Appendix 6A

BDCP/California WaterFix Coordination with Flood Management Requirements

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The proposed project does not include a commitment to improve the current levee system except where the project explicitly includes levees in the project construction (see below; for more information on the purpose and need of the proposed project, please see Chapter 2). However, it would provide additional adaptability to catastrophic failure of Delta levees by providing a mechanism to continue making water deliveries to State Water Project (SWP) and Central Valley Project (CVP) contractors and local and in-Delta water users with conveyance interties even if the Delta were temporarily disrupted. The project objectives are listed below:

- Address adverse effects to state and federally listed species related to:
  - The operation of existing SWP Delta facilities and construction and operation of facilities for the movement of water entering the Delta from the Sacramento Valley watershed to the existing SWP and CVP pumping plants located in the southern Delta.
  - The implementations of actions to improve SWP and/or CVP conveyance that have the potential to result in take of species that are listed under the ESA and CESA.
- Improve the ecosystem of the Delta by reducing the adverse effects to certain listed species of diverting water by siting additional intakes of the SWP and coordinated operations with the CVP.
- Restore and protect the ability of the SWP and CVP to deliver up to full contract amounts, when hydrologic conditions result in the availability of sufficient water, consistent with the requirements of state and federal law and the terms and conditions of water delivery contracts and other existing applicable agreements.

Any modifications to Delta levees and the flood control system, as a result of constructing the project, would be fully mitigated and under the responsibility of the project proponents. In some instances, levees modified by the project would be strengthened relative to existing conditions. Levees are an important public safety resource and the proposed project would not change levee policy or replace ongoing programs and grant projects aimed at facilitating and supporting levee improvements in or outside the Delta. It is recognized that levee maintenance and safety in the Delta is an important issue for the residents of the Delta and for statewide interests.

6A.1 Introduction

6A.1.1 Delta Levees

The Delta is an integral part of the Sacramento and San Joaquin Valley River conveyance systems. It receives runoff from 40 percent of the state's land. This system has been extensively modified to redirect and deliver part of the water to meet the needs of two-thirds of the state's population and irrigate millions of acres of farmland. Today, more than 1,100 miles of levees protect the 738,000 acres of Delta islands, tracts and population centers from flooding, as well as protecting a large portion of the state's water supply. The levee systems have allowed farmers to drain and reclaim a large portion of the Delta from its original state as a tidal marsh. These levees prevent flooding and allow cultivation of the rich soil, while protecting towns and cities as well as public infrastructure such as highways, railroads and pipelines. For more information on the current Delta levee system, please see Appendix 1A, *Primer on California Water Delivery System and the Delta*, Section 1A.2.5.

6A.1.2 "Project" versus "Non-Project" levees

Upstream reservoirs, flood bypasses, and levees affect hydrology and flood management in the Central Valley, including the Delta. Nineteen major multipurpose dams, the Sacramento River Flood Control Project (SRFCP), and San Joaquin River flood management facilities reduce flood potential in the Sacramento and San Joaquin Rivers and their tributaries, and the Delta. Levees built or adopted as part of the SRFCP or Lower San Joaquin Flood Control Project are designated as "project levees" and are maintained by state and local maintaining agencies pursuant to authority delegated to them by the federal government. Approximately 1,600 miles of project levees are part of federal flood management projects in the Central Valley, of which 385 miles are in the Delta. The remaining Delta levees maintained by local maintaining agencies are designated as "non-project levees."

Most of the levees in the Delta are non-project levees, comprising 730 of 1,115 miles. In Suisun Marsh, all of the approximately 230 miles of the levees are non-project levees (see Figure 1). These non-project levees are not part of the federal flood management program and are maintained by local maintaining agencies or similar entities (some of whose activities are regulated by Central Valley Flood Protection Board (CVFPB) and none are affiliated with the United States Bureau of Reclamation (Reclamation). Some of the Delta levee maintenance activities are partially reimbursed by the Department of Water Resources (DWR) under the Delta Levee Subventions Program established in 1973. The Delta Flood Protection Act of 1988 significantly increased reimbursement opportunities and added mitigation requirements to ensure no net long-term loss of habitat. Improvement and frequent maintenance of the Delta levees are challenging for the reclamation districts because many districts have limited funds to both maintain the levees and protect levee wildlife habitat (California Department of Water Resources 1995).

