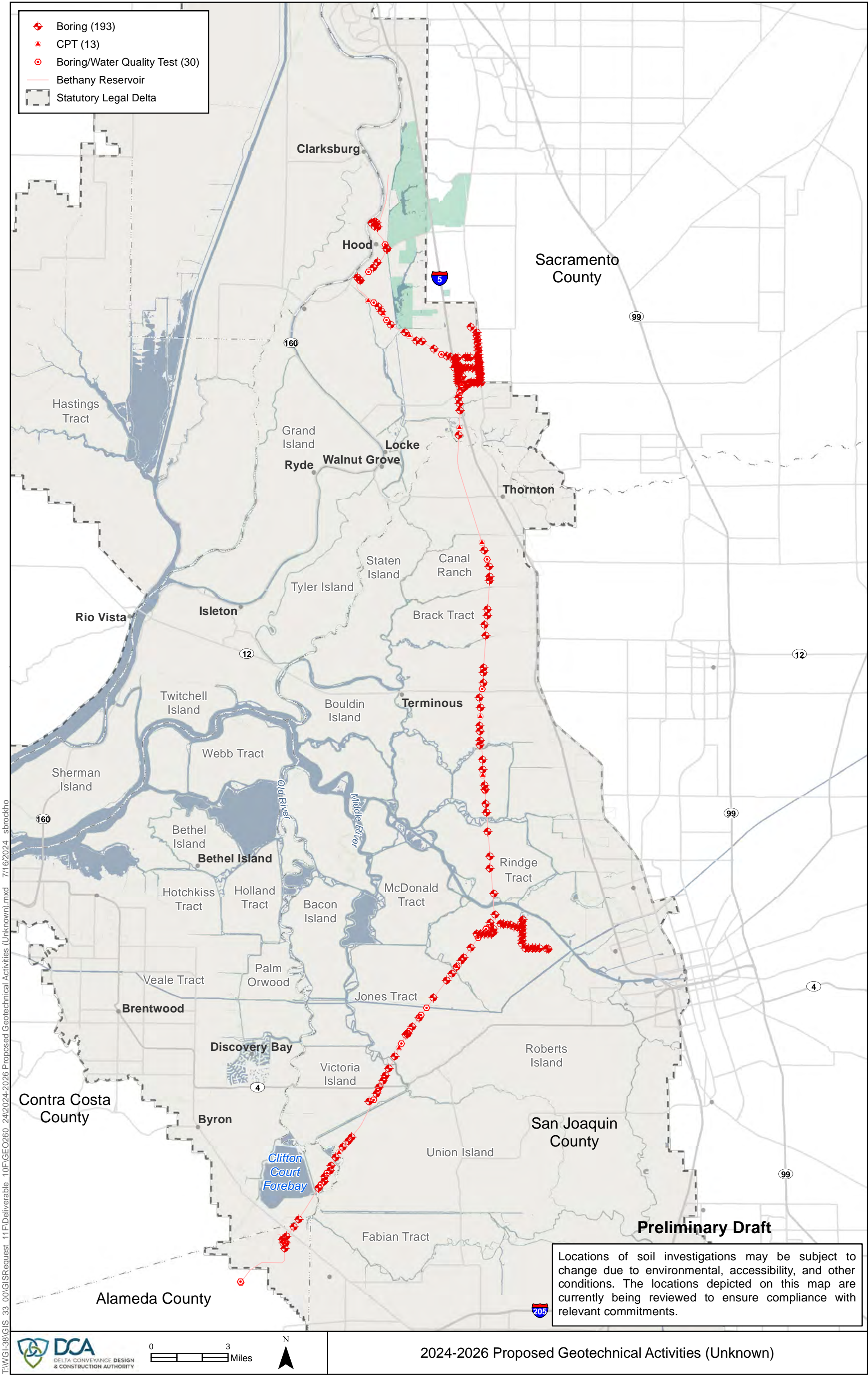
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**EXHIBIT A
TO BUCKMAN
DECLARATION**



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**EXHIBIT B
TO BUCKMAN
DECLARATION**



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**EXHIBIT C
TO BUCKMAN
DECLARATION**

Delta Conveyance Project

Modernizing California's Water Infrastructure | 2024



Fast Facts

WATER SUPPLY RELIABILITY

The Delta Conveyance Project protects against future water supply losses caused by climate driven weather extremes, sea level rise and earthquakes. It will help the State Water Project (SWP) safely capture, move and store water from big, but infrequent, storm events.



Climate change means more rain in the winter and more runoff and river flows than before.



According to the United States Geological Survey there is a **72% chance of a 6.7 or greater magnitude earthquake** occurring in the Bay Area by 2043 that could cause levees in the Delta to fail, crippling the state's ability to deliver clean water.



Significant sea level rise predicted by **2100**.



Sierra snowpack, the state's largest source of surface water, will be reduced by **65%** on average by century's end.

MISSED OPPORTUNITY

If the Delta Conveyance Project was operational during the big winter storms of winter 2021-2022, January 1 through May 9, 2024, a significant amount of water could have been captured and moved.

Winter 2021-2022	January 2023	Jan 1-May 9, 2024
------------------	--------------	-------------------

Amount of water that could have been captured:

236,000
acre-feet

228,000
acre-feet

909,000
acre-feet

That's enough water to supply:

Over **2.5 million**
people for one year

Over **2.3 million**
people for one year

Over **9.5 million**
people for one year

or

Nearly
850,000
households for one year

Nearly
800,000
households for one year

Over
3.1 million
households for one year

Percent of the total volume of water exported by the SWP per year

45%
water year 2021

40%
water year 2022

100%
2024 exports

MODERNIZED WATER INFRASTRUCTURE

Use of design and engineering innovations have resulted in a project that is responsive to community needs and lessens environmental effects to the extent feasible.



1 below-ground tunnel
for approximately
45 miles

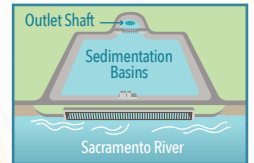
100-130 feet
approximate depth
range of tunnel

Earthquake resilient
due to significantly less
ground motion than at
the surface during a
seismic event

36 feet
tunnel diameter
(inside)

18 inches thickness
of tunnel segments

2 new intakes
in the North Delta with
a total capacity of 6,000
cubic feet per second (cfs)



T-shaped fish screens, with
cleaning apparatus below
surface 1,500 feet long

Pumping plant
connects the tunnel directly to
the existing Bethany Reservoir
on the California Aqueduct



Clifton Court Forebay

Bethany Reservoir

Bethany Complex

California Aqueduct

Tracy

STOCKTON



Facilities designed to withstand **200 year flood event**
on top of **10.2 feet of sea level rise**



Project construction will create over
5,000 good-paying jobs at the peak



Delta Conveyance Project

Modernizing California's Water Infrastructure | 2024



IMPORTANT WATER SUPPLY

The [State Water Project](#) is an important water supply for California that can't be replaced.



27 MILLION PEOPLE

receive clean, safe and affordable water from the SWP, including nearly 7 million disadvantaged community members



750,000 ACRES OF FARMLAND

are irrigated with SWP water



Water supplied by the SWP sustains the world's **FIFTH LARGEST ECONOMY**



2/3 of California's water originates in the **SIERRA NEVADA MOUNTAINS**



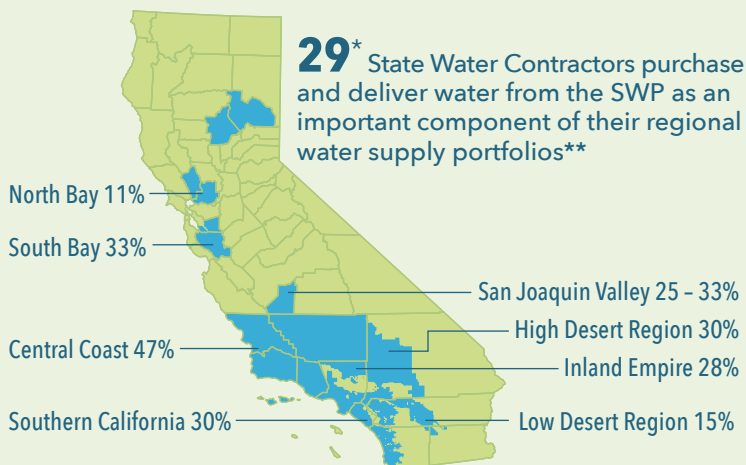
50% of California's water supply flows through the Delta and is delivered to **3 OUT OF 5 CALIFORNIANS**



\$400 billion in contributions to California's economy by SWP water



Important foundation for local water supply projects, including groundwater recharge, recycling, storage and others



*Of the 29 State Water Contractors, 18 are currently participating in the Delta Conveyance Project
**Percentages represent regional water supplies dependent on reliable Delta infrastructure

EXTENSIVE PUBLIC INPUT



Environmental Review

142-day comment period, where **729 letters** and other communications totaling **7,300 individual comments** were received



Community Benefits Program

Acknowledge and address the reality that project impacts are local to the Delta, but direct project benefits accrue to other parts of the state

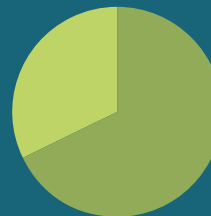


Community Engagement

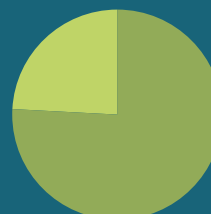
Engaged with Delta communities to hear their ideas and concerns through a **Stakeholder Engagement Committee** comprised of Delta residents, business owners and other stakeholders, and an [Environmental Justice community survey](#)

SUPPORT FOR MODERNIZING WATER INFRASTRUCTURE

The public is highly concerned about the condition of state and local water infrastructure and a [recent poll](#) shows voters strongly support increased funding for water-related infrastructure and are extremely supportive of building a new tunnel.



68% of California voters rate the "condition of state and local water supply infrastructure like reservoirs, dams, canals, sewers and storm drains" as an extremely or very serious problem



76% of voters support building a new tunnel underneath the Sacramento-San Joaquin Delta to upgrade California's primary water delivery infrastructure



**EXHIBIT D
TO BUCKMAN
DECLARATION**



Facts About the Economic Value of the Delta Conveyance Project

Benefits, Costs, Commitments, and Innovations



The Delta Conveyance Project is one of California's most important climate adaptation projects. Extreme weather is leading to more rain, less snow, and a limited ability to capture and move water. The Delta Conveyance Project will protect supplies by capturing water when it is plentiful to better endure dry years and adapt to extreme weather. It protects against the threat posed by earthquakes, sea level rise and levee failure. And it helps resolve conflicts in the south Delta to both protect fish and provide needed water supply.

Need for Protecting the State Water Project

The State Water Project captures and moves water all over California, from the Bay Area to the Mexico border and communities in between. It is an affordable source of high-quality, clean, and safe water for 27 million Californians and 750,000 acres of agriculture. If the State Water Project service area were a nation, it would represent the eighth largest economy in the world. And it is an important foundation for an entire suite of water supply and resiliency programs implemented by local public water agencies.

Economic Benefits

The Delta Conveyance Project passes the benefit-cost test. It enables water needs to be satisfied and water supply reliability to be maintained. It protects against a declining baseline of supplies, allows SWP to adapt against climate change, guards against earthquake risks, and helps resolve conflicts in the south Delta by improving operational flexibility.

Cost Estimate

An updated cost estimate was prepared by the Delta Conveyance Design and Construction Authority (DCA), using a detailed and rigorous approach, the cost of the project is estimated to be \$20.1B in real 2023 (undiscounted) dollars. A preliminary cost assessment conducted in 2020, early in the design process, showed the project would cost about \$16B, which accounting for inflation to 2023 would result in a similar cost. This demonstrates that even as details are added, and refinements are made to the program, costs are holding steady. The DCA is also evaluating potential design or construction innovations that would help manage costs for the program.

Benefits Outweigh Costs

After adjusting to account for the value of money over time (see page 3 regarding “discounting”), the benefits are \$37.96 billion and the costs are \$17.26 billion. This results in a benefit-cost ratio of 2.2, meaning that the benefits outweigh the costs and every dollar spent generates \$2.20 in benefits.

The project passes the benefit-cost ratio test, making the project economically viable and robust under all future scenarios analyzed.

Benefits are quantified in four different areas: Urban water supply reliability, agricultural water supply, water quality, and seismic reliability.

The primary benefit of the DCP is that the project protects against the expected effects of climate change and sea level rise, avoiding future shortages and maintaining water supply reliability.

Understanding Benefits

Urban Water Supply Reliability:

- More SWP deliveries under wetter periods allow agencies to:
 - Fill storage more frequently
 - Enter drought periods with higher reserves
 - Impose fewer periods of mandatory rationing
 - Reduce severity and frequency of shortages
- Urban economic benefits measured as consumers’ willingness to pay (WTP) to avoid shortages.

Agricultural Water Supply

- Agricultural value of water based on the UC Davis Statewide Agricultural Production model and water market transaction data from Nasdaq Veles CA Water Index.

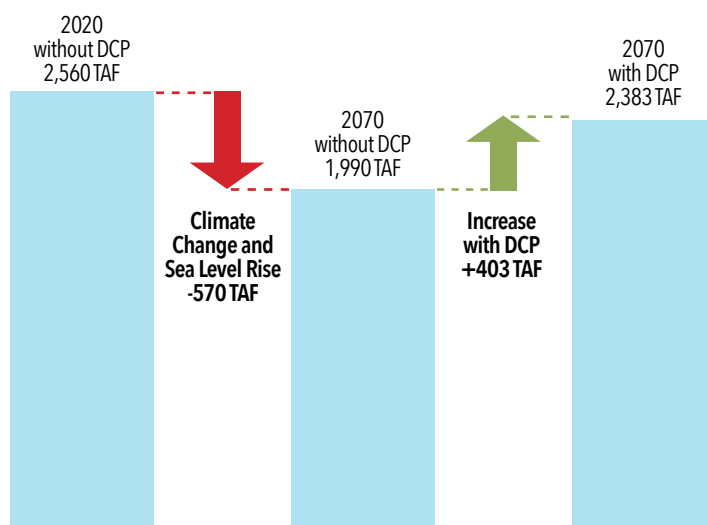
Water Quality:

- Lower salinity improves water quality.
- For urban agencies, this improves taste, the useful life of appliances, the cost of water softening, for example.
- For agricultural agencies, the cost is based on reducing requirements for additional irrigation water needed to flush salts from the root zone of crops.

Earthquake Disruption:

- Avoiding potentially significant disruption to state-wide water supply caused by earthquakes saves time, saves money and protects water quality.

State Water Project Deliveries:



Missed Opportunity

If the Delta Conveyance Project were operational during the big winter storms of winter 2021-2022, January 1 through May 9, 2024, a significant amount of water could have been captured and moved.

Winter 2021-2022	January 2023	Jan 1-May 9, 2024
Amount of water that could have been captured:		
236,000 acre-feet	228,000 acre-feet	909,000 acre-feet
That's enough water to supply:		
Over 2.5 million people for one year	Over 2.3 million people for one year	Over 9.5 million people for one year
or		
Nearly 850,000 households for one year	Nearly 800,000 households for one year	Over 3.1 million households for one year



Assumptions that influence benefits and costs:

- Yield: assumed to provide about 403,000 acre-feet annually on average
- The cost of the project: assumed to be \$20.1 billion in undiscounted 2023 dollars
- Real discount rates: between 2% and 1.4% (Federal Office of Management and Budget, Circular A-4 guidance)
- Environmental mitigation: \$960 million
- Construction period: 15 years
- Life span of the project: 100 years



Summary of Benefits and Costs

	Main Cost Estimate	Cost with DCA Recommended Innovation Savings
Present Value of Future Benefits		
	2023 (\$M)	2023 (\$M)
Urban Water Supply and Reliability	\$33,300	\$33,300
Agricultural Water Supply and Reliability	\$2,268	\$2,268
Urban Water Quality	\$1,330	\$1,330
Agricultural Water Quality	\$90	\$90
Seismic Reliability Benefits (Water Supply)	\$969	\$969
Seismic Reliability Benefits (Water Quality)	\$2	\$2
Total Benefits	\$37,960	\$37,960
Present Value of Future Costs		
	2023 (\$M)	2023 (\$M)
Construction Costs	\$11,486	\$10,723
Other Project Costs	\$3,021	\$2,852
Community Benefit Program	\$153	\$153
Environmental Mitigation	\$735	\$735
O & M Costs*	\$1,697	\$1,697
Environmental Impacts after Mitigation	\$167	\$167
Total Costs	\$17,259	\$16,327
Benefit-Cost Ratio	2.20	2.33

*O&M Costs: includes operations and maintenance costs for project facilities



Understanding Discounting and the “Time Value of Money”

How does a Benefit-Cost Analysis account for inflation?

Inflation is the general increase in the price of goods and services over time, and it poses a challenge for benefit-cost analysis. To ensure a consistent comparison, all future costs and benefits reflect 2023 prices, a method known as using “real prices” in economic terms. This approach removes the distorting effects of inflation, allowing present-day expenditures to be directly comparable to future benefits and providing a clear basis for evaluating a project’s economic viability.

How would unexpected inflation affect the analysis?

If inflation impacts future costs and benefits similarly, changes in the inflation rate will not affect the conclusions of the benefit-cost analysis. However, if inflation disproportionately affects costs or benefits, it could skew the analysis. This is unlikely for the DCP, where benefits tied to water rates and costs associated with construction expenses generally escalate in tandem.

Why does the Benefit-Cost Analysis account for the time value of money (e.g. discount future costs and benefits)?

The time value of money is a recognition that money available today is worth more than the same amount in the future because it can be used immediately—to pay for things or to invest and earn more money. This concept is crucial, especially in long-term projects like the DCP, which assumes a 15-year construction period starting in 2029 followed by a 100-year operational project life.

How is the real discount rate applied?

The ‘real discount rate’ used in this process is determined based on federal guidance and calculated by taking the returns on treasury bills and subtracting the rate of inflation. This discounting process, distinct from the previously discussed use of real prices to account for inflation, helps prioritize projects that offer the best economic returns over their lifecycle, ensuring efficient allocation of resources.

Why is the cost of the project lower in the Benefit-Cost Analysis and higher in the cost estimate?

The cost estimate and benefit-cost analysis are equivalent but expressed differently. The cost estimate is presented in real 2023 dollars. The benefit-cost analysis is shown as “present value.” Present value accounts for various distortions to the value of money over time, including inflation and the potential for investment and it is calculated using a “discount” rate.



Other Important Considerations:

Climate change

Climate change and sea level rise are expected to significantly reduce future SWP deliveries. Future precipitation and runoff are forecasted using multiple climate scenarios that show an annual loss of more than half a million acre-feet by 2070. The primary benefit-cost analysis assumes 1.8 feet of sea level rise by 2070. Multiple sensitivity analyses test robustness of this assumption. In each of the scenarios tested, the benefits of the project significantly exceed costs.

Transfers and Trading

If there are water years that a Public Water Agency's supplies exceed local needs, they may choose to transfer those supplies and the associated costs, consistent with water law and existing water supply contracts. This flexibility will allow PWAs to preserve water supplies for local needs and to transfer those excess supplies—and costs—to other parts of the state, particularly those with limited access to drinking water.

Unmitigated Environmental Impacts

Some environmental impacts are expected to be significant and unavoidable. Where possible, the cost of those impacts has been considered and included. This results in a cost of about \$153 million for lost agricultural land, air quality, noise, and transportation impacts.

Cost of Doing Nothing

Failing to implement the Delta Conveyance Project has real financial consequences resulting from climate change, sea level rise and seismic events.



Some benefits of the Delta Conveyance Project are not monetized in the benefit-cost analysis and yet are compelling for decision-makers:

- Increased operational flexibility: Resolving conflicts in the south Delta between fish and water supply goals.
- Community Benefits Program: \$200 million investments for high-priority local Delta projects, in addition to local business utilization, job training, and infrastructure leave-behinds that have potential to provide benefits that are ultimately likely to represent values beyond this funding commitment.
- Job creation: The project will create 5,000 high-paying jobs.
- Groundwater supplies: Protecting affordable surface water supplies relieves pressure on dwindling or constrained groundwater sources.

Cost Estimate: Conservative, Comprehensive, Based on Industry Standards

DWR approved the Bethany Alignment of the Delta Conveyance Project in December 2023 after concluding the project Environmental Impact Report (EIR). This approved project provided the basis for an updated cost estimate.

The estimate is comprehensive, conservative, and reflects industry standard methodologies. It:

- Is based on the 6,000 cubic feet per second Bethany Reservoir Alternative as outlined in the project Final EIR
- Includes construction costs and other costs, like planning, management, land, mitigation, power and community benefits
- Uses cost estimating approach that builds up based on labor, equipment, materials, and schedule
- Uses a thorough reconciliation process with independent cost-estimating teams and resolves cost differences
- Assumes a reasonable 30% contingency to account for uncertainties

Methodology: A More Rigorous Approach

The updated cost estimate uses a more rigorous approach for concept-level designs. It:

- Uses engineering documentation in drawings and technical reports
- Develops costs based on unit rates, quantities, and durations
- Replaces most cost “allowances” with actual estimates and material price quotes
- Uses better understanding of ground conditions, schedule, and risks

The cost estimate has been prepared by the Delta Conveyance Design and Construction Authority, a joint powers agency comprised of the participating Public Water Agencies responsible for funding, and ultimately building, the project.



Total Project Costs Summary*

Feature	Total Cost (\$M)	Feature	Total Cost (\$M)
Construction Costs		Other Project Costs	
Intakes	\$1,714	DCO Oversight	\$426
Main Tunnels	\$6,353	Program Management Office	\$668
Pumping Plant and Surge Basin	\$2,536	Engineering/Design/Construction Management	\$2,167
Aqueduct Pipe and Tunnels	\$563	Permitting and Agency Coordination	\$67
Discharge Structure	\$99	Total Planning/Design/Construction Management	\$3,328
Access Logistics and Early Works	\$253	Land	\$158
Communication	\$13	DWR Mitigation	\$960
Restoration	\$17	Power	\$415
Construction Subtotal	\$11,548	CCWD Settlement Agreement	\$47
Contingency (30%)	\$3,464	Community Benefits Program	\$200
Total Construction Costs	\$15,012	Total Other Costs	\$1,780

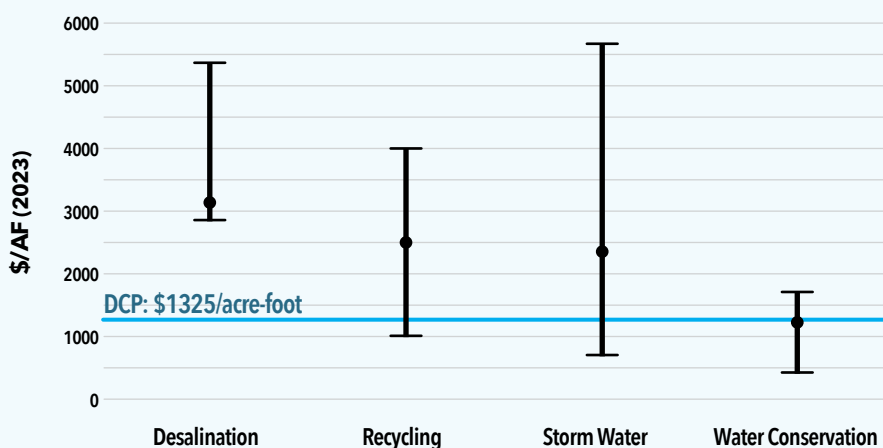
*Costs are in undiscounted 2023 dollars.

Total Project Costs = \$20,120

Cost Category	Total Project Cost Estimate (\$M)	Total Project Cost with Secondary Innovations Estimate (\$M)
Construction Costs	\$15,012	\$14,008
Other Project Costs	\$5,108	\$4,886
Total Project Costs	\$20,120	\$18,894

Comparing the Delta Conveyance Project to Alternative Supplies

The per-acre cost of the Delta Conveyance Project is less than the costs of most other types of supplies. Alternative supplies also lack the ability to provide an equivalent scale of supply and are not able to protect the long-term stability of State Water Project supplies. While a full suite of options is being considered for California and local water purveyors, the Delta Conveyance Project is the most viable and irreplaceable.



Innovations Identify Significant Cost Savings

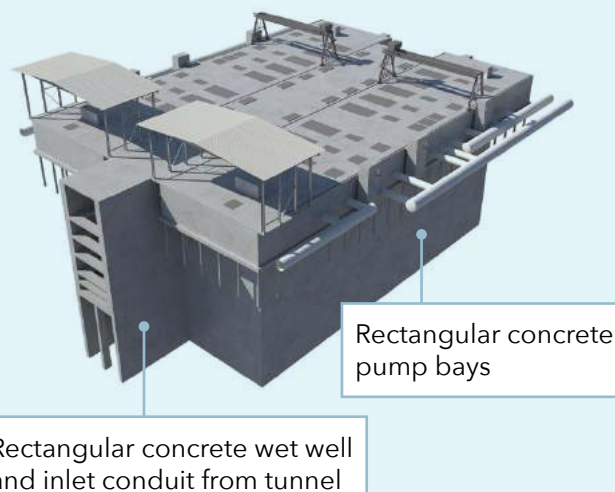
Value engineering is a part of the design phase of a project. It is used to cut costs, save time, reduce risk, or reduce community or environmental disturbances. The approved project represents a conservative configuration for analysis of impacts. An initial review of potential design and construction innovations shows an opportunity to reduce costs by about \$1.2 billion.*

Innovation Example

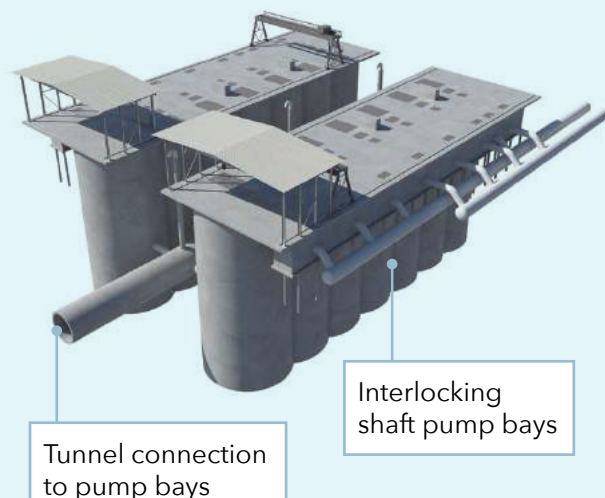
In the Engineering Project Report, the Bethany Reservoir Pumping Plant (BRPP) is a below-ground structure with vertical rectangular diaphragm walls and consists of dry-pit pump bays housing the pumping plant equipment and piping plus an adjoining rectangular concrete wet well and wet well inlet conduit connected to the tunnel reception shaft located along the center of the overall structure.

This innovation would replace the vertical, deep box diaphragm wall arrangement with interlinking shafts of diaphragm wall construction that would house the pumping plant equipment and piping and a tunnel that would replace the wet well and wet well inlet conduit, greatly reducing construction quantities and expediting schedule due to construction sequence improvements.

CURRENT PUMPING PLANT DESIGN



INNOVATION CONCEPT



INNOVATION ADVANTAGES:

- Reduces construction quantities (soil excavation, concrete, rebar)
- Shortens construction schedule by 981 days
- Reduces direct construction cost by \$138,720,000
- No changes to above-ground site configuration and surface features

*Does not represent changes to the approved project description.

For More Information



For more information on cost, benefits, funding and financing of the State Water Project and the Delta Conveyance Project, view this [FAQ](#) or use the QR code.

For more about the Delta Conveyance Project, visit:
water.ca.gov/deltaconveyance

For more about the project permitting process, visit:
deltaconveyanceproject.com

For more information about project design and engineering, visit: dcdca.org



**EXHIBIT E
TO BUCKMAN
DECLARATION**



Benefit-Cost Analysis of the Delta Conveyance Project

Prepared by David Sunding, Ph.D.

and Oliver Browne, Ph.D.

May 16, 2024



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Executive Summary

This report presents the results of a benefit-cost analysis for the Delta Conveyance Project (DCP), a plan to modernize the State Water Project (SWP)'s conveyance infrastructure in the Sacramento-San Joaquin River Delta (Delta). The SWP plays a crucial role in supplying water resources to 27 million Californians. Businesses in the area served by the SWP produce \$2.3 trillion in goods and services annually, making it the world's eighth-largest economy. The SWP delivers an average of 2.56 million acre-feet of water annually to urban and agricultural customers in the Bay Area, Central Valley, Central Coast, and Southern California. However, by 2070, climate change and sea-level rise are expected to reduce SWP deliveries by approximately 22%, or 546 thousand acre-feet per year (TAF/yr). In addition, the SWP faces an ongoing risk of service disruptions following seismic events near the Delta; these events could cause outages and reduce the quality of water exports from the SWP south of the Delta.

The DCP's intended purposes are to mitigate climate and seismic risks for the SWP and provide water managers with additional operational flexibility in the Delta. The DCP would add new intake facilities in the North Delta to divert water from the Sacramento River and a tunnel to convey water to the South Delta for export to the SWP's urban and agricultural customers. The DCP would increase SWP deliveries by approximately 17%, or 403 TAF/yr, largely offsetting the anticipated reduction in water deliveries due to climate change. The DCP would also be less vulnerable to earthquakes near the Delta, meaning that SWP supplies could continue largely uninterrupted following seismic events.

A benefit-cost analysis is a rigorous method for evaluating the economic viability of a project—specifically, by forecasting a project's expected future benefits and costs. The present value of future benefits and future costs is calculated relative to a no-project alternative. Present values are calculated using real discount rates that reflect the time-value of money. As detailed in recent federal guidance (OMB Circular A-94), we adopt a real discount rate that starts at 2% in 2020, reflecting current inflation-adjusted Treasury bond rates, and gradually decreases to 1.4% by 2140 to reflect long-run uncertainties. The benefit-cost ratio is calculated by dividing the present value of future benefits by the present value of future costs. As discussed later in this report, for the DCP, we calculate a benefit-cost ratio of 2.20 and show that this ratio is robust with respect to a number of alternative assumptions regarding climate change, sea-level rise, SWP operations, and project costs. The approach to benefit-cost analysis taken in this report is consistent with the approaches described in the Department of Water Resources (DWR) Economic Analysis Guidebook and with State of California and federal guidelines for economic analysis of water resource-related investments.

The benefits and costs of the DCP are estimated in the context of forecast changes in water supply and demand. Climate change and sea-level rise are expected to significantly reduce future SWP deliveries. Future precipitation and runoff are forecast using an ensemble of climate scenarios selected by DWR's Climate Change Technical Advisory Group. Then, project deliveries are simulated using CalSim 3, a resource planning model that simulates operations of the SWP and Central Valley Project (CVP) under different hydrologic conditions. The project

timeline, based on DWR's most recent expectations, involves preconstruction from 2026 to 2028, construction from 2029 to 2044, and an evaluation of economic benefits for a century of operations from 2045 to 2145.

Benefits of the DCP

This report quantifies the benefits of the DCP in four areas: urban water supply reliability, agricultural water supply, water quality, and seismic reliability.

1) Urban water supply reliability

The primary benefit of the DCP is that it would reduce the anticipated increase in the frequency of water supply shortages for SWP's urban contractors caused by climate change and sea-level rise. The frequency and size of future water supply shortages are assessed using information provided by State Water Contractors, as described in their respective urban water management plans (UWMPs) or, for the Metropolitan Water District, in the Integrated Resource Plan (IRP). These models are used to estimate the frequency and magnitude of shortages for each contractor, with and without the project and under various future climate assumptions. This approach to estimating water supply reliability is consistent with the Delta Independent Science Board's 2020 review of approaches to water supply reliability estimation.¹

The economic impact of future water shortages for urban customers is estimated using economic models that measure consumer welfare, a measure of well-being for urban water customers resulting from the reliability of their urban water supply loss. The estimates of consumer welfare loss use a standard model from the academic literature.² Calibration of this model is based on retail water rates and utility-specific estimates of customer demand sensitivity. Over the project's lifetime, the present value of improved water supply reliability (i.e., the DCP's ability to mitigate the effects of forecast climate change and sea-level rise) is estimated to be worth more than \$33.3 billion in 2023 dollars.

¹Delta Independent Science Board. 2016. *Review of Water Supply Reliability Estimation Related to the Sacramento-San Joaquin Delta*. Report to the Delta Stewardship Council. June. Sacramento, CA. Available: <https://deltacouncil.ca.gov/pdf/isb/products/2022-06-16-isb-water-supply-reliability-review.pdf>.

² See, for example, Brozovic et al. 2007, Buck et al. 2016, or Buck et al. 2023 for examples of this approach.

Buck, S., M. Auffhammer, S. Hamilton, and D. Sunding. 2016. Measuring Welfare Losses from Urban Water Supply Disruptions. In *Journal of the Association of Environmental and Resource Economists*, 3(3), 743–778.

Buck, Steven, Mehdi Nemati, and David Sunding. Consumer Welfare Consequences of the California Drought Conservation Mandate. In *Applied Economic Perspectives and Policy*, 45, No. 1 (2023):510–533.

2) *Agricultural water supply*

The benefits of improved agricultural water supply reliability are estimated using two approaches. First, a willingness-to-pay approach is used, based on the Statewide Agricultural Production (SWAP) model, a regional model of irrigated agricultural production in California's Central Valley developed by researchers at the University of California, Davis that simulates the economic decisions of farmers. This estimate reflects the long-term value of water to agricultural customers in the Central Valley. Second, we use a market-based approach, valuing the incremental water supplies produced by the DCP at average market prices, as measured by the Nasdaq Veles California Water Index. This estimate reflects the ability of farmers to extract additional value by selling water to other urban or agricultural users during short-term periods of scarcity. Averaging estimated benefits across these two approaches, the present value of the DCP's future agricultural water supply benefits is \$2.3 billion in 2023 dollars.

3) *Water quality*

The DCP is expected to lead to a modest improvement in the average quality of water exported south of the Delta. The benefits of improved water quality in the urban sector are estimated using the Salinity Economic Impact Model (SEIM) developed by the U.S. Geological Survey (USGS). The present value of benefits from improved urban water quality in Southern California is worth \$1.33 billion in 2023 dollars. The benefits of improved water quality in the agricultural sector of the San Joaquin Valley and Southern California are estimated using models that calculate the value of a reduced yield impact and irrigation water requirements due to reduced salinity in the agricultural water supply. The present value of improved agricultural water quality is expected to be around \$0.09 billion in 2023 dollars.

Anticipated operation of the DCP would lead to changes in salinity in the Delta; the impacts of these changes are assessed as being "less than significant" in the project's environmental impact report (EIR); however, costs associated with potential increased Delta salinity are accounted for under the costs of remaining environmental impacts after mitigation. Overall, the benefits of improved salinity for downstream agricultural water contractors significantly outweigh the cost of the small increase in salinity in the Delta region. The project would also provide additional operational flexibility to help SWP operations adapt to water regulations in the Delta, the benefits of which are not explicitly quantified in this report.

4) *Seismic reliability*

The project would also provide significant economic benefits by acting as an insurance policy against the risk of water supply interruptions during a major seismic event in the San Francisco Bay or Delta region. The DCP's benefits in terms of improved seismic reliability are estimated using a seismic scenario described in the Delta Flood Emergency Management Plan (DFEMP). This scenario describes a 500-year seismic event that causes up to 50 levee breaches in the Delta, flooding 20 islands. Under the recovery scenario that we consider for such an event, exports from the Delta are expected to cease for between six and 448 days. After that period, exports resume but with impaired water quality for between five to 103 additional days. The DCP is engineered to

withstand such an event and remain operational. The benefits of continued water deliveries during such an event are estimated by assuming that either the DCP operates at capacity for the duration of the seismic impacts or that it operates at a minimum level to meet health and safety requirements. Depending on the specific scenario, the benefits of DCP operations during the seismic event range from \$60 million to \$53 billion. Averaging across the scenarios considered and accounting for the annual likelihood of such an event, we estimate the present value of seismic benefits from DCP operations to be around \$1 billion in 2023 dollars.

We estimate total benefits with a present value of \$33.8 billion. Some benefits of the DCP are not explicitly quantified in this report. For example, this report does not quantify the project's benefits in terms of increased operational flexibility in the Delta or the benefits associated with the Community Benefits Program, which will invest in local communities. The DCP is also expected to relieve pressure on groundwater supplies in the Central Valley and increase the average storage levels of the state's major reservoirs, the impacts of which are not quantified in this report.

Costs of the DCP

In addition to considering benefits, this report quantifies the costs associated with construction of the DCP. Three types of costs are considered in this report: the project costs associated with development and construction of the project, the operations and maintenance (O&M) costs associated with operating the project over its 100-year lifespan, and the costs associated with any remaining environmental impacts after mitigation.

1) Construction costs and related expenditures

The Delta Conveyance Design and Construction Authority (DCA) produced two cost estimates for the DCP. The primary cost estimate reflects the project's current specifications, as detailed in the EIR, estimated at \$20.1 billion before discounting. In addition, a secondary estimate, referred to as the "project-wide innovations and savings estimate," evaluates the financial impact of potential design modifications and construction innovations. These innovations aim to enhance cost efficiency and feasibility without changing core project specifications, potentially reducing costs and construction timelines while minimizing environmental impacts. Before discounting, the secondary estimate stands at \$18.9 billion.

After applying discount rates, the present value of the primary and secondary estimates is \$15.4 billion and \$14.5 billion, respectively. These figures are based on 2023 dollars and include various cost components:

- **Construction costs** for the intakes, tunnels, pumping plants, and other infrastructure, including a 30% contingency, worth \$11.5 billion or \$10.7 billion in present-value terms for the primary and secondary estimates, respectively.
- **Other project costs** include those associated with planning, design, construction management, land acquisition, and power use as well as the cost of a settlement agreement with the Contra Costa Water District, worth \$3.0 billion or \$2.9 billion in present-value terms for the primary and secondary estimates, respectively.

- **Costs for a community benefits program**, worth \$200 million undiscounted or \$153 million in present-value terms.
- **Costs for the mitigation of environmental impacts** identified in the EIR, worth \$960 million undiscounted or \$735 million in present-value terms. Expected environmental impacts and approaches to mitigation are identified in the project’s EIR.

2) *Operations and maintenance costs*

Projected O&M costs for the DCP are detailed in a memorandum authored by the DWR and the DCA.³ This cost forecast included facility O&M, materials, power, capital equipment replacement and refurbishment, and the management of project restoration sites. In 2023 dollars, estimated annual O&M costs are \$52.6 million, amounting to a present value of \$1.7 billion over the project's 100-year operational span from 2040 to 2140.

3) **Remaining environmental impacts after mitigation.**

Most environmental impacts identified as significant in the EIR can be mitigated to levels where they are considered less than significant after mitigation. However, some environmental impacts identified in the EIR are anticipated to have significant and unavoidable impacts after the implementation of proposed mitigation measures. In an appendix to this report, each significant and unavoidable impact is considered, and where appropriate, economic tools are used to estimate the economic costs associated with these impacts. Our assessment also estimates costs associated with an increase in Delta salinity, included despite being “less-than-significant” impacts in the EIR, in order to provide a complete account of all salinity-related impacts alongside the previously discussed water quality benefits. The costs of environmental impacts that remain significant after mitigation are calculated in the following areas:

- Lost agricultural land
- Air quality impacts
- Noise impacts
- Transportation impacts
- Reduced water quality in the Delta

The costs of other impacts—specifically, in terms of aesthetic and visual resources, paleontological resources, and tribal cultural resources—are not estimated because there is no appropriate economic methodology to do so. For the impacts that are quantified, the present value of future costs is \$167 million in 2023 dollars. These impacts may disproportionately affect specific populations adjacent to the construction project.

³ California Department of Water Resources. 2024. *O&M Annual Cost Estimate Basis for Bethany Reservoir Alternative*. April.

Benefit-Cost Ratios and Sensitivity Analyses

Table 1 summarizes the primary DCP benefit-cost estimate. We estimate the present value of the benefits of the DCP to be \$37.96 billion in 2023 dollars, and we estimate the present value of the costs of constructing and operating the DCP to be \$17.26 billion in 2023 dollars. Based on these estimates, we find the proposed DCP project has a benefit-cost ratio of 2.20. Under the cost estimate with project-wide innovations and savings, the benefit-cost ratio is higher, at 2.33.

Table 1 also shows estimates per acre-foot of the benefits and costs of the DCP. These estimates per acre-foot are calculated using a levelized cost-of-water approach that accounts for the timing of future SWP deliveries.⁴ Based on this approach, we estimate levelized benefits of \$2,918 per acre-foot, along with levelized costs of \$1,327 per acre-foot and \$1,255 per acre-foot, respectively, in the primary and secondary cost estimates.

The primary benefit-cost analysis shown in **Table 1** is referred to as the 2070 median scenario with 1.8 feet of sea-level rise. This scenario considers changes in precipitation and runoff from a median climate change projection, based on an ensemble of global climate models for the period 2056–2085.⁵ The primary scenario assumes 1.8 feet of sea-level rise by 2070, based on guidance from the California Ocean Protection Council for the likely range of sea-level rise under a high emissions scenario.⁶ To test the robustness of the estimated benefit-cost ratio to these assumptions, a number of sensitivity analyses are also considered that make alternative assumptions in terms of future precipitation and runoff, sea-level rise, and adaptation measures to reduce operational risks associated with climate change. Across all the sensitivity analyses considered, the incremental deliveries of the proposed project are at least 395 TAF/yr on average, highlighting that the proposed project is robust to different assumptions about climate change and sea-level rise. In each of these sensitivity scenarios, the benefits of the project significantly exceed costs with benefit-cost ratios between 1.54 and 2.69.

4 Levelized cost of water is calculated with the formula $LCOW = \frac{\sum_{t=1}^n \frac{C_t}{(1+r_t)^t}}{\sum_{t=1}^n \frac{Q_t}{(1+r_t)^t}}$ where C_t is the cost associated with the DCP at time t , Q_t is the volume of additional SWP deliveries as a result of the DCP at time t , and r_t is the discount rate at time t . This methodology is described in more detail here:
Fane, Simon, J. Robinson, and S. White. The Use of Levelized Cost in Comparing Supply and Demand-Side Options. In *Water Science and Technology: Water Supply*, 3, No. 3 (2003):185–192.

5 See California Department of Water Resources “CalSim 3 Results for 2070 Climate Change and Sea-Level Projections and Sensitivity Analysis.”

6 See California Ocean Protection Council. 2018. *State of California Sea-Level Rise Guidance: 2018 Update*. Sacramento: CA.

Table 1: Summary of Benefits and Costs

	Main Scenario	
	Primary Cost Estimate	Costs w. Project-wide Innovations & Savings
	Present Value of Future Benefits	
	\$ Millions, 2023	\$ Millions, 2023
Urban Water Supply and Reliability	\$33,300	\$33,300
Agricultural Water Supply and Reliability	\$2,268	\$2,268
Urban Water Quality	\$1,330	\$1,330
Agricultural Water Quality	\$90	\$90
Seismic Reliability Benefits (Water Supply)	\$969	\$969
Seismic Reliability Benefits (Water Quality)	\$2	\$2
Total Benefits	\$37,960	\$37,960
	Present Value of Future Costs	
	\$ Millions, 2023	\$ Millions, 2023
Construction Costs	\$11,486	\$10,723
Other Project Costs	\$3,021	\$2,852
Community Benefit Program	\$153	\$153
Environmental Mitigation	\$735	\$735
O&M Costs	\$1,697	\$1,697
Environmental Impacts after Mitigation	\$167	\$167
Total Costs	\$17,259	\$16,327
<i>Levelized cost per AF</i>	<i>\$1,327</i>	<i>\$1,255</i>
Benefit-Cost Ratio	2.20	2.33

Sources and Notes:

- Construction Costs include 30% contingency.
- Other Project Costs include project design, management, oversight, land, power, and Contra Costa Water District Settlement Agreement cost shares.
- Benefits and costs evaluated under the 2070 median climate scenario with 1.8 feet of sea-level rise. All benefits and costs are net present values in millions of 2023 dollars.
- A declining discount rate of 2% (2023–2079), 1.9% (2080–2094), 1.8% (2095–2105), 1.7% (2106–2115), 1.6% (2116–2125), 1.5% (2127–2134), 1.4% (2135–2140) is used in accordance with Office of Management and Budget guidance.