Non-project and Project 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 and follows the San Joaquin River past Rough and Ready Island to the Port of Stockton via Stockton Channel. 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 project 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-project levees.

The SRFCP levees in the Delta include levees that protect, or partially protect, the following areas: West Sacramento, City of Sacramento, Walnut Grove, Courtland, Clarksburg, Ryde, Hood, lands between the Sacramento River and the Sacramento River Deep Water Channel (east levee of the Deep Water Ship Channel), Merritt Island, Sutter Island, Grand Island, Ryer Island, Tyler Island, Hastings Tract, Prospect Island, Brannan Island, Twitchell Island, Pierson Tract, and Sherman Island (California Department of Water Resources 1993).

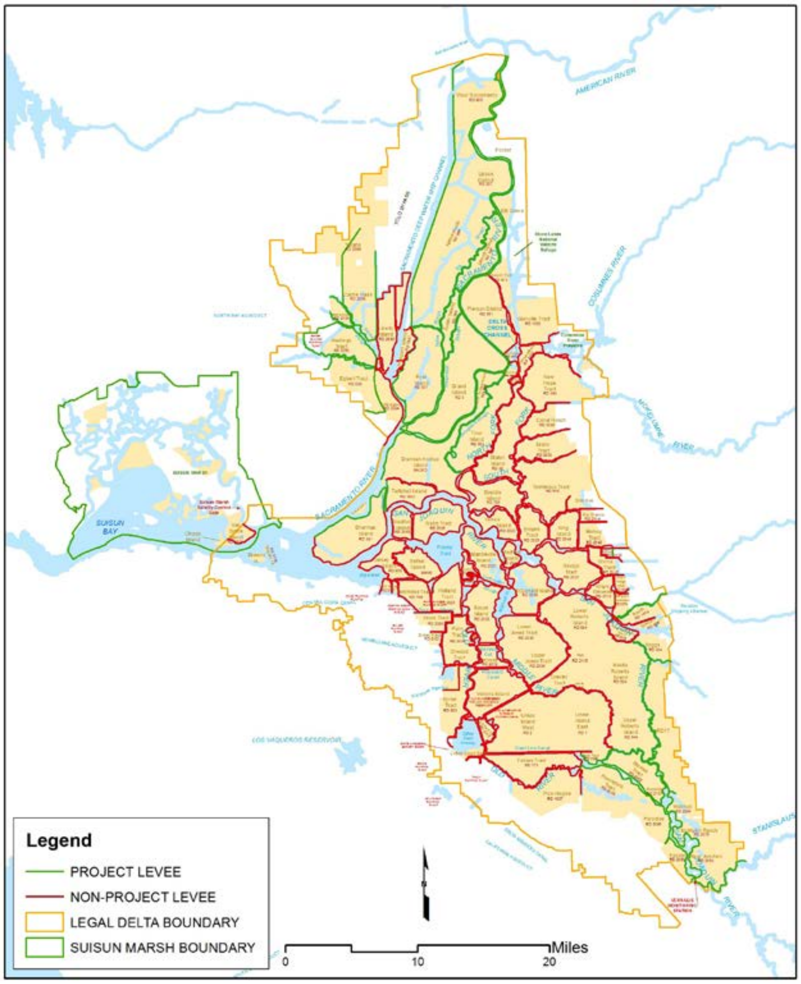

Figure 1 Project and Non-Project Levees in the Legal Delta and Suisun Marsh

6A.2 Guiding Polices and Legislation

This section describes state and federal policies and programs that provide the foundation for flood protection in California, including funding mechanisms towards levees and flood control projects, agencies with jurisdictional and permitting responsibilities for projects that could impact the flood conveyance system, and system-wide approaches to integrate flood and ecosystem protection, among others. Some of these programs also provide assistance towards disaster preparedness and prevention, flood fighting, and emergency response efforts.