1. Introduction

1.1. BACKGROUND ON DELTA CONVEYANCE

The Sacramento-San Joaquin River Delta (Delta) is an expansive network of waterways in Northern California at the confluence of the Sacramento and San Joaquin Rivers. The Delta serves as a critical junction for the distribution of water from the wetter northern and eastern parts of the state to the drier coastal and southern regions through two major water conveyance projects: the State Water Project (SWP) and the Central Valley Project (CVP).⁷ Water conveyed south through the SWP is used to supply residential, agricultural, commercial, and industrial customers in California, including in the South of the San Francisco Bay Area, in the Central Valley, in the Central Coast, and in Southern California. The SWP supports a service area that includes 27 million people with a gross domestic product (GDP) equivalent to the world's eighth-largest economy (\$2.3 trillion). Within this service area, the SWP currently delivers approximately 2.56 million acre-feet of water annually to urban and agricultural customers. However, the SWP infrastructure that moves this water through the Delta is outdated and at risk due to climate change, sea-level rise, and seismic activity. Climate change and sea-level rise are expected to reduce SWP water deliveries by about 22% by 2070. Rising sea levels threaten to increase saltwater intrusion, which can compromise local ecosystems and the quality of water available for export. Furthermore, climate change is expected to bring more extreme weather patterns, including both severe droughts and intense storms. This unpredictability adds stress to existing ecological constraints on storage and conveyance, potentially reducing future deliveries and making their timing more uncertain. Furthermore, the Delta's systems of aging levees, some of which date back to the gold rush era, are vulnerable to failure. A major seismic event in the Delta could lead to numerous levee failures, significantly compromising the conveyance system in the area. This would pose a direct risk to water supply and water quality throughout the region.

The construction of additional conveyance infrastructure in the Delta has been extensively studied in a number of different proposals over several decades. The Department of Water Resources' (DWR's) 1957 California Water Plan suggested a "Trans-Delta System" to convey water; a peripheral canal was part of the original proposal for the SWP. During the 1980s, Governor Brown passed legislation providing for the addition of a peripheral canal in the Delta as part of the CVP. This proposal was extensively studied; however, the legislation was subsequently repealed in a voter referendum in 1982.

⁷ The SWP is a complex system of reservoirs, aqueducts, power plants, and pumping stations. It supplies water to more than 27 million people and irrigates about 750,000 acres of farmland. Planned, built, operated, and maintained by DWR, the SWP is the nation's largest State-owned water and power generator and user-financed water system.

The CVP, managed by the Federal Bureau of Reclamation, serves primarily agricultural users in California's Central Valley. It includes 20 dams and reservoirs, 11 power plants, and 500 miles of major canals, playing a critical role in the region's agricultural productivity.

In 2009, the Bay Delta Conservation Plan proposed by Governor Schwarzenegger studied alternative Delta conveyance facilities, including twin tunnels with a capacity of 9,000 cubic feet per second. A modified version of this proposal, called Cal WaterFix, was proposed in 2015 during Governor Brown’s third term. The current Delta Conveyance Project (DCP) proposal considers a single tunnel with a capacity of 6,000 cubic feet per second, along with a new route close to Interstate 5 and a connection to Bethany Reservoir on the California Aqueduct. Authors of this report have been involved in economic analyses for each of these proposals since 2009. Each analysis has used similar methodologies and has consistently found that the benefits of the proposed project exceed its costs, with comparable results in terms of estimated economic benefits.⁸

1.2. THE PURPOSE OF THE DELTA CONVEYANCE PROJECT

The purpose and objectives of the proposed DCP are described in Chapter 2 of the project’s environmental impact report (EIR).⁹ The purpose of the DCP is to develop new diversion and conveyance facilities in the Delta to protect the reliability of SWP deliveries, in light of anticipated future climate change and sea-level rise. Operation of these conveyance facilities will help achieve several related objectives by addressing sea-level rise, minimizing the impact of major earthquake events on SWP and potentially CVP deliveries, and protecting the ability of the SWP to deliver water and provide further operational flexibility. If approved, these updates would improve climate resiliency and the reliability of the state’s largest source of safe, affordable, and clean water for 27 million Californians and 750,000 acres of farmland, with continued support for local water supply projects, such as local storage, recycling, groundwater recharge, and water quality management projects.

1.3. THE DELTA CONVEYANCE PROJECT

The DCP would modernize the water transport infrastructure in the Delta by adding new facilities in the North Delta to divert water and a tunnel to convey water to the South Delta. The proposed project is described in Chapter 3 of the project’s EIR. This analyzes the costs and benefits associated with the preferred project alternative proposed in the EIR—specifically, Alternative 5. Other alternatives outlined in the EIR and additional planning documents are not included in this evaluation.

Key components of the DCP entail upgrading existing SWP infrastructure and establishing two intakes on the Sacramento River, alongside a 45-mile-long tunnel and a pumping station to channel water into Bethany Reservoir on the California Aqueduct. The tunnel, designed with launch, reception, and maintenance shafts, runs

⁸ Sunding, David L. 2018. *Economic Analysis of Stage I of the California WaterFix*. Prepared for the California Department of Water Resources. September 20, 2018.

Hecht, Jonathan, and David Sunding. 2013. *Bay Delta Conservation Plan Statewide Economic Impact Report*. August 2013.

⁹ Delta Conveyance Project. 2023. *Certified Final Environmental Impact Report*. Permits and Regulatory Compliance. Available: <https://www.deltaconveyanceproject.com/planning-processes/california-environmental-quality-act/final-eir/final-eir-document>. Accessed: April 2024. Hereinafter “DCP EIR.”

along the eastern perimeter of the Delta, strategically avoiding the central Delta region. The proposed conveyance facilities would have a capacity of 6,000 cubic feet per second. Figure 1 presents a map of the infrastructure that would be built for conveyance in the preferred alternative.

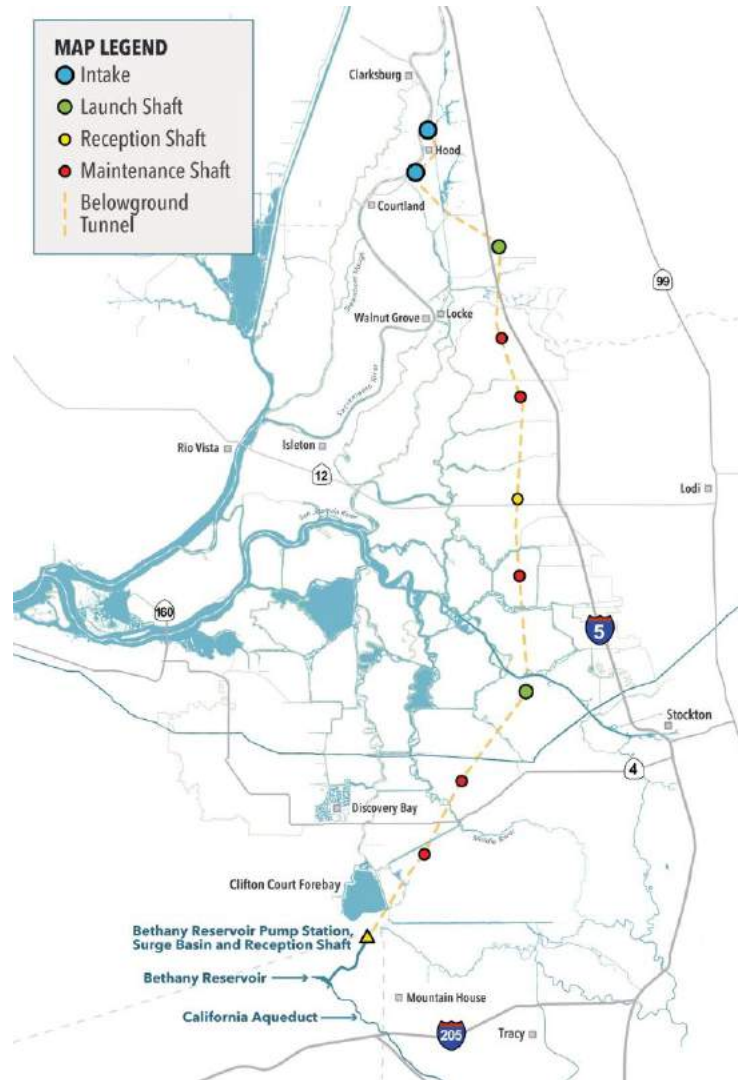
Once the water reaches existing aqueducts and water facilities in the South Delta, it can be conveyed through existing infrastructure to SWP contractors in the Bay Area, Central Coast, Central Valley, and Southern California. These infrastructure enhancements would provide DWR with the flexibility to capture, transport, and store water in accordance with regulatory standards, ensuring its availability during periods of limited supply.

The DCP's increased conveyance capacity will enable increased deliveries of project water to State Water Contractors south of the Delta. The increase in deliveries from the DCP will partially offset the expected reduction in deliveries caused by future climate change and sea-level rise.

The seismic reliability of the DCP ensures the continuous conveyance of water, even during seismic events that might otherwise cause significant disruptions to conveyance operations throughout the Delta. The seismic design criteria adopted for the 45-mile DCP tunnel is based on what is designated as the Maximum Design Earthquake (MDE), an extreme seismic event estimated to happen once every 2,475 years.

Following DWRs currently timeline, in our analysis, preconstruction activities take place between 2026 and 2028. Construction is expected to occur between 2029 and 2044, with subsequent economic benefits estimated over the 100-year operational period from 2045 to 2145.

Figure 1: Map of the Proposed Delta Conveyance Project



Sources: Map of the Delta Conveyance Project, January 2024

2. Framework for Benefit-Cost Analysis

2.1. INFLATION, DISCOUNT RATES, AND RISK

In benefit-cost analysis, as well as in other economic and financial analyses, it is standard to analyze all benefits and costs using “real prices.” For the purposes of this report, all figures are expressed in 2023 dollars. This means that, regardless of the year in which a cost or benefit occurs, the value of the cost or benefit is assessed as if it were occurring in 2023. This is done to account for inflation, the general increase in the price of goods and services over time. Because the upfront investment and benefit streams occur in different years, it is important to measure costs and benefits at different times in comparable units. Using 2023 prices removes the distorting effects of inflation, allowing present-day expenditures to be directly comparable to future benefits and providing a clear basis for evaluating a project's economic viability.

Unexpected inflation should not significantly change the outcome of our benefit-cost analysis. If inflation affects future costs and benefits similarly, changes in the inflation rate will not affect the conclusions of the benefit-cost analysis. Unexpected inflation could skew the project's benefit-cost ratio but only if the inflation experienced disproportionately affects costs relative benefits, or vice versa. This is unlikely for the DCP because the benefits are largely tied to water rates, and costs are associated with construction expenses, whose prices generally move in tandem.

In addition to inflation, benefit-cost analyses must also account for the time-value of money, which recognizes that money available today is worth more than the same amount in the future because it can be used immediately (e.g., to pay for things or to invest and earn more money). This concept is crucial, especially in long-term projects like the DCP, which assumes a 15-year construction and commissioning period starting in 2029 followed by a 100-year operational project life.

To account for the time-value of money, future benefits and costs are discounted at a rate called the “real discount rate.” This is standard in benefit-cost analysis and other infrastructure benefit-cost planning and regulatory analyses.¹⁰ The benefits of money invested at the beginning of the project unfold over 100 years, and the discounting factor incorporates the forgone opportunity cost of the money had it not been invested into the DCP but rather received the risk-free rate of return on savings in a heavily traded market.¹¹

¹⁰ The White House. 2023. *Biden-Harris Administration Releases Final Guidance to Improve Regulatory Analysis*. November 9, 2023. Available: <https://www.whitehouse.gov/omb/briefing-room/2023/11/09/biden-harris-administration-releases-final-guidance-to-improve-regulatory-analysis/>. Hereinafter “OMB Circular A-94.”

¹¹ OMB Circular A-94.

Office of Management and Budget (OMB) Circular A-94 recently updated the guidance on the use of discount rates in benefit-cost analysis. Circular A-94 identifies the real, inflation-adjusted return on long-term government debt is a good measure of the discount rate. The updated long-run discount rate starts at 2% from 2023 to 2079 and gradually falls to 1.4% from 2064 to 2172, reflecting both the social rate of time preference and the expected growth of capital.¹²

It is important to separately account for uncertainty and risk when performing benefit-cost analysis. To account for uncertain but positively correlated discount rates, economists recommend assigning probabilities to future discount rates, resulting in declining certainty-equivalent discount rates.¹³ Because the discount rate captures only the risk-free interest rate, other risks are explicitly accounted for in the benefit-cost analysis (e.g., by simulating a distribution of hydrologic outcomes when assessing the project's water supply benefits, based on historic rainfall patterns and climate change).

The outcome of a benefit-cost analysis is an estimated benefit-cost ratio, the ratio of the discounted present value of benefits to the discounted present value of costs. In this analysis, a project should be considered economically viable if the benefit-cost ratio exceeds some hurdle rate, which is set above one. This hurdle rate is a policy decision that reflects social expectations for the required return on investment. A benefit-cost ratio greater than one does not necessarily mean that the benefits exceed the costs for all parties affected by the project. A more detailed analysis is required to assess the distribution of impacts across different groups because the benefits and costs may not be uniformly distributed.

2.2. DWR AND OTHER AGENCY GUIDANCE

The approach for this benefit-cost analysis is guided by DWR's Economic Analysis Guidebook. The DWR published the guidebook in 2008 as a resource to help DWR economists perform economic analyses through its discussion of economic analysis guidelines, methods, and models, among other topics.¹⁴ In the guidebook, it is preferred that analyses be performed in a manner that is also consistent with the federal Principles, Requirements, and Guidelines (PR&Gs), except where State of California (State) interests might differ from federal interests or where the PR&Gs are considered outdated. As such, the approaches in this report have been made consistent with the federal PR&Gs, despite the fact there is no federal component to this project.

¹² OMB Circular A-94.

¹³ Arrow, Kenneth J., Maureen L. Cropper, Christian Gollier, Ben Groom, Geoffrey M. Heal, Richard G. Newell, William D. Nordhaus, Robert S. Pindyck, William A. Pizer, Paul R. Portney, Thomas Sterner, Richard S. J. Tol, and Martin L. Weitzman. 2014. Should Governments Use a Declining Discount Rate in Project Analysis? In *Review of Environmental Economics and Policy*, Volume 8, No. 2. Available: <https://www.journals.uchicago.edu/doi/full/10.1093/reep/reu008>. Accessed: December 6, 2023.

¹⁴ California Department of Water Resources. 2008. *Department of Water Resources Economic Analysis Guidebook*. January 2008, pp. vii–viii. Hereinafter “CADWR Guidebook.”

The guidebook advocates for an economic evaluation “of all economic costs for structural and non-structural alternatives. These costs include capital, operations, maintenance, and mitigation. Non-monetary costs and benefits must also be taken into account. In addition, identifying how the costs and benefits are allocated among involved parties is an important component of any plan.”¹⁵

The DWR guidebook identifies three common economic analysis methods:

1. **Cost-effectiveness analysis** is used to compare multiple alternatives for achieving an identical set of objectives and identify which alternative achieves those objectives at the lowest cost.
2. **Benefit-cost analysis** estimates all the benefits and costs of a proposed project and compares them to a no-project alternative. In a benefit-cost analysis, a project is considered economically viable if the ratio of a project’s benefits to its costs is larger than some proposed hurdle rate that is greater than one.
3. **Socioeconomic impact analysis** considers the distribution of benefits and costs of a proposed project among different parties.

This report contains only a benefit-cost analysis. It does not determine which of the proposed project alternatives is least costly, and it does not consider the distributional impacts of the proposed project.

The DWR guidebook also emphasizes the importance of incorporating risk and uncertainty into any economic analysis. In this context, risk describes situations where the probability of various outcomes can be measured or estimated, whereas uncertainty arises in scenarios where these probabilities are unknown or unquantifiable. For example, estimating the future distribution of precipitation and hydrologic inflows is a key part of our analysis. In this context, risk is described by our estimates of the probability of a future dry year, with low precipitation and inflows based on historical years. There is remaining uncertainty about the extent of future climate change, which we model by simulating a range of different climate scenarios and examining the robustness of our estimates to different climate assumptions.

2.3. CLIMATE ASSUMPTIONS

This report analyzes a range of possible future climate scenarios to give a full picture of the robustness and uncertainty in estimated benefits and costs. The primary benefit-cost analysis scenario considers changes in precipitation and runoff using a median climate change projection, based on an ensemble of global climate models for the period 2056–2085. The primary scenario assumes 1.8 feet of sea-level rise by 2070, based on guidance from the California Ocean Protection Council for the likely range of sea-level rise under a high emissions scenario. In separate sensitivity analyses, we also consider lesser degrees of climate change, either under existing conditions or 2040 climate conditions. We also consider scenarios with greater and lesser degrees

¹⁵ CADWR Guidebook, p. 3.

of sea-level rise. For a comparison across climate scenarios, refer to the Sensitivity Analyses section of the report.

To simulate the 2070 climate scenarios, meteorologic and hydrologic boundary conditions were developed with 10 Coupled Model Intercomparison Project 5 global climate projections. Historical meteorological data perturbed with the differences observed in the ensemble of selected global climate projections are used to estimate future climate conditions, including runoff, surface water evaporation, and evapotranspiration. Ten hydrologic scenarios are used, each representing one General Circulation Model (GCM). The 10 projections were selected from the 64 datasets of Locally Constructed Analogs, based on three metrics of projected change: the mean annual streamflow, a coefficient of variation of streamflow, and the average annual temperature. The inclusion of projected variability in annual streamflow served as an important factor because it is identified as an important driver affecting California's water supply.¹⁶

Because much of the land in the Delta is below sea level and it relies on more than 1,000 miles of levees for protection against flooding, taking into consideration future sea-level rise scenarios is crucial for analysis.¹⁷ The projections for sea-level rise in the San Francisco Bay considered for this analysis are based on the California Ocean Protection Council's guidance as of 2018.¹⁸ The modeling takes a probabilistic approach, assigning likelihoods of occurrence for potential sea-level rise heights and rates tied to a range of emissions scenarios. The median scenario of sea-level rise is estimated to be 1.8 feet by 2070. The model also produces estimates under extreme scenarios. A 3.5-foot sea-level rise with a probability of occurrence being less than 0.5% is considered in the Sensitivity Analyses section, corresponding to a medium-high risk aversion scenario. Sea-level rise estimates are trained on the Delta hydrodynamic model, then inputted into CalSim 3 through the Artificial Neural Network to simulate the delivery and salinity outputs considered for this analysis.¹⁹

2.4. PROJECT DELIVERIES

The future deliveries under both the project alternative and no-project baseline are simulated with the CalSim 3 model. The climate models discussed in the previous section simulate future precipitation and runoff. The results are then inputted into the CalSim 3 model to simulate future water supply scenarios, water quality estimates, reservoir levels, groundwater levels, and more. CalSim 3's modeled output with the DCP operations, given environmental and regulatory constraints and demand forecasts, compared to the no-project future

¹⁶ DCP EIR, Appendix 30A.

¹⁷ DCP EIR, Appendix 5A, Section B.

¹⁸ California Ocean Protection Council, 2018. *State of California Sea-Level Rise Guidance: 2018 Update*. Sacramento: CA.

¹⁹ DCP EIR, Appendix 30A.

baseline serve as the basis of the benefit analysis. The allocation of deliveries is based on the existing Table A allocations among contractors that joined the Agreement in Principle.

CalSim 3 is a resource planning model that simulates operations of the SWP and CVP under different hydrologic conditions. The model was developed jointly by DWR and U.S. Bureau of Reclamation.

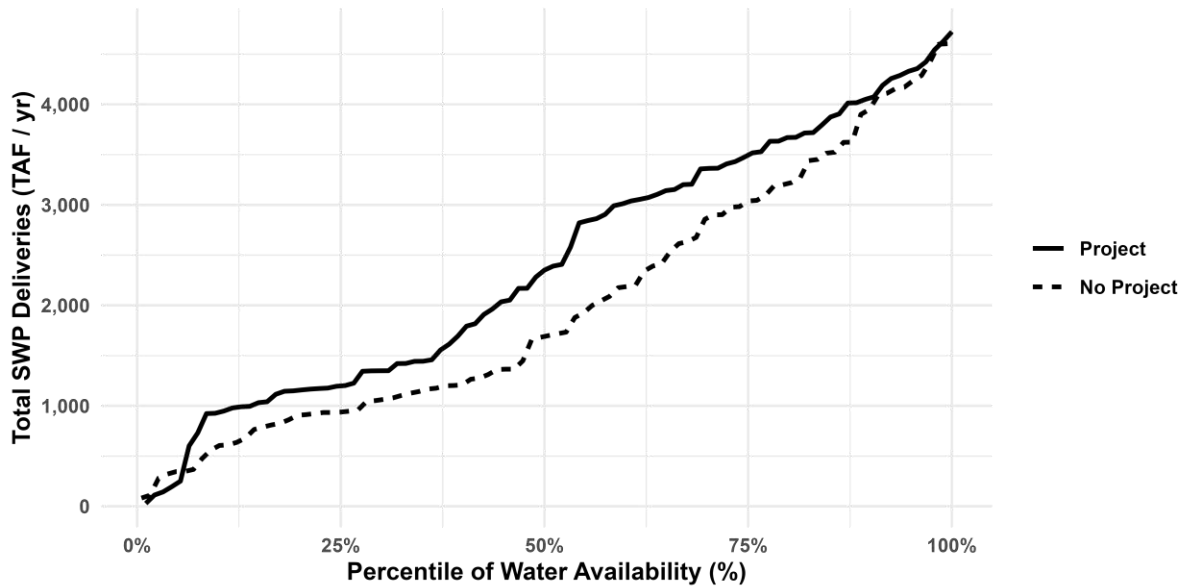
CalSim 3 uses linear programming on monthly timesteps to make water allocation and management decisions.²⁰ The 94 years of historical hydrology from 1921 to 2015, including unimpaired inflows and rainfall runoff, water demands, return flows, and groundwater recharge from precipitation and irrigation, are used to simulate a distribution of outputs, including river and streamflows, reservoir storage, Delta channel flows, exports, and project deliveries. The water supply and quality measures for Delta exports are of particular interest in analyzing the benefits of DCP.

The simulation of future SWP deliveries under both no-project and with project conditions is shown in Figure 2, below. Without DCP, the SWP deliveries range from 150 thousand acre-feet (TAF) to more than 4,000 TAF. The highly variable deliveries are a result of the variable climate conditions of California, characterized by interchanging drought and wet years. The average delivery under the 2070 median climate scenario, with 1.8 feet of sea-level rise without DCP, is 1,990 TAF.

With DCP, the average additional deliveries would be around 403 TAF per year (TAF/yr) compared to a no-project scenario. The additional water deliveries would be substantial during below normal and above-normal water years. However, during extreme drought and the wettest water years, DCP would not substantially increase SWP deliveries. As shown in Figure 2, in the bottom 10th percentile and above the 95th percentile, project deliveries are almost identical to no-project baseline scenarios.

²⁰ DCP EIR, Appendix 5B.

Figure 2: Total State Water Project Deliveries with and without DCP



Sources and Notes: Based on CalSim 3 simulations of SWP deliveries to all contractors under the 2070 median climate change scenario, with 1.8 feet of sea-level rise and 94 simulations of historical hydrology.

2.5. FRAMEWORK FOR ESTIMATION OF WELFARE BENEFITS

Two approaches are commonly used to estimate benefits: those based on market prices and those based on estimating consumers' willingness to pay (WTP). The DWR Economic Analysis Guidebook and the federal PR&Gs identify both approaches as appropriate methodologies for economic analysis, depending on the context.

In a market-based approach, estimates of benefits are based on market prices; this is frequently considered the gold standard in economics because the estimates are a straightforward way to measure and reflect actual market activity. However, markets may not exist or prices might not be observable for benefits in many settings. For example, during droughts and seismic events, utilities typically do not increase prices to ration the water supply, instead relying on unpriced conservation programs and rationing. Furthermore, because extreme droughts and major earthquakes are rare, data may not be available to identify market prices in such contexts. Furthermore, WTP is typically highest during extreme shortages resulting from such rare events. Similarly, water quality is typically not priced in the market but has significant implications for consumer welfare. Finally, many environmental impacts, such as reduced air quality or increased noise and traffic impacts, are not explicitly priced in the market. In these cases, instead of adopting a market approach, benefits are estimated by calculating a consumer's hypothetical WTP, the maximum price the consumer would be willing to pay for a good or service. In these situations, WTP can be estimated by observing behavior in adjacent markets or estimating an economic model of consumer demand.

2.6. SENSITIVITY ANALYSES

To evaluate the robustness of the DCP's economic benefits provided by the DCP under uncertain climate trajectories, a sensitivity analysis is performed under different assumptions of future climate scenarios. Three time periods are considered: 2040 median, 2040 central tendency (CT), and 2070 median.

The two 2040 climate assumptions differ mainly in the ensemble of general circulation models that were used to represent climate change in 2040.²¹ For the 2040 CT scenario, 20 GCM projections are selected by the DWR Climate Change Technical Advisory Group, consisting of 10 GCMs that each consider two future emission scenarios, or Representative Concentration Pathways (RCPs). The 2040 median scenario consists of 10 GCM projections selected by the DWR Climate Change Program. Both 2040 climate scenarios show similar flow patterns, as flow in December–March increases and in April–July decreases consistently. Both 2040 scenarios also assume 1.8 feet of sea-level rise, which has a probability of occurrence of less than 0.5%.

Because DCP becomes operational only after 2040, and benefits unfold for the next 100 years, the 2070 climate scenarios are more relevant for analyzing the benefits. For 2070, the analysis considers both the median climate scenario of 1.8 feet, which has a probability of occurrence of 66%, and the extreme scenario of 3.5 feet, which has a probability of occurrence of less than 0.5%. In addition, further operational assumptions and scenarios with adaptation measures are included to avoid operational constraints associated with conveyance and the operation of the system's major reservoirs.²²

Table 2 compares the deliveries across all seven scenarios considered. The incremental deliveries from the DCP are robust to a wide range of climate assumptions, showing that the project is robust to differing degrees of assumed climate change. Furthermore, deliveries in the 2070 project scenario are similar to non-project deliveries in 2020. As such, the project can be viewed as mitigating 50 years of future climate change by bringing future levels of water supply reliability closer to current levels.

²¹ DCP EIR, Appendix 30A.

²² California Department of Water Resources. n.d. *CalSim 3 Results for 2070 Climate Change and Sea Level Projections and Sensitivity Analysis*.

Table 2: Scenarios Considered in Sensitivity Analyses

Scenario	Main Scenario	Sensitivity Analyses					Existing Conditions
		1	2	3	4	5	
	2070 Median w. 1.8' SLR	2070 Median w. 1.8' SLR & Adaptation	2070 Median w. 3.5' SLR	2070 Median w. 3.5' SLR & Adaptation	2040 Median w. 1.8' SLR	2040 Central Tendency w. 1.8' SLR	2020 EC
	[TAF / Yr]						
No Project	1,990	2,019	1,876	1,920	2,098	2,314	2,560
Project	2,393	2,416	2,281	2,315	2,505	2,751	3,014
Difference	403	397	404	395	406	437	454

Sources and Notes: All modeled deliveries are measured in thousand acre-feet and averaged over 94 simulations with historical hydrology. In 2070, analysis is conducted under the median climate scenario along with multiple sea-level rise scenarios and whether adaptation measures are adopted. In 2040, both the median climate scenario and central tendency are considered for analysis. The 2020 EC scenario represents estimated deliveries under existing climate conditions.

3. Urban Water Supply Benefits

A key benefit of the DCP is the increase in water supply reliability for the SWP's urban customers. The SWP supplies water to urban customers in Southern California, the Central Coast, the Central Valley, and the Bay Area.²³ The reliability of the urban water supply has critical implications for public health and safety in urban areas, ensuring consistent access to clean water for drinking, cooking, and sanitation. Water is also critical for daily business operations in the state's commercial and industrial sectors; water supplied south of the Delta by the SWP services an area that accounts for more than half of California's GDP. Business interruptions from disruptions in water supply, if significantly large and sustained, can affect the growth and stability of the local economy.²⁴

The DCP will provide additional water supply that will increase reliability by reducing the frequency and magnitude of shortages during dry periods. This section gives an overview of our approach to estimating the economic benefits of reduced water shortage welfare losses for urban customers resulting from the construction of the DCP. Further details on our approach are provided in Appendix B. For each SWP contractor with urban customers, we estimate urban water supply reliability benefits using the following steps:

1. The level of demand and price sensitivity are forecast for different types of urban water supply customers, including residential, commercial, and industrial customers.
2. Future shortages are forecast for each type of urban customers with and without the DCP.
3. The economic cost of future shortages is estimated for each type of urban customers with and without the DCP.
4. The reliability benefits of the DCP are based on the difference in the economic cost of future shortages with and without the project.

3.1. DEMAND FORECASTS FOR URBAN CUSTOMERS

Our estimates of the benefits of improved urban water supply reliability are based on forecasts of water demand and water conservation for each State Water Contractor. These forecasts are based on each contractor's Urban Water Management Plan (UWMP) or, in the case of Metropolitan Water District (MWD), its Integrated Resource Plan (IRP). Agencies are required to produce these plans every five years to ensure

²³ There are currently 17 participants in the Agreement in Principle: Alameda Zone 7, Alameda County WD, Santa Clara Valley, Empire West Side ID, Kern County WA, SLO FCWCD, Antelope Valley-East Kern, Santa Clarita Valley, Coachella Valley, Crestline Lake Arrowhead, Desert WA, MWDSC, Mojave, Palmdale, San Bernadino Valley, San Gabriel, San Geronio Pass, Ventura County.

²⁴ Boarnet, Marlon, Wallace Walrod, David L. Sunding, Oliver R. Browne. 2022. *The Economic Impacts of Water Shortages in Orange County*. July 2022.

adequate water supplies are available to meet existing and future water needs under California’s 2009 Water Conservation Act (SB X7-7). Demand and conservation forecasts are based on various economic, demographic, and climatic characteristics and produced following best management practices under consultation with local communities. Different agencies take different approaches to forecasting future demand; however, these approaches cover the full spectrum of urban water use, including residential, commercial, industrial, institutional, and unmetered water uses.²⁵

In the 2020 UWMPs and MWD’s 2020 IRP, agencies project water demands out to 2045. For our analysis, we use these agency-produced forecasts for 2045 and assume no growth in demand during the period for which we simulate DCP operations, 2045 to 2145.

3.2. SHORTAGE ESTIMATES FOR URBAN CUSTOMERS

For urban customers, we define water shortages as the difference between a baseline level of demand, as forecast in urban water management plans, and the actual volume of water made available to customers, based on the realized hydrology in a particular year. In this sense, any reductions in demand relative to the forecast baseline are considered a shortage. The term “shortage” is used to include reductions in consumer demand during drought conditions, including voluntary reductions in response to media campaigns, along with savings from management policies that restrict the scope of when and how water can be used; responses to drought surcharges; and other forms of demand curtailment.

Shortages are estimated using reliability models provided by State Water Contractors, principally an extended version of MWD’s IRP Simulation Model (IRPSIM), a supply-and-demand mass balance simulation model that was developed for MWD as a basis for its IRP. IRPSIM forecasts demand using a sales model and simulates supply according to local supplies and imports, SWP supplies, Colorado River Aqueduct supplies, and MWD’s storage portfolio. Outputs from the CalSim 3 model are used as inputs in IRPSIM to forecast SWP deliveries. The model accounts for climate change by adjusting inflows from other imported supplies. IRMSIM simulates MWD’s

²⁵ Most agencies consider only a single demand scenario in forecasting their future water supply reliability; however, MWD considers four scenarios in its IRP that consider different future demand and supply assumptions. The four scenarios assume different levels of demand and imported water supply, ranging from a scenario with falling demand and stable imports to a scenario with growing demands and reduced imports. The key differences between these scenarios are assumed climate change, regulatory requirements, and economic conditions. For further details, see “2020 IRP – Regional Needs Assessment,” The Metropolitan Water District of Southern California, April 2022.

In this analysis, we consider the IRP’s Scenario D, which is characterized by growing demand and reduced imports. This scenario most closely comports with our other assumptions pertaining to climate change and population growth. It is described in the IRP as follows: “This scenario is driven by severe climate change impacts to both imported and local supplies during a period of population and economic growth. Demands on Metropolitan are increasing due to rapidly increasing demands and diminishing yield from local supplies. Efforts to develop new local supplies to mitigate losses underperform. Losses of regional imported supplies are equally dramatic.”

storage portfolio by considering operational constraints, put-and-take capacities, contractual arrangements, and other operational considerations.²⁶

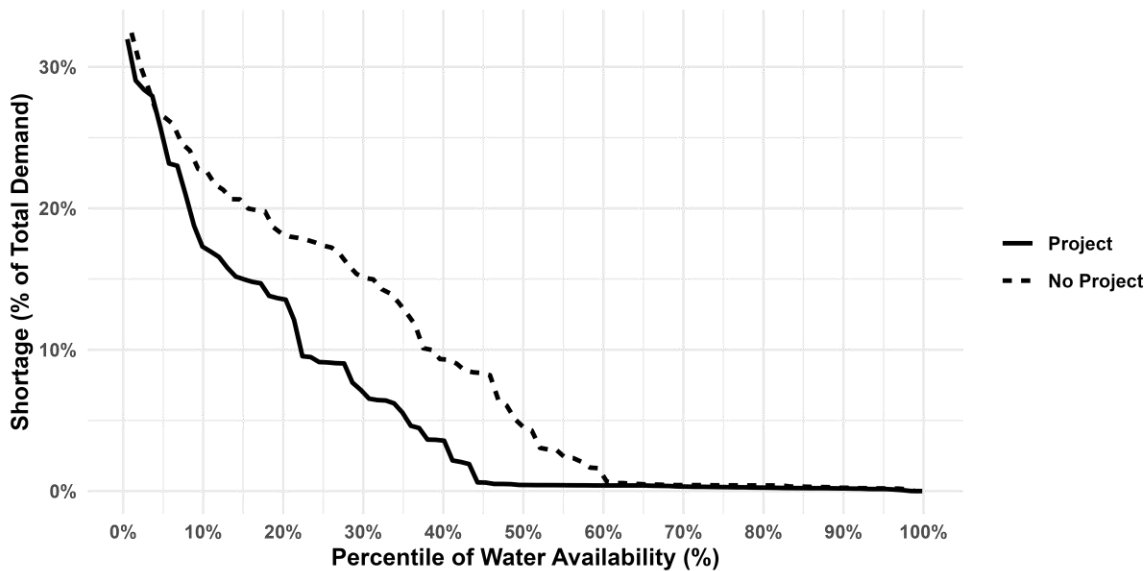
For each year of demand, IRPSIM simulates supply, based on each year of the historic hydrologic trace, adjusted for climate change. This results in 96 trials, based on historical hydrologic data, beginning in 1922. IRPSIM then calculates a distribution of outcomes, allowing MWD to evaluate probabilities of surpluses and shortages and further forecast the magnitude and frequency of shortages. This report uses an extended version of IRPSIM that simulates supply and shortages for most urban State Water Contractors, except the Santa Clara Valley Water District, which provided separate hydrologic modeling for this report that follows a similar methodology, as described in its UWMP.²⁷ Shortages are forecast with and without the DCP, based on demand levels in 2045. Levels of reliability are assumed to remain constant for the duration of the DCPs operating life between 2045 and 2145.

Based on this modeling, the frequency and magnitude of shortages are estimated for 2070 under the median climate change scenario, with 1.8 feet of sea-level rise. Figure 3 summarizes the results. The vertical axis shows the shortages as a percentage of total demand, ranging from 0% to 32%. The horizontal axis shows the frequency of shortages by arranging simulated hydrologic years from the driest (0%) to the wettest (100%). In the no-project scenario, by 2070, there are demand shortages in 61% of all years. Construction of the DCP increases the water supply such that there are shortages in only 44% of all years. In the no-project scenario, there is an average shortage of 9% of total demand. Construction of the DCP reduces the size of the average shortage to only 5% of total demand.

²⁶ MWD 2020 IRP.

²⁷ Santa Clara Valley Water. 2021. *2020 Urban Water Management Plan*. June 2021.

Figure 3: Shortage as a Percentage of Total Urban Water Demand



Sources and Notes: Based on MWD's IRPSIM modeling. The distribution represents 96 simulated shortages under a wide range of historical hydrology and the 2070 median climate scenario with 1.8 feet of sea-level rise.

3.3. ECONOMIC COSTS OF URBAN WATER SHORTAGES

Estimates of the economic costs of urban water shortages are based on an economic model of consumers' WTP to avoid water supply interruptions. Water supply reliability benefits are estimated using a WTP-based approach rather than a market-based approach. Utilities usually rely on non-price mechanisms such as conservation campaigns and water use restrictions to manage demand rather than charging elevated drought rates during droughts. As a result, a market-based approach that estimates water supply reliability benefits only, based on customer rates, would understate the water supply benefits during droughts, which are expected to become frequent due to future climate change and significantly mitigated by construction of the proposed DCP.

To estimate district-specific price elasticities of demand, we rely on econometric models that are estimated in Buck et al. (2016).²⁸ This paper constructs a panel dataset of average monthly water consumption and average rates over five years that covers 75 urban water utilities, including State Water Contractors in the South Bay and

²⁸ Buck, Steven, Maximilian Auffhammer, Stephen Hamilton, and David Sunding. 2016. Measuring Welfare Losses from Urban Water Supply Disruptions. In *Journal of the Association of Environmental and Resource Economists*, 3, No. 3 (2016): 743–778.

Southern California. The authors then perform a log-log panel regression of average monthly water use on water rates and household income. This regression also controlled for weather fluctuations, seasonal effects, and utility-specific and secular trends. The result is an estimate of how changes in price and income affect demand for water, based on relative changes across utilities over time. The paper finds that water demand is less elastic for lower-income consumers. For example, across all State Water Contractors, the average price elasticity of demand is -0.18, meaning that a 10% increase in rates would induce only about a 1.8% reduction in water use. This average estimate varies, based on income; customers in higher-income communities typically have more discretionary water uses, such as larger yards with more landscape irrigation, and so can reduce consumption in a less costly manner during drought. In contrast, lower-income consumers who depend heavily on water for basic needs such as drinking and sanitation experience larger welfare losses to reduce their consumption by a similar amount.

Based on the econometric relationships estimated in this paper, we construct an estimate of the price elasticity of demand for each urban State Water Contractor participating in the DCP and for each member agency of the MWD. The estimates presented in this paper have been updated with current water rates and household income data for each water agency.

Using an economic model described further in Appendix B, we apply a formula that estimates welfare losses based on the size of the shortage, the marginal cost of SWP deliveries, and the estimated price elasticity of demand. The derived welfare loss function exhibits a declining marginal utility of water, meaning the larger the welfare loss per unit of shortage, the larger the magnitude of the shortage. This behavior implicitly captures complexities in water consumption behavior; for example, when shortages are small, customers can reduce water use relatively cheaply by reducing outdoor irrigation, leading to relatively small unit welfare losses. However, as shortages become more severe, consumers must reduce water use in more costly ways that might directly affect daily household activities or business operations, leading to much larger unit welfare losses. This behavior is also consistent with drought management plans that utilities are required to put in place to identify the least costly way to meet different levels of conservation.

For each year we simulate, we calculate welfare losses for 96 trials, based on the historical hydrologic trace between 1922 and 2018. Average welfare losses across all simulations are then calculated separately for each district participating in the DCP using customer-specific elasticity estimates and retail water rates.²⁹ Significant costs are associated with forecast shortages due to forecast reductions in supply as a result of climate change; in the no-project scenario, more than 61% of all years are expected to have water shortages, leading to annual welfare losses of more than \$1.1 billion.

²⁹ Note that currently the reliability estimates are calculated only for Metropolitan Water District and Santa Clara Valley Water. Estimates of welfare losses are then extrapolated to all other agencies. However, the final economic analysis will incorporate water district-specific estimates that will be produced once modeling of district specific shortages becomes available.

3.4. WATER SUPPLY RELIABILITY BENEFITS

The quantified economic benefits of the DCP in terms of improved water supply reliability are based on the change in the frequency and size of water shortages between the project and no-project scenarios. As previously discussed, the costs of shortages are calculated for each State Water Contractor and MWD customer using an economic model that estimates customer welfare losses from shortages, based on the frequency and size of shortages in each district and district-specific rates and demand elasticities. The economic benefits of the DCP for urban customers are estimated as the difference in the welfare losses from shortages between the project and no-project scenarios. Using this approach, the present value of improved water supply reliability is estimated to be worth, on average, more than \$33.3 billion in 2023 dollars over the project's lifetime. These benefits amount to an average value of \$2,560 for every additional acre-foot of water supplied to urban customers from the DCP's operations. However, there is significant variability in the benefits of these deliveries, depending on the prevailing hydrologic conditions. In the driest 5% of years, additional deliveries from the DCP have an average value of between \$6,000 and \$9,000 per acre-foot.

4. Agricultural Water Supply Benefits

The DCP is estimated to deliver, on average, an additional 148.5 TAF/yr of water to agricultural contractors. Agricultural State Water Contractors may use the additional water supplied by the DCP to grow crops, to recharge or otherwise offset deficits in groundwater extraction, or to sell to other customers in urban sectors.

We take two approaches to estimating water supply benefits to agricultural users. The first approach is a demand-based approach that uses a planning model to estimate the shadow value of water in the Central Valley, based on unmet demands for water of agricultural activity in the Central Valley. The second approach is a market-based approach, based on an index of the prices for water transfers in the Central Valley.

4.1. VALUATION OF WATER USE IN AGRICULTURE – SWAP MODEL

The benefits of agricultural water supply are estimated using a WTP approach that identifies the “shadow price” of water, based on a model of agricultural production in the Central Valley. The SWAP is a multi-region, multi-input and output economic optimization model that simulates agricultural production in California.³⁰ The model is widely used for policy analysis and planning purposes by the state and federal agencies.

SWAP simulates the behavior and decisions of farmers under the assumption of profit maximization in a static competitive market subject to resource, technical, and market constraints. With 37 regions in the model, 27 of which are in the Central Valley, SWAP provides detailed data coverage and production estimates for agricultural water supply and cost changes. The SWAP model takes account of water supplies (SWP and CVP, other local supplies, and groundwater) into production cost-effectiveness optimization by adjusting the crop mix, water resource availability, and land fallowing.³¹

The SWAP model is widely used in recent studies. It is considered an appropriate and conservative approach for estimating DCP’s agricultural water supply benefits. Based on the SWAP model, the marginal value of agricultural water is \$301 per acre-foot in 2023 dollars.

³⁰ UC Davis Center for Watershed Sciences. n.d. *SWAP Model*. Available: <https://watershed.ucdavis.edu/project/swap-model>.

³¹ UC Davis Center for Watershed Sciences. n.d. *A Brief Overview of the SWAP Model*. Available: <https://watershed.ucdavis.edu/doc/water-economics-and-management-group/brief-overview-swap-model>.

4.2. VALUATION OF WATER USE IN AGRICULTURE – MARKET APPROACH

In addition to a WTP based approach for estimating the benefits of the SWP for the agricultural sector, we also adopt a market-based approach. To provide a comprehensive valuation of marginal agricultural water value, we estimate the water supply benefits of the DCP. The water transfer includes voluntary buying and selling of a quantifiable allocation between a willing seller and buyer; the price of water set in the water bidding process reflects people's perceived marginal value of water.

This analysis relied on the empirical Nasdaq Veles California Water Index. Developed in conjunction with Westwater Research and Veles Water, the index reflects the commodity value of water at the source, not accounting for transportation costs or losses.³² The price data are aggregated from the five largest and most actively traded markets in California, with Southern California being the most active market.³³ The water is priced weekly and on a per-acre-foot basis, reflecting the prevailing market price for water transactions. The Nasdaq Water Index price is a spot price that reflects the short-term value of water; to estimate a long-run value for agricultural water, we average the historical weekly prices over the entire history of the water index from September 2019 to April 2024. Using this approach, the marginal value of water use in agriculture is \$646 per acre-foot in 2023 dollars.