6A.2.1 State

6A.2.1.1 Proposition 1E and 84

The Disaster Preparedness and Flood Protection Bond Act of 2006 (Proposition 1E) authorized $4.09 billion in general obligation bonds to repair and improve California's most vulnerable flood control structures to protect homes and prevent loss of life from flood-related disasters, including levee failures, flash floods, and mudslides and to protect California's drinking water supply system by rebuilding delta levees that are vulnerable to earthquakes and storms. This bond funds levee repairs and improvements, upgrades flood protection for urban areas, improves emergency response capabilities, and provides funds for stormwater flood management projects. Proposition 1E funding is directed towards the repair of erosion sites and removing sediment from channels, repairing and improving levees and other facilities of the State Plan of Flood Control (SPFC), and providing environmental mitigation that may become necessary. Funds have also be used for local assistance for levee maintenance and improvement in the Sacramento-San Joaquin Delta, flood control and prevention projects outside of the Central Valley, and for identification of flood risks and protection and enhancement of flood corridors and bypasses.

Proposition 1E provides funding for several flood and levee related DWR programs including the Central Valley Flood Management Planning Program (CVFMP) and Levee Repairs Program. The purpose of the CVFMP is to develop a sustainable, integrated flood management plan for areas protected by facilities of the state-federal flood protection system in the Central Valley. The Levee Repairs Program is addressing deficiencies identified and prioritized in the Levee Evaluation Program. Through these programs, DWR has conducted numerous investigations to determine the most critical sites for repair. Based on these investigations, the most critical levee repairs and erosion sites were identified, and DWR along with the Corps of Engineers went to work repairing the sites, and the work continues today.

The Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006 (Proposition 84) enhances these efforts. Proposition 84 authorizes $5.388 billion in general obligation bonds to water quality and supply projects, water conservation, and natural resource protection efforts, among others. In addition, $800 million is directed towards flood control projects, including the Flood Control Subventions Program, Local Levee Assistance Program, and the Delta Levees System Integrity Program.

6A.2.1.2 Central Valley Flood Protection Act of 2008 and the 2012 Central Valley Flood Protection Plan

The Central Valley Flood Protection Act of 2008 (CVFPA) recognized that improvements to the Central Valley flood protection system are necessary to address increasing flood risks to various flood prone areas throughout the Central Valley. As required by the CVFPA, the state has adopted the *2012 Central Valley Flood Protection Plan (CVFPP)* (SPFC) (California Department of Water Resources 2011). The plan addresses current and future flood risks and recommends an investment approach to improve public safety, ecosystem conditions, and economic sustainability in areas protected by the SPFC. The adoption of the CVFPP, fulfills a legislative mandate outlined in the CVFPA of 2008 to approve the plan by July 1, 2012, and provides conceptual guidance to reduce the risk of flooding for about one million people and $70 billion in infrastructure, homes and businesses with a goal of providing 200-year (1 chance in 200 of flooding in any year) protection to urban areas, and reducing flood risks to small communities and rural agricultural lands.

In preparing the CVFPP, DWR examined a range of potential approaches for improving flood management. The recommended approach—known as the State Systemwide Investment Approach (SSIA)—sets forth a strategy for responsibly meeting the state’s objectives to improve public safety, ecosystem conditions, and economic sustainability, while recognizing the financial challenges facing local, state, and federal governments today. Under this approach, California will prioritize investments in flood risk reduction projects and programs that incorporate ecosystem restoration and multi-benefit projects, without precluding future actions, such as those presented in the

Enhance Flood System Capacity Approach, should additional state and federal funding become available.