In the benefit-cost analysis, we assess the value of additional SWP deliveries in the agricultural sector, based on the average of the prices estimated using the WTP and the market-based approaches, a value of \$474 per acre-foot in 2023 dollars. With an average additional delivery of 148.5 TAF/yr to the agricultural water users, the estimated total benefit is \$68.5 million per year.

³² Nasdaq. 2024. *Nasdaq Veles California Water Index*. Available: <https://www.nasdaq.com/solutions/nasdaq-veles-water-index>. Accessed: December 8, 2023.

³³ Ibid.

5. Water Quality Benefits

Construction of the DCP will reduce the salinity of water supplies exported south of the Delta to customers in both the urban and agricultural sectors. This improvement in water quality will be a result of some SWP deliveries being conveyed through the proposed tunnels directly to the Banks Pumping Plant where they will be exported through the California Aqueduct rather than being conveyed through more saline parts of the Bay Delta.

Chapter 9 of the EIR quantifies the impacts of the operations of the DCP on a number of different water quality dimensions in the Delta and the Delta's export service area. Water quality is evaluated under project and no-project scenarios using Delta Simulation Model II (DSM2). Based on this modeling, construction of the DCP would reduce the average salinity of Delta exports by 22 milligrams per liter (mg/l), from 237 mg/l under the project scenario to 215 mg/l under the no-project scenario. Note that this average conceals the significant variability of the change in water quality, which is highly correlated with the volume of export volumes and seasonal flows.

The DCP's operations will improve water quality for SWP contractors on two dimensions. First, the DCP will improve the water quality of exports themselves. Secondly, it will lead to a substitution toward relatively higher-quality SWP water and away from lower-quality sources such as groundwater or water imported from the Colorado River.

5.1. WATER QUALITY FOR URBAN WATER CUSTOMERS

The benefits of improved water quality due to the DCP are estimated in the SWP's Southern California service area and evaluated using the Salinity Economic Impact Model (SEIM).³⁴ The SEIM, a product of a collaborative effort between the Bureau of Reclamation and MWD, is designed to evaluate the economic impact of salinity changes in Southern California and the broader Lower Colorado River service area.

Within Southern California, the SEIM model estimates economic impacts for each of the 15 subregions, accounting for region-specific water supply conditions and economic variables. For each subregion, estimates of salinity costs are based on demographic data, water deliveries, total dissolved solids (TDS) concentrations, and sector-specific cost relationships. To simulate the overall salinity of urban water, SEIM explicitly accounts for the distribution and blending of different water sources within each region, including local surface water and groundwater, desalinated seawater, and the water from the Colorado Aqueduct, along with water delivered through the Delta to the East and West Branch Aqueducts of the SWP. The weighted average salinity in terms of

³⁴ Metropolitan Water District of Southern California and Bureau of Reclamation. 1999. *Salinity Management Study, Final Report*.

TDS is estimated in terms of mg/l for each region. Economic impacts are calculated for different end uses of water, including residential, commercial, industrial, utilities, groundwater, recycling, and wastewater, based on region-specific demand estimates for each end use.

In the residential sector, the SEIM assesses the damage caused by salinity through its reduction in the useful life of household appliances like water heaters, faucets, and washing machines. It also models the costs of avoidance strategies, such as the installation of water softeners and the purchase of bottled water. In the commercial sector, the SEIM estimates the share of regional water use in sanitary, cooling, landscape irrigation, kitchen, laundry, and other uses; estimates of economic impacts are based on a unit price in each use category. Similarly, in the industrial sector, estimates of economic impacts are based on the total volume of water used in each sector and sector-specific estimates for the cost of demineralization and softening as well as for specific industrial applications such as cooling towers and boiler feed.

To estimate the salinity benefits from the construction of the DCP, estimates of the salinity of project water exported from the Banks Pumping Plant into the California Aqueduct from the DSM2 model are inputted into the SEIM under the project and no-project scenarios. The SEIM then estimates the salinity deliveries on the West Branch Aqueduct and East Branch Aqueduct of the SWP in Southern California.

Table 3 summarizes the annual urban water quality benefits estimated by the SEIM model. Based on this modeling, improvements in water quality as a result of DCP operations lead to an annual benefit of more than \$41 million in terms of reduced economic impacts as a result of improved water quality. These benefits are accounted for primarily by benefits to residential customers, improved quality for recycled water, and reduced impacts on groundwater resources. Note that this estimate does not include estimates of the benefits to agricultural customers, which are accounted for separately in the next section. This estimate also does not include benefits to urban customers outside of Southern California, who are not accounted for in this model.

5.2. WATER QUALITY FOR AGRICULTURAL WATER CUSTOMERS

The analysis of water quality benefits to agriculture also focuses primarily on the impact of reduced salinity on water treatment costs and yield losses. Crop production and yield are greatly affected by the salinity of the crop's root zone. High salinity in the crop's root zone creates unfavorable osmotic pressure for the plants to absorb water.³⁵ This hindered water absorption induces physiological drought within the plant, even if the soil contains abundant water.³⁶ The salinity threshold for yield losses is below 10 decisiemens per meter (dS/m) for most crops grown in the region. Some sensitive crops such as alfalfa, beans, and maize start to experience yield

³⁵ University of California Salinity Management. 2024. Crop Salinity Tolerance and Yield Function. Available: https://ucanr.edu/sites/Salinity/Salinity_Management/Effect_of_soil_salinity_on_crop_growth/Crop_salinity_tolerance_and_yield_function/.

³⁶Ibid.

losses below two dS/m.³⁷ Salt-tolerant crops such as cotton and barley also start to experience declining yields when the soil's electrical conductivity reaches eight dS/m.

Irrigation using river or groundwater that contains salts is the primary man-made cause of soil salination. After irrigation water is applied to the soil, the water gradually evaporates or absorbed by a plant, leaving the dissolved salts in the soil. To reduce the salinity level in the soil, farmers adopt a common practice of applying excess irrigation water that drains the salt downward past the root zone, called leaching. The more saline the irrigation water is, the more excess water is required for leaching the salt away from the plant's root zone.

For the salinity benefit to agricultural water users, we calculated the amount of irrigation water savings from leaching due to reduced salinity with the DCP project alternative. Detailed crop coverage data are obtained from the U.S. Department of Agriculture (USDA). For each crop, the irrigation requirements and leaching fractions to lower the salinity level below yield loss thresholds are used to calculate the annual leaching savings in each water district benefiting from the DCP. Overall agricultural irrigation water use would be reduced by nearly 6,000 acre-feet annually. Along with the agricultural water cost estimates produced by the SWAP model and the water transfer market, the annual savings on irrigation water amounts to more than \$3 million. The breakdown of agricultural water quality benefits is summarized in Table 3, below. The San Joaquin Valley benefits the most from agricultural water quality improvement, at nearly \$2.9 million annually, while Southern California's annual benefit is nearly \$300,000.

Because the EIR assessment predicted a slight increase in salinity in the Delta, we also estimate the costs of increased salinity on agricultural water users in the Delta. The CalSim 3 model predicts an increase in electrical conductivity of 0.008 dS/m on average across the Delta. Although deemed "less than significant" in the EIR, we still quantified the costs of increased Delta salinity and incorporated them in the analysis of remaining environmental impacts after mitigation. Overall, the benefits of improved salinity to downstream agricultural water contractors significantly outweigh the cost of the small increase in salinity in the Delta region.

Similar to the urban water quality analysis, this water quality analysis provides a conservative estimate of total DCP water quality benefits. Because this analysis focuses only on salinity improvement, it does not explicitly price many other measures of water quality improvements, such as reductions in pollutants, pathogens, and man-made chemicals that pose health risks.

³⁷Ibid.

Table 3: Water Quality Benefits

Urban Water Quality Benefits	Millions of 2023 \$
Residential	\$12.0
Commercial	\$4.3
Industrial	\$0.6
Utilities	\$0.1
Groundwater	\$15.8
Recycled Water	\$8.4
Total	\$41.2
Agricultural Water Quality Benefits	
Southern California	\$0.3
San Joaquin Valley	\$2.9
Total	\$3.2
Total Annual Water Quality Benefits	\$44.4

Sources and Notes: Urban water quality benefits based on SEIM model simulations.

Agricultural water quality benefits based on soil leaching water savings analysis.

5.3. WATER QUALITY IN THE DELTA

The EIR evaluates construction and operation of the project on a number of dimensions of water quality, including on boron, mercury, nutrients, organic carbon, dissolved oxygen, selenium, pesticides, trace metals, and total suspended solids and turbidity relative to existing conditions and concludes that the impact on water quality from construction of the project alternatives would be less than significant.³⁸ Operation of the proposed project facilities has the potential to affect water quality through differences in Delta inflows from the Sacramento River, relative to existing conditions, resulting in increased proportions of the other Delta inflow waters (such as eastside tributaries, the San Francisco Bay, and the San Joaquin River) in some regions of the Delta.³⁹ The EIR concludes that changes in bromide, chloride, and electrical conductivity (EC) would be less than significant.

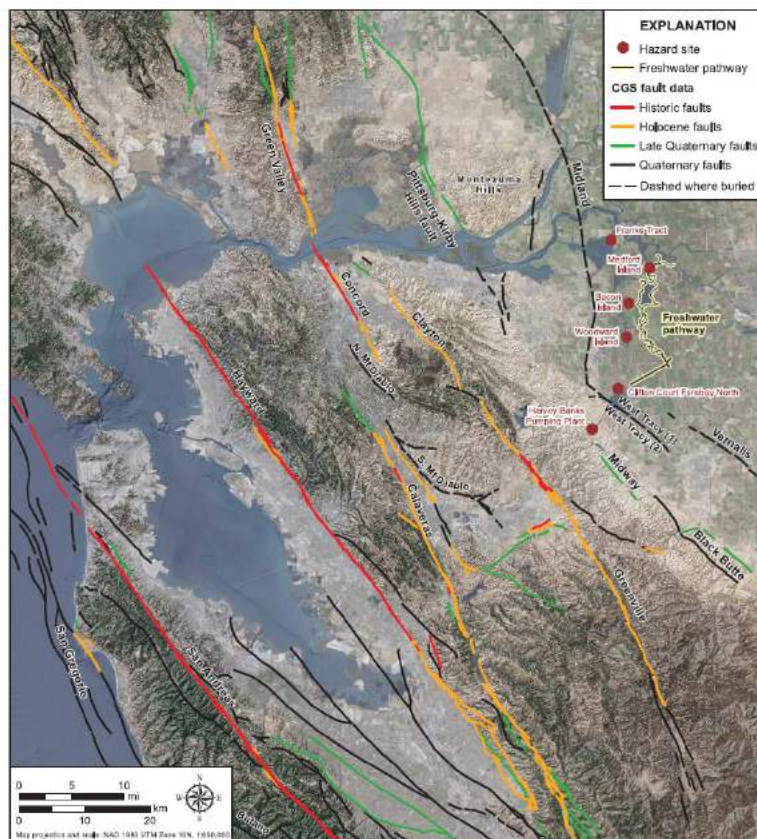
³⁸ DCP EIR, Chapter 9.

³⁹ Ibid.

6. Improvements to the Seismic Reliability of the SWP

A key objective of the DCP is to mitigate the impact of seismic events on the Delta's water conveyance infrastructure. By adding redundancy to the current conveyance infrastructure, DCP will help mitigate the impact of seismic events on the quantity and quality of water delivered south of the Delta. Therefore, it would minimize the potential for adverse public health and safety impacts from a major earthquake.

Figure 4: Major Fault Lines near the Delta



Sources and Notes: "Delta Flood Emergency Management Plan – Supplement C," California Department of Water Resources, October 2018.

There are many active faults surrounding the Delta. Figure 4 displays active faults and historical seismicity near the Delta. The USGS analyzed the earthquake potential of the faults in the Bay Area. The Hayward-Rodgers Creek fault poses the highest probability of generating an earthquake of magnitude 6.7 or greater in the following 30 years, at 27%. The estimates of maximum magnitude range from 6.5 to 7.3. Other than the Hayward-Rodgers Creek fault, there are a couple of smaller faults adjacent to or below the Delta. The West Tracy fault, passing beneath the Clifton Court Forebay at the southwestern part of the Delta, is estimated to

have a maximum magnitude of 6.25 to 6.75. The Midland fault that passes beneath the western margin of the Delta has the potential to produce an earthquake of magnitude 7.1. The Greenville fault, the easternmost part of the San Andreas fault system and located southwest of the Banks Pumping Plant, has the potential to generate earthquakes ranging from 6.6 to 7.2.⁴⁰

Active faults, along with land subsidence and poor, highly organic soils that are subject to liquefaction and settlement, make earthquakes the greatest risk associated with flooding. A large earthquake in the San Francisco Bay Area could cause levees in the Delta to breach, leading to an inundation of brackish water in areas where existing SWP and CVP pumping plants operate in the southern Delta. Historically, levee failure and breaches have occurred for various reasons. In the past century, there were 161 breaches of Delta levees. Despite there being few breaches since the 2000s, the Upper Jones Tract levee failure in 2004 demonstrated that there are still significant breach risks.⁴¹

In any major seismic event with significant brackish water invasion, conveyance through the Delta will most likely be impossible for an extended period. A major seismic event could also damage the SWP and CVP conveyance infrastructure in the Delta. Cessation of conveyance through the Delta for any extended period of time would pose major reliability challenges to State Water Contractors south of the Delta. This could lead to shortages significantly more severe than those posed by dry-year events.

DCP project facilities are designed to withstand at least a 500-year return-period earthquake while maintaining system operational capability. For some more complex or difficult-to-repair facilities, a much higher return period event is assumed for design. Building the DCP serves as an insurance policy that would allow at least some water to continue to be delivered south of the Delta in the event of a major earthquake.

It is difficult to precisely quantify the likelihood and water supply impacts of different seismic events that may occur. These impacts will depend on the location, magnitude, and nature of the seismic event; the number and location of levee failures; and the response to repairing failed levees. Furthermore, the economic costs of water supply interruptions from a major seismic event will also depend on other factors, including the hydrologic and economic conditions that influence the water demand. Rather than attempting to provide a comprehensive analysis of the likelihood and impacts of the full range of hypothetical seismic events that could occur in the Delta region, we instead describe a hypothetical seismic scenario and estimate the impacts and economic costs associated with this scenario.

⁴⁰ Wong, Ivan G., Patricia Thomas, Nora Lewandowski, and Dennis Majors. 2021. Seismic Hazard Analyses of the Metropolitan Water District Emergency Freshwater Pathway, California. In *Earthquake Spectra*, Volume 38(2), 981–1020, 2022, DOI: 10.1177/87552930211047608.

⁴¹ California Department of Water Resources. 2018. *Supplement C – Water Project Export Disruptions for Multiple-Island Breach Scenarios Using the Delta Emergency Response Tool*. May 2018.

The Delta Emergency Response Tool (ERT) is used to simulate Delta levee failures and help forecast impacts and develop response mitigation strategies. The ERT allows a user to test various response strategies to each simulated scenario and helps support decision-making. The ERT simulated 11 base scenarios, ranging from four to 20 breached islands, of which Scenario 1 represents a 500-year earthquake. Scenario 1 simulated a 20 island/ 50 breach event, with a total flooded volume of 1,296 TAF.⁴² Figure 5 shows the specific breach locations. Export disruption and water quality are modeled under a range of hydrologic conditions, including specific scenarios involving severe flood and drought conditions. Eight different response strategies were simulated in an incremental approach, and for each strategy, ERT modeled the distribution of export disruption time, Delta recovery time, and response cost across 20 hydrologic simulations for each response strategy. Out of the eight responses, the Middle River Corridor Strategy results in a shorter disruption time than the basic strategy and a lower cost compared to the cumulative strategy.⁴³ The cost of restoring the seismic damage consists of three parts: breach repair cost, island dewatering cost, and barrier repair cost. For the Middle River Corridor Strategy, the costs are \$1.4 billion, \$35 million, and \$31 million, respectively.⁴⁴

The Middle River Corridor Strategy attempts to construct a freshwater pathway from the northern Delta to the pumps in the southern Delta. It accomplishes this by prioritizing the repair of levees along the Middle River and installing channel barriers to isolate the corridor from the rest of the Delta. Without the DCP, under the Middle River Corridor Strategy, the export disruption ranges from six days to 448 days, with an average of 203 days. The Delta recovery time, defined as the time required for the Delta water quality to recover to the level with no breach, ranges from 11 days to 498 days, with an average of 306 days. Under the DCP alternative, we considered two scenarios for analysis: DCP operating at 6,000 cubic feet per second (cfs) capacity and DCP operating at 500 cfs health and safety levels. These scenarios reflect the maximum and minimum balance at which DCP might be able to operate under the seismic event; however, the exact operation is uncertain and affected by other infrastructure.

Table 4 outlines benefits under the DCP alternative for different disruption and DCP operation scenarios. Assuming the DCP operating at the minimum health and safety levels, the average avoided water supply disruption benefits amount to \$2.36 billion, and the improved water quality benefits amount to \$2.65 million. Assuming the DCP operating at capacity during an earthquake event, the average avoided water supply disruption benefits amount to \$28.4 billion, and improved water quality benefits amount to \$31.6 million. Assuming a 500-year return period, the net present value of the DCP is estimated to be \$1.8 billion when it operates at capacity and \$152 million when it operates at health and safety levels. The overall seismic benefit

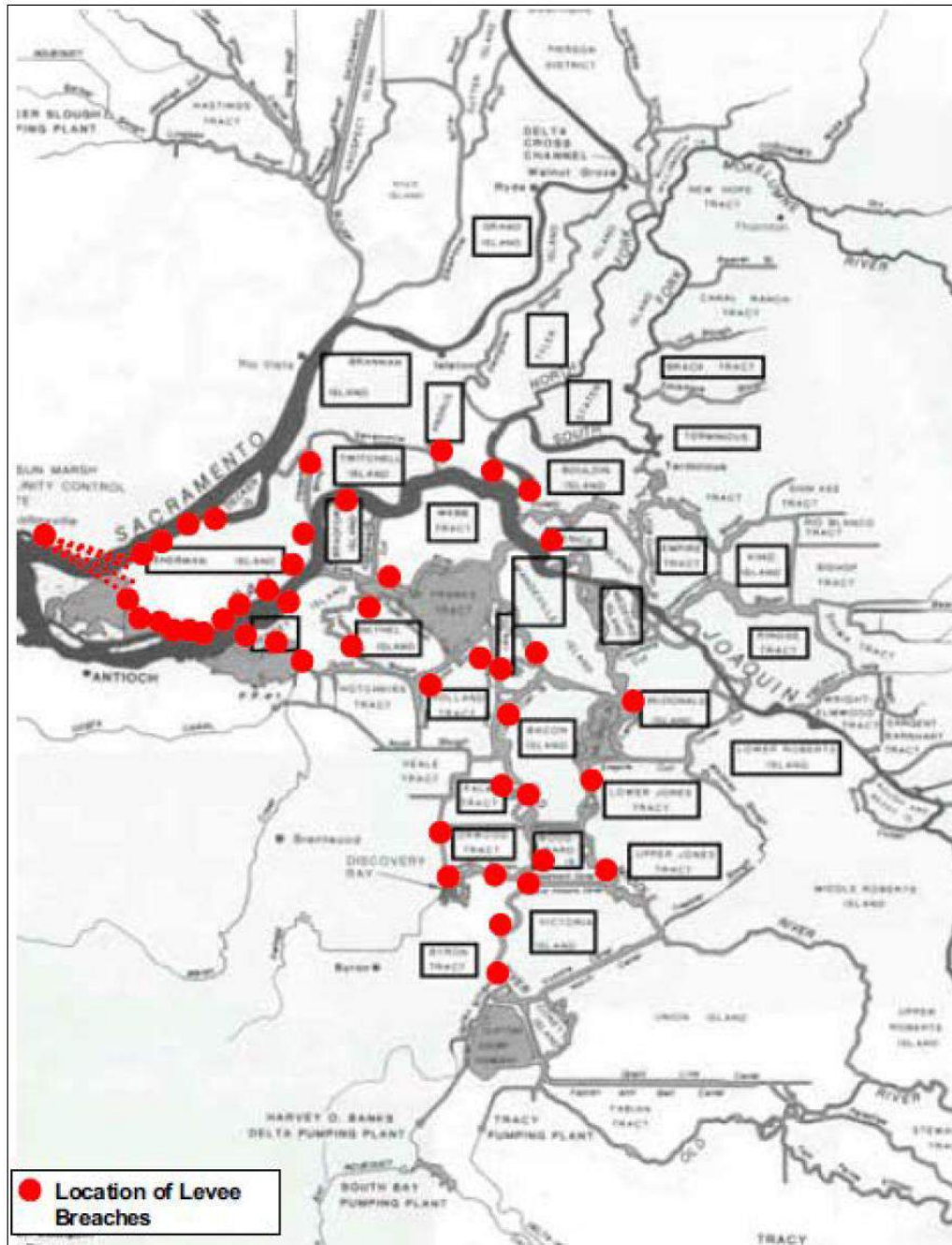
⁴² Ibid.

⁴³ The assumptions of the seismic analysis, based on the ERT, is significantly more conservative compared to an economic analysis this team previously produced for the WaterFix project. The previous analysis assumed more breaches and islands flooded and a significantly more probable earthquake event with a 100-year return period.

⁴⁴ Ibid.

estimate takes into account the full range of scenarios by averaging the net present-value estimates under various export disruption, Delta recovery duration, and DCP operating scenarios.

Figure 5: Seismic Scenario Levee Locations



Sources and Notes: Seismic scenario with 50 levee breaches and 20 flooded islands. "Delta Flood Emergency Management Plan – Supplement C, "California Department of Water Resources, October 2018.

Table 4: Benefit Summary under Seismic Disruption Scenarios

Scenario	Export Disruption Days	Delta Recovery Days	Benefits during Seismic Event		Net Present Value w. 500-year Return Period	
			\$ millions, 2023		\$ millions, 2023	
			Water Supply Benefits	Water Quality Benefits	Water Supply Benefits	Water Quality Benefits
DCP Operates at Health & Saftey Levels (500 CFS)						
Minimum Disruption	6	11	\$63.3	\$0.5	\$4.1	\$0.2
Average Disruption	203	306	\$2,141.3	\$5.3	\$138.1	\$0.3
Maximum Disruption	448	498	\$4,725.6	\$10.9	\$304.9	\$0.7
Average			\$2,310.1	\$5.6	\$149.0	\$0.4
DCP Operates at Capacity (6,000 CFS)						
Minimum Disruption	6	11	\$759.5	\$6.3	\$49.0	\$0.4
Average Disruption	203	306	\$25,695.7	\$63.3	\$1,657.8	\$4.1
Maximum Disruption	448	498	\$56,707.7	\$130.4	\$3,658.5	\$8.4
Average			\$27,721.0	\$66.7	\$1,788.4	\$4.3

Sources and Notes: Benefits calculated under the 20 island / 50 breach scenario with the Middle River Corridor response strategy.

All benefits valued in millions of 2023 dollars.

7. Other Benefits not Explicitly Valued

The analysis of benefits in the previous four sections concentrates solely on those that can be reliably measured and quantified. However, the DCP is expected to yield additional benefits that are not included in this analysis, primarily because the necessary data to quantify them are unavailable.

- The DCP creates **redundancy in the Delta conveyance** that will enhance short-term operational flexibility in the Delta. At certain times, this additional flexibility may allow short-term actions to be undertaken to either increase SWP deliveries (e.g., Article 21 water) or improve water quality. However, this benefit-cost analysis relies on CalSim 3 modeling that has a monthly time step and therefore lacks the granularity to quantify these short-term operational benefits. Therefore, these benefits are underestimated in our current modeling analysis. For example, if the DCP had been operational between January 1 and March 9, 2024, DWR estimates that an additional 909 TAF of water could have been captured by the DCP due to fishery-related regulatory constraints in the South Delta. These constraints are not reflected in our current modeling, resulting in an understatement of program benefits.⁴⁵
- The costs estimate for the DCP includes a **Community Benefits Program**,⁴⁶ which is anticipated to fund a variety of specific local projects such as enhancing public safety, improving water and air quality, and developing educational programs and recreational facilities like parks and walking trails. However, this analysis has not attempted to quantify any benefits arising from these investments.
- The DCP could play a role in the **conservation of groundwater resources** in the Central Valley and other parts of California. The increase in SWP deliveries will be a substitute for groundwater in the SWP service area. To the extent that the DCP leads to a reduction in groundwater demand, it will help agencies achieve the goals under the Sustainable Groundwater Management Act (SGMA). A reduction in groundwater demand could also lead to higher groundwater levels and consequently reduced pumping costs. These benefits have not been quantified in this analysis.

⁴⁵ See California Department of Water Resources. 2024. *Missed Opportunity*. March 2024. Available: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Delta-Conveyance/Public-Information/DCP_Missed-Opportunity.pdf.

⁴⁶ California Department of Water Resources. 2022. *Community Benefits Program Overview*. June 2022.

8. Project Costs

The DCA has produced two cost estimates for the DCP. The primary cost estimate, based on the project's specifications outlined in the EIR, projects the total design and construction cost at approximately \$20.1 billion in undiscounted 2023 dollars. A secondary estimate, referred to as the “project-wide innovations and savings estimate,” considers potential cost reductions through design, construction, and management innovations that do not alter the core project specifications. These innovations lower construction costs by \$1.2 billion, bringing the estimate to \$18.9 billion. These cost estimates are broken down in Table 5, below.⁴⁷

The cost estimates cover various phases and components of the project. Construction costs, which include major works on tunnels, aqueducts, intakes, and a pumping plant, are detailed in both estimates. For example, in the primary estimate, construction costs include \$1.7 billion for two 3,000 cfs intakes, \$6.4 billion for tunnels and shafts, and \$3.2 billion for the pumping plant and related structures, with a 30% contingency adding another \$3.5 billion. The secondary estimate slightly reduces these costs due to the anticipated innovations.

In addition to construction costs, other significant expenses include design, planning, and management, which total \$3.3 billion in the primary estimate and \$3.1 billion in the secondary cost estimate with project-wide innovations.

Other costs, totaling \$1.78 billion, are the same in both the primary and secondary cost estimates. These expenses cover land acquisition, environmental mitigation, power, a settlement agreement with the Contra Costa Water District, and a community benefits program. Further details on the environmental mitigation and community benefits programs are provided in the sections below.

Construction is scheduled to take place between 2029 and 2044, with the highest rate of spending focusing on the tunnels and aqueducts occurring between 2035 and 2040. Before 2029, expenditures are mainly for project design, planning, and land acquisitions. The project's cumulative cost trajectory is displayed in Figure 6 below.

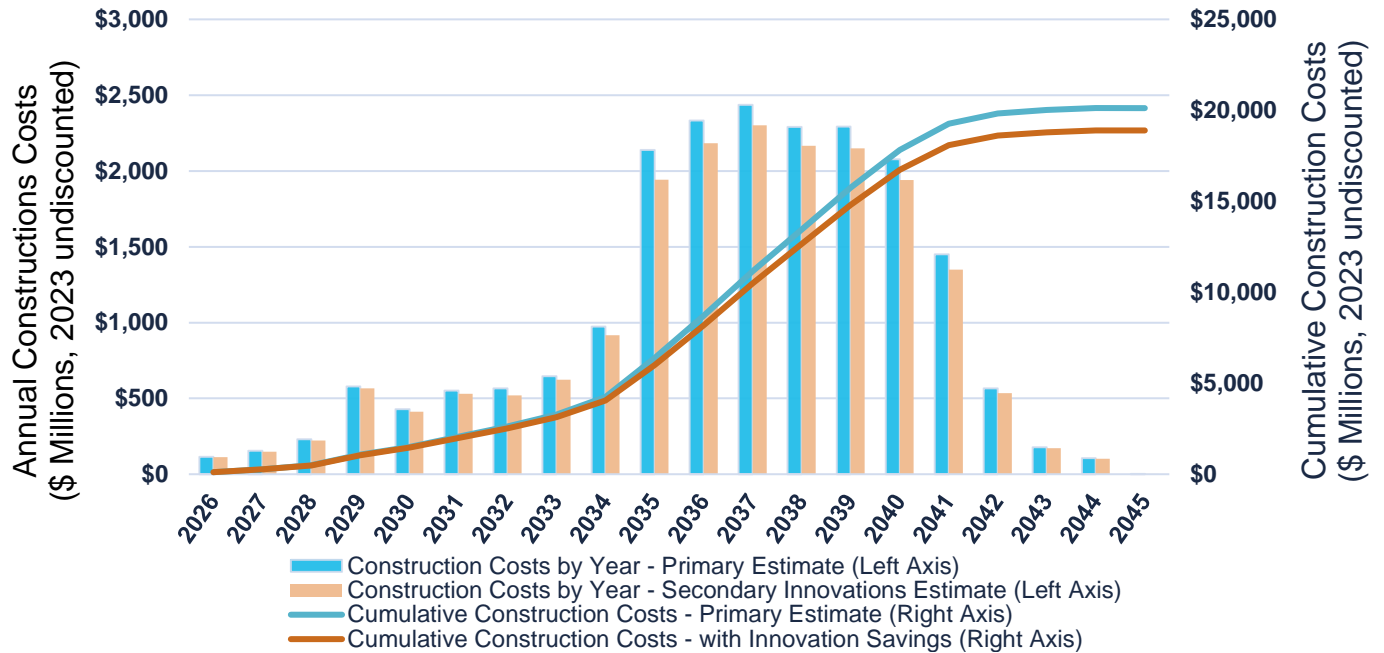
⁴⁷ Note that these are undiscounted and not directly comparable to the costs presented in Table 1 and Table 8.

Table 5: Project Construction Costs

Cost Category	Primary Cost Estimate	Costs w. Project-wide Innovations & Savings
Construction	\$ Millions, 2023	
Intakes	\$1,714	\$1,678
Main Tunnels	\$6,353	\$6,130
Pumping Plant & Surge Basin	\$2,536	\$2,160
Aqueduct Pipe & Tunnels	\$563	\$485
Discharge Structure	\$99	\$58
Access Logistics & Early Works	\$253	\$234
Communication	\$13	\$13
Restoration	\$17	\$17
Construction Subtotal	\$11,548	\$10,775
Contingency (30%)	\$3,464	\$3,233
Total Construction Cost	\$15,012	\$14,008
Other Project Costs		
DCO Oversight	\$426	\$398
Program Management Office	668	\$623
Engineering/ Design /Construction Management	\$2,167	\$2,022
Permitting and Agency Coordination	\$67	\$63
Total Planning/Design/Construction Management	\$3,328	\$3,106
Land	\$158	\$158
DWR Mitigation	\$960	\$960
Power	\$415	\$415
CCWD Settlement Agreement	\$ 47	\$47
Community Benefits Program	\$200	\$200
Total Other Costs	\$1,780	\$1,780
Grand Total	\$20,120	\$18,894

Sources and Notes: Costs measured in millions of undiscounted 2023 dollars and not escalated to the time of construction. For the secondary cost estimate, the planning, design, and construction management costs are assumed to be the same percentage of construction as the primary cost estimate. Cost estimate provided by the DCA.

Figure 6: Construction Costs by Year



Sources and Notes: DCA Cost Estimate, March 2024

8.1 ENVIRONMENTAL MITIGATION COSTS

The design and construction of the DCP incorporate environmental commitments and best management practices to minimize the environmental impacts of the project’s construction and operation, as required under the California Environmental Quality Act (CEQA). The project’s EIR evaluates its environmental and socio-economic impacts on more than 20 different areas. The report proposes mitigation measures to meet requirements under CEQA (i.e., the project adopts feasible mitigation measures where available to reduce significant impacts to a “less-than-significant” level). The DCA budgets \$960 million for proposed mitigation measures to meet these requirements. These costs include items for tribal monitoring, mitigation plan development, habitat mitigation (including compensatory mitigation), and other significant mitigation, as described in the EIR.

For some environmental impacts identified in the EIR, it is not feasible to mitigate impacts to less-than-significant levels. In these cases, compensatory measures and resource specific mitigation are considered.⁴⁸ The

⁴⁸ DCP EIR.

costs associated with remaining environmental impacts that cannot be mitigated to less-than-significant levels are estimated in Section 10 and Appendix C and incorporated into the benefit-cost analysis.

8.2 COMMUNITY BENEFITS PROGRAM

The proposed DCP includes a \$200 million Community Benefits Program to support local communities affected by the project, beyond what's required by CEQA and other laws. This program will collaboratively provide resources to those most affected, including tribal groups, local residents, government agencies, non-governmental organizations, and other Delta stakeholders.⁴⁹

The program consists of two main parts:

- The **Delta Community Fund** aims to finance projects that preserve and enhance the Delta's cultural, historical, recreational, agricultural, and economic aspects through community-led initiatives. It will support projects related to water and air quality, public safety, recreation, habitat conservation, cultural celebrations, economic growth, transport and communication infrastructure, agriculture, education, and levee maintenance.
- The **Economic Development and Integrated Benefits Program** will focus on economic growth by hiring locally and involving businesses in construction of the DCP. It also includes plans to build or repurpose construction features for community use.

⁴⁹ EIR, Appendix 3G, California Department of Water Resources.

9. Operation and Maintenance Costs

The DCP’s annual operations and maintenance (O&M) costs were estimated by the DCA and DWR to be approximately \$52.6 million per year in undiscounted 2023 dollars. This estimate includes DWR’s O&M labor, materials, equipment refurbishments and replacements, power, and restoration sites during the first 100-year lifespan of the proposed project.⁵⁰ Table 6 breaks down the annual DCP O&M costs for each component listed in the formula above.

The facility O&M cost is calculated with the labor rates of relevant civil engineers, mechanical engineers, electrical engineers, and hydroelectric plant technicians and contractors. The material costs include periodic activities such as sediment removal and disposal, repaving, and sealing roadways and parking lots. The power cost associated with moving water through the DCP system is estimated using CalSim 3 monthly modeling, averaging over all water year types, including critical and dry years. The O&M costs associated with restoration sites, including farmland, levee, channel margin, tidal, and other habitats, consist of ground and vegetation management, access work, monitoring, and other restoration needs.

Table 6: Operation and Maintenance Costs

Category	Annual O&M Costs
	\$ Millions, 2023
Water Facility Costs	
Facility O&M	\$17.5
Material Cost	\$0.5
Power Cost	\$2.7
Capital Equipment Refurbishment	\$4.8
Capital Equipment Replacement	\$18.7
Restoration sites Costs	
Restoration sites O&M Cost	\$84
Total Annual O&M Costs	\$52.6

Sources and Notes: Average annual power cost only includes the energy needed to convey 621,266 AF of water through the tunnel from the North Delta Intake to an average South Delta elevation. It does not include the energy needed to move additional water through the entire SWP system. From DWR’s O&M annual cost estimate basis for Bethany reservoir alternative memorandum.

⁵⁰ California Department of Water Resources. 2024. *O&M Annual Cost Estimate Basis for Bethany Reservoir Alternative*. April 2024.

10. Remaining Environmental Impacts after Mitigation

This section provides a brief overview of the estimation of the costs associated with environmental impacts identified as being “significant” or “significant and unavoidable” after mitigation in the project’s EIR. Additional details on these impacts and the process for estimating the associated costs is provided in Appendix C. Of the 223 areas for environmental and socio-economic impacts reviewed in the EIR, impacts on eight of these areas are identified as being “significant and unavoidable” after proposed mitigation measures. For four of these areas, aesthetic, cultural, paleontological, and tribal impacts, we do not attempt to assign any costs to the remaining economic impacts because there is not a generally accepted economic best practice for valuing costs of those nature. In four remaining areas, we estimate the costs of remaining environmental impacts following best practices from the economics literature:

- Lost agricultural land in the Delta
- Construction-related air quality impacts
- Construction-related noise impacts
- Construction-related transportation impacts

To ensure our assessment considers all salinity impacts of the DCP, including both benefits and costs, this section also quantifies the costs related to increased salinity for agricultural water users in the Delta, even though the EIR found this increase to be insignificant.

In terms of lost agricultural land, the construction of the DCP will result in both permanent and temporary effects on certain land parcels in the Delta. To value the loss of farmland, we rely on average market or rental prices by county and crop type. In present-value terms, the total cost of the farmland conversion is estimated to be \$22.6 million, of which \$2.9 million is associated with temporary farmland conversion and the remaining \$19.7 million is associated with permanent farmland conversion. Of the permanent impacts, the crop types with the highest value of converted land are alfalfa, grapes, and almonds.

Project construction will increase airborne emissions across three California air districts: Sacramento Metropolitan Air Quality Management District (SMAQMD), San Joaquin Valley Air Pollution Control District (SJVAPCD), and the Bay Area Air Quality Management District (BAAQMD). These increased emissions will impose social costs to affected areas, which we quantify using estimates published by the U.S. Environmental Protection Agency (EPA). Applying these social cost metrics to total estimated pollution emissions attributable to the DCP, we estimate a total social cost of \$48.7 million in present-value terms. Note that this section does not estimate the impacts of greenhouse gas emissions associated with construction and operation of the DCP because these emissions will be offset by a proposed mitigation program that is included in the project’s costs.

DCP construction is also expected to create noise nuisance in the local areas surrounding construction sites. The impact of construction noise on residents can best be quantified using the hedonic pricing method. Based on a review of relevant literature, we assume a temporary 14% drop in residential home prices for approximately 800

homes affected by project noise for the duration of the noise impacts.⁵¹ This temporary price drop is applied to average housing values in the relevant property and rental markets. In present-value terms, we estimate a total of \$6 million in remaining noise impacts across the construction period after mitigation measures are undertaken. This estimate does not include the cost of the mitigation measures, such as window replacement and temporary relocation, whose costs are accounted for as part of the project’s environmental mitigation costs.

Finally, DCP construction will most likely affect 120 road segments. To calculate the economic impact of the travel delays on these road segments, we consider historical traffic data and each roadway’s speed limit. Then, by approximating the average speed of travel on a congested roadway, we obtain the increased travel time resulting from DCP construction. Multiplying this by a range of opportunity costs for time lost due to traffic, we estimate the social cost to be \$78.8 to \$105.3 million, with a midpoint of \$84.7 million in present-value terms.

The estimated impact of increased salinity on Delta yields, calculated in present-value terms, is \$68.53 million due to the higher demand for irrigation water. Modeling from the EIR indicates this increase to be an average change in EC of 0.008 dS/m across the Delta. Although this change in salinity is deemed “less than significant” in the EIR, these costs are still incorporated into our analysis. Similar to cost discussion in Section 5.2, the costs of increased salinity are based on the additional water requirements to leach soils and manage salinity levels. Using detailed crop coverage data from the USDA, the calculation included the irrigation requirements and leaching fractions necessary to maintain salinity below the thresholds that cause yield loss.

Table 7, below, summarizes the total cost of the remaining environmental costs after mitigation quantified in this report. The total cost of these impacts after mitigation is \$248 million in present-value terms, or \$167 million in discounted terms.

Table 7: Costs of Remaining Environmental Impacts after Mitigation

Total Costs	\$ Millions, 2023
Agriculture	\$25.9
Air Quality	\$61.3
Noise	\$7.7
Transportation	\$84.7
Delta Salinity	\$68.5
Total	\$248.1

Sources and Notes: All costs measured in millions of 2023 undiscounted dollars. See Appendix C for cost breakdown within each category.

⁵¹ We use the low end of the 14% to 18% range estimated by a 2016 study on housing price impacts from railroad noise.

11. Benefit-Cost Ratio and Sensitivity Analysis

11.1. BENEFIT-COST RATIO ESTIMATE

Table 1, shown in the executive summary, presents the results from our main benefit-cost scenario. The primary estimate, based on a 2070 median climate scenario with 1.8 feet of sea-level rise, shows an overall benefit of \$38.0 billion, measured in discounted 2023 dollars. The majority of this benefit comes from urban water supply, valued at \$33.3 billion (87%). Agricultural water supply benefits, the second-largest component, are valued at \$2.3 billion. The DCP also significantly enhances water quality, providing \$1.3 billion in benefits for urban customers and \$90 million for agricultural customers. In addition, by adding redundancy to the existing water supply infrastructure, the expected benefits for a 500-year earthquake include \$969 million for reduced water supply disruption and \$2 million for improved water quality.

On the cost side, two scenarios are considered: the primary scenario, based on the costs of building the project as currently described in the EIR, and a secondary scenario, incorporating project-wide innovations and savings. When discounted to present values, the total costs in the primary scenario, including construction, other project costs, the Community Benefit Program, environmental mitigation, O&M costs, and the costs of remaining environmental impacts, amount to \$17.3 billion. The secondary scenario, with project-wide innovations and savings, the total costs amount to \$16.3 billion. The levelized cost of water from the DCP is calculated by discounting the total costs of the project over its lifetime and then dividing this by the discounted total volume of water deliveries. In the primary scenario, this results in a cost of \$1,327 per acre-foot, while in the secondary scenario, which includes project-wide innovations and savings, the cost is \$1,255 per acre-foot.⁵²

The benefit-cost ratio is calculated by dividing the present value of total benefits by the present value of total costs. In the primary scenario, we find a benefit-cost ratio of 2.20, and in the secondary scenario, the ratio is 2.33. This means that for every dollar spent on the DCP, the expected benefits are worth \$2.20 in the primary scenario and \$2.33 in the secondary scenario. Under either cost estimate, the benefits of the project significantly exceed the costs.

⁵² Levelized cost of water is calculated with the formula $LCOW = \frac{\sum_{t=1}^n \frac{C_t}{(1+r_t)^t}}{\sum_{t=1}^n \frac{Q_t}{(1+r_t)^t}}$ where C_t is the cost associated with the DCP at time t , Q_t is the volume of additional SWP deliveries as a result of the DCP at time t , and r_t is the discount rate at time t .

This methodology is described in more detail here:
Fane, Simon, J. Robinson, and S. White. 2003. The Use of Levelized Cost in Comparing Supply and Demand Side Options. In *Water Science and Technology: Water Supply* 3, No. 3 (2003):185–192.

11.2. SENSITIVITY ANALYSES

Table 8 compares the results from the main benefit-cost scenario to five sensitivity scenarios. The primary estimate, as discussed in Section 2.3, is based on a 2070 median climate scenario with 1.8 feet of sea-level rise. The sensitivity analyses compare benefits of the project under various climate, sea-level rise, and adaptation scenarios.

Sensitivity analysis 1, which incorporates adaptation measures into the main scenario, estimates total benefits and a benefit-cost ratio of \$38.0 billion and 2.20, respectively. The adaptation assumptions in Scenario 1 include improved SWP operations. However, their impact on contractors is mixed (i.e., relaxed water quality standards and the fallowing policy enhance water supply reliability, while Delta export restrictions diminish it). Overall, benefits still exceed costs, and the net impact of the adaptation assumptions is nearly zero.

Sensitivity analyses 2 and 3 assume an extreme sea-level rise of 3.5 feet and find higher benefits due to the low DCP deliveries and water supply reliability in the no-project scenario. Scenario 2 has benefits of \$45.4 billion and a benefit-cost ratio of 2.63. Scenario 3, which adds the adaptation assumptions, has benefits of \$42.3 billion and a benefit-cost ratio of 2.45.

Sensitivity analyses 4 and 5 are based on 2040 climate scenarios and therefore reflect less severe climate change and water scarcity. Analysis 4, using a median ensemble of climate models, finds benefits of \$30.6 billion and a benefit-cost ratio of 1.78, while Analysis 5, using a CT ensemble, finds benefits of \$26.6 billion and a benefit-cost ratio of 1.54.

Across all scenarios, the benefits of the DCP range from \$26.5 billion to \$45.4 billion, consistently exceeding costs and passing the benefit-cost ratio test. The DCP is economically viable and robust under various future climate scenarios, with the greatest benefits seen in the extreme 2070 median scenario, with a 3.5-foot sea-level rise. Even in the 2040 scenarios, the benefits still outweigh the costs.