The SSIA outlines a sustainable flood management strategy that will support California's vital agricultural economy, maintain agricultural land uses, limit growth in undeveloped floodplains, and provide policies, programs, and incentives to encourage wise long-term floodplain management. The SSIA calls for significant capital investments to strengthen levees that protect existing urban areas and small communities, prioritizing improvements to the 1,600-mile levee system included in the SPFC. The SSIA also will help improve system resiliency in the face of climate change by expanding flood conveyance capacities, coordinating reservoir operations, and restoring floodplains.

DWR will continue to work collaboratively with local, state, and federal agencies, environmental interests, and other parties to develop regional flood management plans (RFMP) and focus investments on expanding flood bypasses to lower flood risks in flood prone areas. In addition, DWR will continue to refine the CVFPP as projects and policies evolve, additional information is gathered, elements are implemented, and funding becomes available.

6A.2.1.3 Central Valley Flood System Conservation Strategy

The Central Valley Flood System Conservation Strategy (CVFSCS) will be considered as an integral part of the CVFPP 2017 Update. It supports the attainment of all CVFPP goals, but focuses on the integration and improvement of ecosystem functions with flood risk reduction projects where feasible. The Strategy describes the basis for recommending various conservation actions and setting long-term objectives for the Central Valley flood management system as a whole. The Strategy and CVFPP (and 2017 Update) as a whole are consistent with and would contribute to several of the ten "key actions" identified in the California Water Action Plan (California Natural Resources Agency, California Department of Food and Agriculture, and California Environmental Protection Agency 2014), in particular: increase flood protection; protect and restore important ecosystems; and increase operational and regulatory efficiency. The purpose of the Strategy is to provide 1) a comprehensive, long-term approach for improving riverine and floodplain ecosystems through multi-benefit projects that provide ecological benefits while protecting public safety; 2) a regional programmatic framework for increasing the predictability and cost-effectiveness of permitting, while resulting in more effective and less costly conservation outcomes; and 3) contextual information and tools for use in planning and permitting processes.

6A.2.1.4 Basin-Wide Feasibility Studies

The CVFPP considered and evaluated three preliminary approaches to flood management for the areas protected by the SPFC. Assessment of these three approaches resulted in formulation of the SSIA. The SSIA is an assembly of the most promising, affordable, reasonable, and balanced elements of the three preliminary approaches. DWR has now initiated Basin-Wide Feasibility Studies (BWFS), along with associated Regional Flood Management Planning and the Conservation Strategy, to advance both ongoing and long-term implementation of the SSIA. DWR's BWFS are refining system improvements identified in the CVFPP, including cross-regional flood management and conservation actions, while considering recommendations from regional plans. Efforts stemming from the 2012 CVFPP, including the BWFS, will continue to focus on the SPFC and lands receiving protection from the SPFC.

6A.2.1.5 FloodSAFE

FloodSAFE is a long-term strategic initiative developed to reduce flood risk in California. It is designed with the recognition that addressing risks of flood damage statewide will take decades. FloodSAFE is also an important component of DWR's Integrated Water Management (IWM) Initiative, which is designed to achieve a sustainable, robust, and resilient flood and water management system for the benefit of all Californians. Using the FloodSAFE framework, flood management improvements will be achieved through the following processes:

- Improve basic flood management functions, including flood emergency response, O&M of flood management facilities, management of floodplains, repair of erosion sites, and implementation of local projects.
- Implement regional projects to reduce flood risks including "early implementation projects" and implementation of USACE projects.
- Implement a system-wide approach in which broad system evaluation is conducted (i.e., map floodplains and evaluate levee conditions throughout the system) to determine flood system deficiencies and define feasible projects/programs to remedy system deficiencies by developing a comprehensive system-wide flood protection plan for the Central Valley (i.e., CVFPP).

6A.2.1.6 Regional Flood Management Planning

To document site-specific flood system improvement needs and to involve local agencies in developing local investment strategies, the state has been working with local entities and engaging other interested stakeholders to define local flood system improvements that support the SSIA. The regional plans will be prepared with participation of local maintaining agencies, regional flood management agencies, counties and cities within the region, and agricultural and environmental interests. DWR will participate in the planning process, will provide any available information, and may provide financial assistance for preparing the regional plans, if funds are available.