Table 8: Sensitivity Analysis

	Main Scenario	Sensitivity Analyses				
		1	2	3	4	5
		2070 Median w. 1.8' SLR & Adaptation	2070 Median w. 3.5' SLR	2070 Median w. 3.5' SLR & Adaptation	2040 Median w. 1.8' SLR	2040 Central Tendency w. 1.8' SLR
\$ Millions, 2023	Benefits					
Urban Water Supply and Reliability	\$33,300	\$33,395	\$40,847	\$37,729	\$25,940	\$21,642
Agricultural Water Supply and Reliability	\$ 2,268	\$ 2,221	\$2,211	\$2,165	\$2,317	\$2,520
Urban Water Quality	\$ 1,330	\$ 1,330	\$1,330	\$1,330	\$1,330	\$1,330
Agricultural Water Quality	\$ 90	\$ 90	\$90	\$90	\$90	\$90
Seismic Reliability Benefits (Water Supply)	\$969	\$969	\$969	\$969	\$969	\$969
Seismic Reliability Benefits (Water Quality)	\$ 2	\$ 2	\$2	\$2	\$2	\$2
Total Benefits	\$37,960	\$38,008	\$45,449	\$42,285	\$30,648	\$26,553
	Costs					
Construction Costs	\$11,486	\$11,486	\$11,486	\$11,486	\$11,486	\$11,486
Other Project Costs	\$ 3,021	\$ 3,021	\$3,021	\$3,021	\$3,021	\$3,021
Community Benefit Program	\$153	\$153	\$153	\$153	\$153	\$153
Environmental Mitigation	\$735	\$735	\$735	\$735	\$735	\$735
O&M Costs	\$ 1,697	\$ 1,697	\$1,697	\$1,697	\$1,697	\$1,697
Environmental Impacts after Mitigation	\$167	\$167	\$167	\$167	\$167	\$167
Total Costs	\$17,259	\$17,259	\$17,259	\$17,259	\$17,259	\$17,259
Benefit-Cost Ratio	2.20	2.20	2.63	2.45	1.78	1.54

Sources and Notes: All benefits and costs are measured in millions of discounted 2023 \$. A declining discount rate is used from 2% to 1.4%, consistent with guidance from OMB. The primary estimate considers the 2070 median climate with 1.8 feet of sea-level rise. The sensitivity analyses vary in terms of climate assumptions, sea-level rise, adaptation measures introduced to reduce operational risks for the State Water Project

12. Conclusions

This report has conducted a benefit-cost analysis of the proposed DCP. The project's benefits are estimated in terms of water supply reliability and water quality, in light of anticipated climate change, future sea-level rise, and seismic risks. The project's costs are estimated in terms of capital and O&M costs as well as the costs of mitigated and unavoidable environmental impacts. We consider the difference in the total benefits and costs between a scenario in which the proposed project is built and a no-project scenario. We estimate a benefit-cost ratio of 2.20.

In addition to the primary estimate of the benefit-cost ratio, a number of sensitivity analyses are conducted that consider various scenarios for climate and sea-level rise. The additional deliveries under the project scenario relative to the no-project scenario are similar across all sensitivity analyses, and consequently, the benefit-cost ratio remains above 1.5 in all scenarios. The DCP's benefits tend to increase in scenarios with more extreme climate change, assuming the project continues to deliver similar incremental water supplies.

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Appendix B: Additional Details on Estimation of Urban Water Supply Reliability Benefits

This appendix provides additional details on the methodology that is used to estimate the urban water supply reliability benefits. These benefits are estimated using a framework that is described in several peer-reviewed academic papers including Brozovic et al. (2007), Buck et al. (2016), and Buck et al. (2023) and the text in this appendix has been closely adapted from those works.⁵³

B.1. FRAMEWORK FOR CONSUMER WELFARE LOSS ANALYSIS

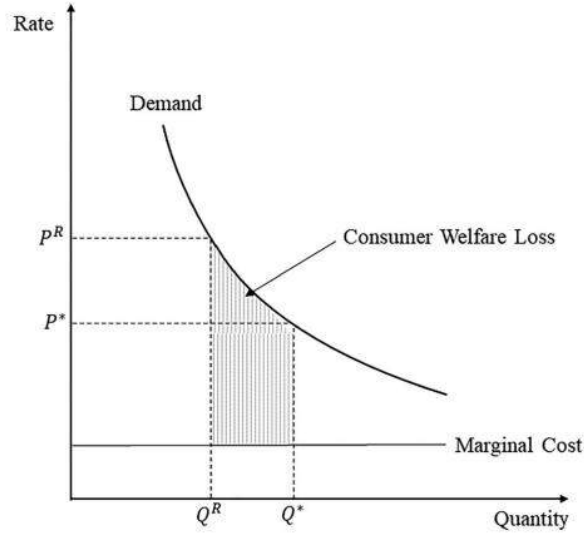
Urban consumers are evaluated using a measure of willingness to pay to avoid observed water supply reductions. This same approach is adopted in other works in the recent peer-reviewed literature including Brozovic et al. (2007), Buck et al. (2016), and Buck et al. (2023). Under this approach, welfare losses are measured as the area under an estimated demand curve and above estimated marginal costs. Figure B-1 shows a visual illustration of this area representing the consumer welfare losses experienced in response to water supply disruptions. The demand curve in Figure B - 1 depicts a constant-elasticity demand curve, a curve in which a one percentage change in water prices leads to a constant percentage change in consumption of water at any baseline level of consumption. In this figure the welfare loss from a reduction in water supply from Q^* to Q^R is equal to the area shaded in grey. This welfare loss has two components: 1) a consumer welfare loss equal to the triangle that is shown with an arrow on the figure and 2) a loss in revenue for the utility that is equal to the square below the triangle or $P^*(Q^* - Q^R)$. The remainder of this sub-section uses economic theory to formalize this approach to estimating consumer welfare losses.

⁵³ Brozović, Nicholas, David L. Sunding, and David Zilberman. 2007. Estimating Business and Residential Water Supply Interruption Losses from Catastrophic Events. In *Water Resources Research*, 43, No. 8 (2007).

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Figure B - 1: Depiction of Welfare Losses under Demand Curve



Source: Buck, Steven, Mehdi Nemati, and David Sunding. "Consumer Welfare Consequences of the California Drought Conservation Mandate." *Applied Economic Perspectives and Policy* 45, no. 1 (2023): 513.

The severity of the water supply disruption in region i at time t is denoted as $z_{it} \in [0; 1]$, where $z_{it} = 0$ corresponds to a complete outage and $z_{it} = 1$ corresponds to the baseline level of service. Let $f_{it}(z_{it})$ represent the probability density function of residential water disruption z_{it} in region i at time t and let $W_i(z_{it})$ denote consumer willingness to pay to avoid a supply disruption z_{it} in region i at time t . For a period of duration T until baseline water service is reestablished, consumer willingness to pay to avoid a cumulative service disruption across sectors I regions and T periods is given by:

$$W = \sum_{t=1}^T \sum_{i=1}^I \int_0^1 W_i(x) f_{it}(x) dx$$

with x as the variable denoting the values z_{it} can assume. For a given region and time, the computation of $W_i(z_{it})$ involves integrating the area under a demand curve for a supply disruption level of z_{it} . Specifically, willingness to pay to avoid a supply disruption of magnitude z_{it} in region i at time t can be defined as:

$$W_i(z_{it}) = \int_{Q_i(z_{it})}^{Q_i^*} P_i(x) dx,$$

where $P_i(Q_i)$ is the (inverse) demand function for residential water in region i , $Q_i^* = Q_i(z_{it} = 1)$ is the baseline quantity of water delivered to residences in region i prior to a supply disruption, and $Q_i(z_{it})$ is the quantity of supply available after a water supply disruption in region i at time t .

Consumer willingness to pay to avoid a (contemporaneous) water supply disruption of a given magnitude i is calculated for each region by constructing an aggregate demand curve to represent the residential water segment. For utilities with a uniform pricing structure, $P_i^* = P_i(Q_i^*)$ is the volumetric rate paid by residential homeowners under baseline conditions prior to the water supply disruption in region i . For regions with an increasing block pricing (IBP) structure, P_i is the marginal rate paid by a representative residential consumer in region i corresponding to the tier on which the last unit of household water consumption occurred.

Ratepayer welfare losses that result from water supply disruption in a given market are mitigated to the extent that delivering a smaller quantity of water reduces the system-wide cost of water service. The ratepayer welfare loss that occurs in region i following a water supply disruption is therefore the difference between the measure in the first equation and the avoided cost of service. If water service is characterized by constant unit cost at the prevailing baseline price level, P_i , then the avoided cost of service is $P_i^*(Q_i^* - Q(z_{it}))$, and the ratepayer welfare loss following a water supply disruption of a given magnitude reduces to the usual consumer surplus triangle.

Let $c_i(z_{it})$ denote the avoided unit cost of service in region i at time t . Accordingly, the contemporaneous ratepayer welfare loss in region i of a given magnitude water supply disruption is given by:

$$L_i(z_{it}) = \int_{Q_i(z_{it})}^{Q_i^*} P_i(x) - c_i(x) dx$$

Once again, notice that the contemporaneous welfare loss in this equation corresponds with a consumer surplus measure in the case where $c_i(z_{it}) = P_i^*$. In this case, the equation reduces to:

$$L_i(z_{it}) = \int_{Q_i(z_{it})}^{Q_i^*} P_i(x) dx - P_i^*(Q_i^* - Q(z_{it}))$$

The expression for losses in the above equation is a lower bound on the economic loss experienced by ratepayers and corresponds to the case of marginal cost pricing. For a period of duration T until baseline water service is reestablished, the ratepayer welfare loss in the residential (R) sector resulting from a cumulative service disruption across I regions and T periods is given by:

$$L^R = \sum_{t=1}^T \sum_{i=1}^I \int_0^1 L_i(x) f_{it}(x) dx$$

where $L_i(z_{it})$ is defined in the previous equation. We note that L^R represents aggregate expected losses across I regions between the current period and period T , which reflects the value of a perfectly reliable supply.

B.2. ECONOMETRIC MODEL OF WATER DEMAND

To operationalize the theory in Section B.1, we need to estimate the function $P_i(Q_i)$. A key parameter in estimating $P_i(Q_i)$ is the price-elasticity of demand. We rely on estimates of demand elasticity produced in Buck et al. (2016).⁵⁴ This paper estimates utility-specific demand elasticities from a panel of utility service area level water price and consumption data. The main challenge in this estimation is avoiding simultaneity bias, typically addressed by including year fixed effects and considering utility fixed effects to control for unobserved time-invariant characteristics. The study avoids the endogeneity issue, common with increasing block price schedules, by using the median tier price of each utility's tiered pricing schedule and instrumenting this price with lagged prices. Additionally, the research considers different pricing structures, like uniform pricing and increasing block pricing (IBP), as they may affect the estimated price elasticity of demand. The study addresses the complications introduced by increasing block pricing by using an instrumental variables approach where price tiers are used as instruments for the median price.

The authors estimate a regression consumer demand on water rates using the following equation:

$$\ln(q_{it}) = \beta_1 \ln(\widetilde{p_{it}}) + \beta_2 \ln(\widetilde{p_{it}}) \ln(y_{it}) + \mu_i + \tau_t + \xi_{it}$$

Where q_{it} is average consumption in utility i at time t . $\ln(\widetilde{p_{it}})$ is an instrumented measure of median rates, y_{it} is median household income within the utility service area, μ_i are utility fixed effects, τ_t are year and month fixed effects and ξ_{it} are controls for weather. Using this approach, the authors produce the regression estimates shown below in Table B - 1.

In the paper, these estimated coefficients are subjected to a number of robustness checks regarding impact of increasing block pricing, drought, and other omitted variables and found to be reliable. Since the data in this paper is dated, in the next section we recalculate utility-specific demand elasticity estimates based off of the most recent data on each utility's rates, income, and demand.

⁵⁴ Buck, S., M. Auffhammer, S. Hamilton, and D. Sunding. 2016. Measuring Welfare Losses from Urban Water Supply Disruptions. In *Journal of the Association of Environmental and Resource Economists*, 3(3), 743–778.

Table B - 1: Econometric Estimate of Water Demand from Buck et al. (2016)

	OLS (1)	OLS (2)	IV (3)	OLS (4)	IV (5)
ln(Price)	0.173 (0.120)	-0.100*** (0.033)	-0.143*** (0.046)	-0.591*** (0.194)	-0.637*** (0.242)
ln(Price) x ln(Income)				0.110** (0.041)	0.113** (0.050)
Observations	453	453	453	453	453
Weather controls	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Utility fixed effects	No	Yes	Yes	Yes	Yes

Note.—Standard errors clustered at the water utility level reported in parentheses.

* p < .10.

** p < .05.

*** p < .01.

Source: Buck, S., Auffhammer, M., Hamilton, S., & Sunding, D. (2016). "Measuring Welfare Losses from Urban Water Supply Disruptions," *Journal of the Association of Environmental and Resource Economists*, 3(3), 743-778.

B.3. ESTIMATION OF WELFARE LOSSES

This subsection describes the derivation of the function that is used to estimate welfare losses from water shortages. This derivation is presented in more detail in Buck et al. (2016). We assume a constant elasticity of demand specification:

$$P_i = A_i Q_i^{1/\varepsilon_i}$$

for $i = 1 \dots n$, where ε_i is the price elasticity of water demand in region i and A_i is a constant. Let P_i and Q_i , respectively, denote the retail water price and quantity of water consumed by residential households in region i under baseline conditions. For a given water supply disruption with an available level of water given by $Q_i(z_{it}) < Q_i^*$, it is helpful to define the relationship between these quantities in terms of the percentage of water rationed in region i at time t , r_{it} , as

$$Q_i(z_{it}) = (1 - r_{it})Q_i^*.$$

Based on the preceding equations, the welfare loss following a supply disruption of magnitude z_{it} in region i at time t can be calculated as:

$$L_i(z_{it}) = \frac{\varepsilon_i}{1+\varepsilon_i} P_i^* Q_i^* \left[1 - (1 - r)^{\frac{1+\varepsilon_i}{\varepsilon_i}} \right] - \int_{Q_i(z_{it})}^{Q_i^*} c_i(x) dx.$$

Under the assumption of a flat marginal cost curve, we can rewrite this equation in terms of average loss per unit of shortage:

$$\frac{L_i}{Q_i^* r_{it}} = \frac{\varepsilon_i}{1+\varepsilon_i} P_i^* \left[1 - (1 - r_{it})^{\frac{1+\varepsilon_i}{\varepsilon_i}} \right] / r_{it} - c_i,$$

where c_i is a constant per unit marginal cost. This makes clear that conditioned on a supply disruption r_i , the welfare implications of a supply disruption in a particular region depends on heterogeneity in (i) price elasticities, (ii) initial prices, and (iii) the variable cost of water service, where ii and iii provide insight into the extent to which fixed costs are bundled into volumetric rates.

Using the above equations, we calculate welfare losses from shortages for State Water Contractors and Metropolitan Water District customers under both the project and no-project scenarios. In our calculations, P_i is each districts' median-tier water rate. Where possible we rely on forecast rates for the year 2045 that are produced as part of the district's planning process. Otherwise, current rates are used based on the most recent available data. It is assumed that there is no increase in real rates for the duration of our estimate. Where a State Water Contractor is a wholesaler that serves multiple retailers, a median rate is calculated across all retailers. Baseline Demand, Q_{it}^* , is based on each demand forecast produced by each district as part of their resource planning process. Shortages, r_{it} , are calculated based on district specific reliability modeling. Long-run variable costs for water deliveries, c_i , are calculated based on data reported in the State Water Project's Bulletin 132-19.⁵⁵

Due to the constant elasticity of demand assumption, welfare losses in our model are unbounded as shortages become increasingly large. In the model, we have limited consumer welfare losses at a marginal value of \$10,000 per acre-foot, which is approximately equal to the costs of providing emergency water supplies to residential and commercial customers via truck.⁵⁶

⁵⁵ California Department of Water Resources. n.d. *Bulletin 132, Management of the California State Water Project*.

⁵⁶ Brozović, Nicholas, David L. Sunding, and David Zilberman. 2007. Estimating Business and Residential Water Supply Interruption Losses from Catastrophic Events. In *Water Resources Research*, 43, No. 8 (2007).

Appendix C: Additional Details on Costs of Remaining Environmental Impacts after Mitigation

This appendix provides further details on the estimation of the costs of remaining environmental impacts after mitigation provided in Section 10 of the report. The Environmental Impact Report is a comprehensive study that identifies the significant environmental and social impacts associated with the construction of the Delta Conveyance Project. It assesses impacts in over twenty areas and identifies mitigation measures to offset them. After mitigation, remaining environmental impacts are quantified or identified as ‘Less than Significant.’ The proposed mitigation project will be financed by the environmental mitigation costs discussed in Section 0 and incorporated into the DCA’s cost estimates. Several environmental impacts are still identified as being significant after mitigation efforts, particularly in terms of lost agricultural land in the delta region and construction-related air quality, noise, and transportation impacts.

C.1. LOST AGRICULTURAL LAND IN THE DELTA

The EIR identifies parcels of land that would be affected by construction of DCP and categorizes impacts to them as either permanent or temporary. Permanent impacts are described as “resulting from the physical footprint of project facilities” and as “land that cannot be returned to farmland.”⁵⁷ Impacts that would last for the duration of construction, but for which there also exists post-construction uncertainty were additionally designated as permanent. Temporary impacts are those which would be “largely limited to the duration of construction activities at a given site but could be returned to active farmland after cessation of construction activities.”⁵⁸

To value permanent loss of farmland, we rely on the average market prices for farmland by county and crop type. Temporary loss of farmland is valued using the annual rental price by county and crop type. Non-agricultural land impacted by construction, such as seasonal wetlands and miscellaneous grasses, are excluded from the analysis. To value affected cropland, we rely on appraisal values calculated in the “Trend in Agricultural Land and Lease Values” report provided by the California chapter of the American Society of Farm Managers and Rural Appraiser, the largest professional association for rural property land experts. If an appraisal value was not available for an affected crop type and county, we rely on the average value of Delta farmland. In the case of almond croplands, we rely on the mean value per acre across irrigated and well-watered almond cropland. Appraisal values for relevant croplands are presented in Table C-1 below.

⁵⁷ DCP EIR, 15–25.

⁵⁸ Ibid.

Table C-1: Value of Cropland in Project Area

Crop Type	County	Low Value (\$ per Acre)	High Value (\$ per Acre)	Mid Value (\$ per Acre)
[A]	[B]	[C]	[D]	[E]
Almonds	San Joaquin, Contra Costa, Sacramento	\$19,145	\$58,499	\$38,822
Rangeland Grazing Only	San Joaquin, Contra Costa, Sacramento	\$638	\$ 3,191	\$1,915
Rangeland (perm plant potential)	San Joaquin, Contra Costa, Sacramento	\$5,318	\$ 9,573	\$7,445
Walnuts	San Joaquin, Contra Costa, Sacramento	\$19,145	\$37,227	\$28,186
Wine Grapes	San Joaquin, Contra Costa, Sacramento	\$23,400	\$42,545	\$32,972
Cherries	San Joaquin, Contra Costa, Sacramento	\$26,591	\$38,290	\$32,440
Delta	San Joaquin, Contra Costa, Sacramento	\$15,954	\$19,145	\$17,550
Row Crops	Santa Clara	\$26,591	\$63,817	\$45,204

Sources and Notes:

[A]: These are the crop types with available information in the 2022 ASFMRA report, and values converted to 2023 dollars.

[B]: Note that ASFMRA combines counties into agricultural regions. San Joaquin, Contra Costa, and Sacramento fall into the Northern San Joaquin region, whereas Alameda County is placed in the Central Coast region.

[C] – [D]: The ASFMRA lists a high and a low value for each type of farmland.

[E]: The mid value is just the average of the high and low values listed in the 2022 ASFMRA report.

To value the cost of temporary impacts, we rely on rent values provided by the United States Department of Food and Agriculture’s National Agricultural Statistics Service (NASS). NASS rent values are characterized as irrigated and non-irrigated; we calculate a mean across both types. Rental prices are presented below in Table C-2. We calculate the cost of temporary impacts as the product of rental value per acre and the total temporary affected acreage by county. We assume all temporarily affected fields are affected for the entire duration of construction, thereby potentially overestimating the cost of lost farmland.

Table C - 2: Summary of Rent by County for Irrigated and Non-Irrigated Farmland

	Irrigated Land Rent	Non-Irrigated Land Rent	Average Land Rent
County	(\$ per Acre)	(\$ per Acre)	(\$ per Acre)
[A]	[B]	[C]	[D]
Alameda	1,414.62	21.27	717.94
Contra Costa	344.61	19.15	181.88
Sacramento	264.84	40.95	152.90
San Joaquin	447.78	36.69	242.24

Sources and Notes:

All rent measured in 2023 dollars.

[A]: Affected counties as described in DCP EIR.

[B],[C]: From the United States Department of Agriculture National Agricultural Statistics Service.

[D]: $([B] + [C]) / 2$.

We assume all permanent impacts begin in the first year of construction. Due to discounting, this assumption yields a relatively high estimate of total costs. Acreage impacted is inclusive of the farmland that will be affected by construction of mitigation measures such as on Bouldin Island and within I-5 Ponds 6, 7, and 8.

Using the mean value for the appraisal of farmland and the average value between the rent prices of irrigated and non-irrigated farmland in the four counties, the total undiscounted cost of the farmland conversion is estimated to be \$25.94 million, as shown in Table C-3. Of this total, \$3.99 million is associated with temporary farmland conversion and \$21.96 million are associated with permanent farmland conversion. Of the permanent impacts, the crop types with the highest value of converted land are alfalfa, grapes, and almonds.

Table C - 3: Summary of Costs Associated with Conversion of Farmland

Construction Year	Cost of Temporary Acres Impacted	Cost of Permanent Acres Impacted	Total Cost
(\$ millions, 2023)			
CY1	\$0.249	\$21.950	\$22.199
CY2	\$0.249	\$0.000	\$0.249
CY3	\$0.249	\$0.000	\$0.249
CY4	\$0.249	\$0.000	\$0.249
CY5	\$0.249	\$0.000	\$0.249
CY6	\$0.249	\$0.000	\$0.249
CY7	\$0.249	\$0.000	\$0.249
CY8	\$0.249	\$0.000	\$0.249
CY9	\$0.249	\$0.000	\$0.249
CY10	\$0.249	\$0.000	\$0.249
CY11	\$0.249	\$0.000	\$0.249
CY12	\$0.249	\$0.000	\$0.249
CY13	\$0.249	\$0.000	\$0.249
CY14	\$0.249	\$0.000	\$0.249
CY15	\$0.249	\$0.000	\$0.249
CY16	\$0.249	\$0.000	\$0.249
Total	\$3.991	\$21.950	\$25.941

C.2. CONSTRUCTION-RELATED AIR QUALITY IMPACTS

This section evaluates the social cost of construction with respect to four pollutants: reactive organic gases (ROG), nitrogen oxides (NO_x), particulate matter less than 10 microns in diameter (PM₁₀), and particulate matter less than 2.5 microns in diameter (PM_{2.5}). Project construction will increase emissions across three districts: Sacramento Metropolitan Air Quality Management District (SMAQMD), San Joaquin Valley Air Pollution Control District (SJVAPCD), and the Bay Area Air Quality Management District (BAAQMD). In particular, construction will increase PM₁₀ in excess of SMAQMD and SJVAPCD thresholds and increase NO_x emissions above thresholds set in all three districts. Note that this section does not estimate the impacts of greenhouse gas emissions associated with the construction and operation of the DCP because these emissions will be offset by a proposed mitigation programs that are included in the project's costs.

Both nitrogen oxides and particulate matter are associated with negative impacts on human health. Short-term NO_x exposure is associated with respiratory symptoms, especially in people with asthma. Longer-term exposure is associated with development of asthma.⁵⁹ In addition to its health effects, NO_x is associated with acid rain, global warming, and nutrient overload. Particulate matter refers to microscopic solids or liquid droplets which are small enough to be inhaled. Particulates less than 10 micrometers in diameter can be inhaled deep in the lungs and absorbed into the bloodstream.⁶⁰ Because smaller particulates can be absorbed more deeply into the lungs and bloodstream, PM_{2.5} poses a greater health risk than PM₁₀.

Due to the health risks posed by air pollutants, the DCP incorporates mitigation plans to reduce the impact of project-related emissions. DWR will enter into agreements with the affected air districts to provide offset fees. DWR will establish programs to fund emissions reduction projects which include but are not limited to alternative fuel school busses and transit public vehicles, diesel engine retrofits, electric vehicle rebates, and video-teleconferencing systems and telecommuting start-up costs for local businesses. DWR will additionally fund compensatory mitigation plans which restore wetlands and tidal habitats on Bouldin Island and in the North Delta Arc. A more complete discussion of mitigation plans is found in Chapter 23 of the EIR.

Table C - 4 presents baseline levels of annual pollution and the expected increase across the four studied air quality districts. Project-related pollution constitutes less than a 1% increase in pollution levels in all pollutants and counties except for a 2.2% increase in NO_x emissions in SMAQMD. No significant changes in pollution levels are predicted in Yolo-Solano Air Quality Management District for any of the studied pollutants.

⁵⁹ U.S. Environmental Protection Agency. n.d. *Basic Information about NO₂*. Available: <https://www.epa.gov/no2-pollution/basic-information-about-no2#Effects>. Accessed: December 6, 2023.

⁶⁰ U.S. Environmental Protection Agency. n.d. *Particulate Matter (PM) Basics*. Available: <https://www.epa.gov/pm-pollution/particulate-matter-pm-basics#effects>. Accessed: December 6, 2023.

Table C - 4: Annual Air Quality Changes between no project and project scenarios (Tons/Year)

		ROG	NOX	CO	PM 10 Total	PM2.5 Total	SO2
Sacramento Metropolitan Air Quality 1 Management District							
Baseline Emissions	[1]	18,849	12,676	75,887	11,779	3,927	303
Increased Emissions	[2]	21	278	603	108	24	0
Percent Increase	[3]	0.1%	2.2%	0.8%	0.9%	0.6%	0.0%
Yolo-Solano Air Quality Management District							
Baseline Emissions	[1]	8,329	6,453	21,864	12,136	2,508	164
Increased Emissions	[2]	0	0	4	0	0	0
Percent Increase	[3]	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Bay Area Air Quality Management District							
Baseline Emissions	[1]	89,976	81,997	331,062	32,730	13,600	8,424
Increased Emissions	[2]	14	147	505	220	34	0
Percent Increase	[3]	0.0%	0.2%	0.2%	0.7%	0.3%	0.0%
San Joaquin Valley Air Pollution Control District							
Baseline Emissions	[1]	117,136	83,384	248,244	97,495	25,130	2,347
Increased Emissions	[2]	15	153	255	120	22	0
Percent Increase	[3]	0.0%	0.2%	0.1%	0.1%	0.1%	0.0%
Total							
Baseline Emissions	[1]	234,290	184,511	677,057	154,140	45,165	11,238
Increased Emissions	[2]	50	578	1,367	448	80	0
Percent Increase	[3]	0.0%	0.3%	0.2%	0.3%	0.2%	0.0%

Sources and Notes:

[1]: California Air Resources Board, "Emissions by Air District," accessed September 2022.

[2]: Environmental Impact Report for the Delta Conveyance Project, Chapter 23B, Table 23-22.

[3]: [2] / [1].

To quantify the social cost of increased pollutants, we apply EPA estimates of social cost per ton. The EPA estimates the social costs of air pollution using BenMAP-CE. The BenMAP-CE model first estimates health impacts using inputs from the published epidemiological literature: air quality changes, population levels, baseline incidence rates, and health effect estimates. The model calculates economic values from these estimates using cost-of-illness and willingness-to-pay metrics. Cost-of-illness reflects expenses associated with pollution-related illness, while willingness-to-pay reflects the more comprehensive toll of pollution related illness, incorporating individuals' reduction in quality of life beyond medical expenses. This analysis relies specifically on BenMAP social cost estimates in the refineries sector: values in 2023 dollars per ton are presented in Table C - 5 below.

Table C - 5: Social Cost of Pollutants

		Social Cost (\$ / ton)
ROG	[1]	\$14,556
NOX	[2]	\$102,016
PM 10	[3]	\$12,315
PM2.5	[4]	\$465,781
SO2	[5]	\$64,425

Sources and Notes:

Social cost reported in 2023 \$/ton.

[1], [2], [4], [5]: EPA BenMAP Emissions by Sector.

[3]: Regulatory Impact Analysis of the Proposed Reciprocating Internal Combustion Engines NESHAP.

[3], [4]: For PM10 and PM2.5, social costs are determined using values reported for exhaust.

Applying these social cost metrics to total estimated pollution emissions attributable to the DCP, we estimate a total social cost of \$61.29 million.⁶¹ Annual social costs are presented in Table C - 6 below. This estimate is likely an upper bound for two reasons. First, the DCP EIR evaluates its emissions estimates to be an upper bound on expected emissions; if actual increased emissions are lower, then the corresponding social cost will be closer to zero. Second, EPA BenMAP social cost estimates have increased in recent years to reflect a more comprehensive account of social costs. Past EPA estimates have been only looking at the social costs of PM_{2.5} precursors, while the current estimates use both PM_{2.5} precursors and ozone precursors. This causes an increase in social costs of NO_x and ROG_s. In a comparable analysis conducted for an earlier version of the project in 2013, the social cost of NO_x was estimated to be \$13,691; the current social cost is more than seven times this amount.⁶² Because the total costs are driven primarily by increases in NO_x emissions, the change in estimated cost/ton explains 81% of the total social cost of increased air pollution; using the values in the 2013 report, we find a total social cost of \$7.1 million.⁶³ This comparison is not intended to trivialize the impact of air pollutants in the project air districts, but rather to give context to the magnitude of the estimated social cost.

⁶¹ Measured in undiscounted 2023 dollars and assuming preliminary field investigation year (PFIY 1) will begin 2 years from the time of this analysis.

⁶² The original input was \$11,000; the value in text is adjusted to 2023 dollars.

⁶³ The 2013 values for social cost are adjusted for inflation. As in the main analysis, we assume a 2% discount rate and that the preliminary field investigation year (PFIY 1) will begin 2 years from the time of this analysis.

Table C - 6: Total Annual Social Cost of Project-Related Air Pollution

Construction Year	Total Social Cost (\$ Millions, 2023)
PFIY1	\$0.64
PFIY2	\$0.64
PFIY3	\$0.64
CY1	\$1.22
CY2	\$0.73
CY3	\$1.14
CY4	\$4.23
CY5	\$9.40
CY6	\$10.59
CY7	\$8.86
CY8	\$6.60
CY9	\$6.59
CY10	\$6.38
CY11	\$2.80
CY12	\$0.61
CY13	\$0.22
CY14	\$0.00
Total	\$61.29

Notes:

Costs are reported in millions of undiscounted 2023

\$. PFIY 1 is assumed to begin two years from the time of this analysis.

C.3. CONSTRUCTION-RELATED NOISE IMPACTS

Construction of the Delta Conveyance Project is expected to increase noise in the local areas surrounding construction sites. The project will primarily impose noise nuisances during the construction of permanent project features over a period of 12 to 14 years. Heavy equipment noise will occur at project sites, and construction of levee improvements, bridges, and other project developments will also generate localized noise disruptions. A more complete description of expected noise impacts can be found in Chapter 24 of the EIR.

Excess noise is a nuisance to local residents. In addition to quality-of-life impacts, excess noise may incur economic costs if, for example, work from home is disrupted or outdoor recreation businesses are negatively affected. The economic value of this nuisance is challenging to quantify; two individuals may experience different burdens from the same level of noise, and the ultimate noise impact itself can depend on factors such as home insulation. To quantify the overall burden of excess noise on a locality, we depend on an econometric method called hedonic pricing. The hedonic pricing method uses the value of related market goods to estimate the value of non-market goods. More specifically, the hedonic pricing method uses statistical techniques to infer the value of environmental attributes, such as noise levels, by comparing values of properties that have a given

environmental attribute and those that do not. If houses are comparable across characteristics other than the attribute of interest (in this case, noise), then differences in the market price can be attributed to differences across this attribute.

Common sources of disruptive noise levels include roadways, general construction, airports, railroads, and industrial activity. Roadways are not a close comparison point because they primarily impose ambient noise. Typical construction projects may also be an inappropriate comparison point because the longevity of the DCP construction imposes higher costs than would short-term construction projects. While a perfect comparison is elusive, noise from railroad activity is analogous to DCP construction-related noise because both impose irregular noise impacts and are long-term nuisances. For this analysis, we thus rely on hedonic values derived from a study of housing price differences attributable to railroad proximity. Walker (2016) finds a 14% to 18% decline in residential property values in Memphis, Tennessee, if the property is exposed to sixty-five decibels or greater of railroad noise.⁶⁴ The study finds no impact on commercial property values.

Relying on this study, we assume a 14% impact on housing values due to increased noise. We apply this cost metric to average California housing values in both the property and rental markets.⁶⁵ The duration of noise disruption varies by location. Of the seventeen locations discussed in the EIR, five experience disruptions lasting five hours to one week, and an additional three locations are not located near any residences. These eight locations are excluded from the social cost analysis. Of the remaining nine locations, five experience disruptions lasting one month to 3.5 years. For these locations, we apply the cost metric to an estimated average California monthly rental price for the duration of the disruption. For the four locations experiencing nine or more years of disruptions, we apply the cost metric to the full property value.

The results of the analysis are presented in Table C - 7 below. We estimate an undiscounted cost of \$8.7 million in noise impacts. These estimates assume that disruptive noise begins in the first year of construction. Note that the EIR finds that if all eligible property owners participate in the proposed the Noise Control Plan proposed in the EIR, the impacts would be less than significant.

⁶⁴ Walker, Jay. 2016. Silence is Golden: Railroad Noise Pollution and Property Values. In *The Review of Regional Studies*, 45 (2016), 75–89.

⁶⁵ Local housing prices in the affected areas are lower than average California housing values. To conduct a socially equitable analysis, we rely on statewide averages. We assume a home value of \$788,679 and a rental value of \$7,886.79, or 1% of a home's value.

Table C - 7: Social Cost of Project-Related Noise

Location/ Site	Construction Activity	Duration	Number of Residences Daytime	Damages with Local Average House Values (\$ millions, 2023)
Intakes Construction	Pile Driving	42 Months	117	\$3.21
	Nighttime concrete pours	2 Months	147	\$0.19
	Heavy Equipment	12 years	9	\$0.59
Tunnel Shaft Construction	Lower Roberts Island Levee Improvements	1 month	19	\$0.01
	Lower Roberts Island RTM Stockpile	9 years	5	\$0.33
	Upper Jones Tract Maintenance Shaft Buildout	9 years	1	\$0.09
Bethany River Complex Construction	Bethany Reservoir Pumping Plant, Surge Basin and Aqueduct Buildout	13 years	12	\$1.70
	Bethany Reservoir Pumping Plant, Surge Basin and Aqueduct night concrete pours	2 months	0	\$0.07
Bridges, New Access Roads, Road Improvements, and Park-and-Ride Lots	Construction	1.5 months	450	\$0.79
Total				\$6.97

Notes:

Costs are reported in millions of undiscounted 2023\$. The number of residences includes both daytime and nighttime residences. Twin cities complex is shown in this table as there are no adjacent residences that might experience noise impacts.

C.4. CONSTRUCTION-RELATED TRANSPORTATION IMPACTS

This section estimates the costs associated with construction induced traffic delays associated with the construction of the DCP. The costs as estimated based on total time delays estimated in the EIR and U.S. Department of Transportation (DOT) estimates of the opportunity cost of such delays to road users.

The EIR identifies 120 road segments, ranging from local roads to interstate highways, which are likely to be impacted by DCP construction based on the regional and local travel routes of construction workers and estimated truck traffic delivering project materials to and from project features.⁶⁶

⁶⁶ Not all segments would be included in the adopted EIR project. For this project, construction access would not be allowed along SR 160 and River Road or along SR 4 between Old River and Middle River. See DCP, Appendix 20A 20A-1.

For each segment, baseline roadway traffic estimates from 6 AM to 7 PM for 2020 were developed using data collected from 2015 to 2019 and adjusted upward to estimate 2020 traffic absent Covid-19 impacts.⁶⁷ Within a road segment's range of traffic flows, we assume the upper end during rush hour (7AM to 10 AM and 4 PM to 7 PM) and the lower end during non-rush hour periods.

To estimate the economic impact of travel delays resulting from the construction of the Delta Conveyance Project, we first calculate the speed at which vehicles travel on a congested roadway using the following equation (Singh 1999):

$$\text{Congested Speed} = \frac{\text{Free Flow Speed}}{1 + 0.20[(\frac{\text{Volume}}{\text{Capacity}})^{10}]}$$

We assume free flow speed to be the roadway's speed limit. We assume capacity corresponds to a LOS E grade.⁶⁸ We estimate baseline volume using the EIR volume estimates discussed above. Average time to traverse the segment in each hour of the day is estimated using the congested speed and length of the segment.⁶⁹ Finally, the cumulative time spent across drivers on a given segment is calculated using average time to traverse and the total estimated volume of traffic on the segment during that hour.

The EIR identifies two segments that will deteriorate below acceptable LOS standards during morning and evening commute periods because of construction in listed years. For these segments during these hours, the traffic volume increases to the threshold of LOS E. This assumption constitutes an extreme upper bound, as we assign traffic impacts to the entire year, whereas the EIR expects the maximum volume to be reached only one to two weeks per year. To account for traffic increases which do not result in deterioration below LOS acceptable standards, remaining DCP-related trips are assumed to be distributed across road segments proportionally to the share of baseline traffic on each road segment.

Using the distribution of DCP-related trips across segments and hours, we calculate congested speed with project construction and compare this value to that under the baseline scenario to find the increased travel time resulting from the construction of the Delta Conveyance Project.

⁶⁷ DCP, Appendix 20A 20A-16.

⁶⁸ The certified final EIR conducts a level-of-service (LOS) analysis to qualitatively evaluate the level of comfort and convenience associated with driving on a segment at a given time. Segments are assigned a letter grade, wherein LOS A reflects free-flow conditions and LOS F reflects stop-and-go conditions.

⁶⁹ To illustrate, if the congested speed is 60 mph and the segment is 60 miles long, then average time to traverse is one hour. This step implicitly assumes that each vehicle will be on the roadway segment for the entire length of the segment. Although this assumption might result in an overestimation of time spent on congested roadways, data are not available on how long each vehicle remains on each roadway segment. Because most segments are freeways and highways, and the average segment is relatively short (3.07 miles), this assumption is reasonable.

To estimate the economic value of increased local travel time under DCP construction, we rely on an opportunity cost methodology. The opportunity cost of a travel delay is the value of the time lost because of additional time spent in traffic. The value of this time differs depending on what the time would have been used for had it not been spent in traffic. As construction will affect both business and personal travel, the value chosen for the opportunity cost of time spent in traffic is representative of both leisure and work. The total delay time is multiplied by estimates of the opportunity cost of a traveler's time used by DOT to assign a monetary value to delay times in regulatory analyses. DOT develops and periodically updates the value of travel time to be used in analyses of proposed regulations. This value is widely used by transportation agencies to estimate the time burden of proposed regulations, including those promulgated by DOT, the Transportation Security Administration, and the U.S. Coast Guard. DOT's 'all purpose' estimate of the value of time is used in the calculation, which is a weighted average of the value of time for both business and leisure trips based on historical rates of each type of trip. DOT estimates an intercity low value of \$26.52 and a high value of \$35.45.⁷⁰

Using a high and low price for the opportunity cost of time lost in traffic, we develop a range for the total cost associated with the traffic impacts of construction. These results are presented in Table C-8 below. The additional traffic caused by construction incurs an undiscounted social cost of \$78.9 million to \$105.4 million incurred between 2024 and 2035. Annual costs stemming from traffic delays peak during year six of construction and taper off afterward due to discounting and decreased construction activity.

The estimates presented here constitute an upper bound of total transportation costs. 86.5% of the total time lost in traffic because of construction occurs on the five segments which the EIR states will experience LOS E conditions because of the project during morning and evening commute periods. We assume that these segments will experience LOS E conditions on every construction day of the affected years, but segments are likely to only be affected for a few weeks of the year.

⁷⁰ California Department of Transportation. 2016. *Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis*. Values are converted from 2016 dollars to 2023 dollars.

Table C - 8: Costs Associated with Traffic Impacts

Construction Year	Traffic Impact, Day of Construction (hours / day)	Construction Time (days)	Yearly Traffic Impact (hours)	DOT Value of Travel Time Savings (\$ / hour)			Yearly Traffic Impact (\$ millions, 2023)		
				Low	Mid	High	Low	Mid	High
[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]	[J]
1	23.11	325	7,517.66	\$26.52	\$28.47	\$35.45	\$0.20	\$0.21	\$0.27
2	23.11	325	7,517.66	\$26.52	\$28.47	\$35.45	\$0.20	\$0.21	\$0.27
3	115.64	325	37,613.03	\$26.52	\$28.47	\$35.45	\$1.00	\$1.07	\$1.33
4	161.95	325	52,675.62	\$26.52	\$28.47	\$35.45	\$1.40	\$1.50	\$1.87
5	2,394.28	325	778,740.48	\$26.52	\$28.47	\$35.45	\$20.65	\$22.17	\$27.60
6	2,451.04	325	797,200.68	\$26.52	\$28.47	\$35.45	\$21.14	\$22.70	\$28.26
7	2,394.28	325	778,740.48	\$26.52	\$28.47	\$35.45	\$20.65	\$22.17	\$27.60
8	1,348.98	325	438,754.71	\$26.52	\$28.47	\$35.45	\$11.63	\$12.49	\$15.55
9	104.07	325	33,848.93	\$26.52	\$28.47	\$35.45	\$0.90	\$0.96	\$1.20
10	80.93	325	26,322.62	\$26.52	\$28.47	\$35.45	\$0.70	\$0.75	\$0.93
11	23.11	325	7,517.66	\$26.52	\$28.47	\$35.45	\$0.20	\$0.21	\$0.27
12	23.11	325	7,517.66	\$26.52	\$28.47	\$35.45	\$0.20	\$0.21	\$0.27
Total							\$78.86	\$84.67	\$105.42

Sources and Notes:

All Yearly Traffic Impact costs measured in millions of undiscounted 2023 \$.

[A]: From DCP EIR Appendix 20A Figure 20A-11. Vehicle Trips per Day for DCP project alternative.

[B]: From Total Daily Time lost in Traffic by Year for each Impacted Segment.

[C]: From DCP EIR Appendix 20A, p. 30.

[D]: [B] x [C].

[E] – [G]: From Department of Transportation’s 2016 Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis.

[H]: [D] x [E].

[I]: [D] x [F].

[J]: [D] x [G].

[K]: [H] / (1.02 ^ ([A] + 1)).

[L]: [I] / (1.02 ^ ([A] + 1)).

[M]: [J] / (1.02 ^ ([A] + 1)).

C.5. OTHER IMPACTS

The DCP's EIR provides a comprehensive assessment of the impacts of the construction and operation of the project on over twenty different resources. Some of these impacts are identified in the EIR as being less than significant without any mitigation measures.⁷¹ Other resources are identified having impacts from the DCP; however, these impacts are less than significant after the adoption of mitigation measures.⁷² Impacts on the following resources are identified in the EIR as being less than significant after the adoption of mitigation measures.⁷³

The following impacts are identified in the EIR as being significant and unavoidable, however they are not quantified in this report because there are not appropriate economic tools to estimate a monetary value of their impacts:

- Aesthetic and Visual Resources (Chapter 16)
- Cultural Resources (Chapter 19)
- Paleontological Resources (Chapter 29)
- Tribal and Cultural Resources (Chapter 32)

⁷¹ Specifically, these resources and their respective chapters in the EIR are:

Groundwater, Ch.8; Water Quality, Ch.9; Geology and Seismicity, Ch.10; Land Use, Ch.14; Recreation, Ch.16; Public Utilities and Services, Ch.21; Energy, Ch.22; Mineral Resources, Ch.27.

⁷² Groundwater, Ch.8 ; Water Quality, Ch.9; Geology and Seismicity, Ch.10; Land Use, Ch.14; Recreation, Ch.16; Public Utilities and Services, Ch.21; Energy, Ch.22; Mineral Resources, Ch.27.

⁷³ Flood Protection, Ch.7; Soils, Ch.11; Fish and Aquatic Resources, Ch.12; Terrestrial Biological Resources, Ch.13; Hazards, Hazardous Materials, and Wildfire, Ch.25; Public Health, Ch.26.