Development of RFMP and formulation of specific capital improvement projects will continue after completion of the 2012 CVFPP. This plan development process will coordinate with other overlapping planning efforts by identifying common goals and pursuing opportunities to collaborate and reduce potential conflicts with these other efforts. The information gathered for the RFMP will be used to help develop of the state BWFS scheduled for completion by 2017.

6A.2.1.7 Delta Protection Act of 1992

The Delta Protection Act of 1992 created the Delta Protection Commission and declared that a primary goal of the state for the Delta is, among other findings, to improve flood protection by structural and nonstructural means to ensure an increased level of public health and safety. Section 29704 of the Delta Protection Act focuses on the Delta levee system. The section recognizes that some of the Delta islands are flood-prone, and that improvement and ongoing maintenance of the levee system is very important to protect farmlands, population centers, the state's water quality, and significant natural resource and habitat areas of the Delta. Section 29704 also notes that most of the existing levee systems are degraded and in need of restoration, improvement, and continuing management. Other sections include goals pertaining to the quality of the Delta environment (agriculture, wildlife habitat, and recreational activities) and the balanced conservation and development of Delta land resources.

6A.2.1.8 California Water Action Plan

The California Water Action Plan (Action Plan) lays out challenges, goals and decisive actions needed to put California's water resources on a safer, more sustainable path. This Action Plan will serve to coordinate and streamline flood control efforts and result in multi-benefit flood projects, helping to mitigate the significant investments needed to improve flood protection for existing communities and infrastructure. Actions to increase flood protection in the Action Plan include:

- Streamline and Consolidate Permitting
- Create a Delta Levee Assessment District
- Improve Access to Emergency Funds
- Better Coordinate Flood Response Operations
- Prioritize Funding to Reduce Flood Risk and Improve Flood Response
- Identify State Funding Priorities for Delta Levees
- Encourage Flood Projects That Plan for Climate Change and Achieve Multiple Benefits

6A.2.2 Federal

6A.2.2.1 Federal Emergency Management Agency

The Federal Emergency Management Agency (FEMA) is responsible for maintaining minimum federal standards for floodplain management within the United States and territories of the United States. As discussed below, FEMA plays a major role in managing and regulating floodplains. FEMA is responsible for management of floodplain areas, which are defined as the lowland and relatively flat areas adjoining inland and coastal waters subject to a 1% or greater chance of flooding in any given year (the 100-year floodplain).

The FEMA 100-year protection standard, often called the 1% annual chance flood level of protection, is based on criteria established in the Code of Federal Regulations and is often used with established USACE (U.S. Army Corps of Engineers) criteria to meet certain freeboard, slope stability, seepage/under seepage, erosion, and settlement requirements. Numerical hydrologic models are used to project surface water elevations at different locations in the rivers for the statistically probable 100-year flood event. Model runs are updated periodically to reflect changes in river bathymetry and historical hydrology. Meeting this level of flood protection means that communities will not require mandatory purchase of flood insurance for houses in the floodplain or be subject to building restrictions. This standard generally does not address seismic stability. Currently, FEMA 100-year criteria are based on historical conditions and do not include considerations for climate change or sea level rise. FEMA is currently completing a study on the Impact of Climate Change on the National Flood Insurance Program (Federal Emergency Management Agency 2010) to determine how to accommodate these factors and the long-term implications.

6A.2.2.2 USACE Vegetation Policy

The USACE vegetation policy provides guidelines to assure that landscape planting and vegetation management provide aesthetic and environmental benefits without compromising the reliability of levees, floodwalls, embankment dams, and appurtenant structures. A design that integrates landscape plantings and vegetation management into a system for flood damage reduction requires a coordinated, interdisciplinary effort that involves the local sponsor and multiple disciplines. The policy states that where the safety of the structure is not compromised, and effective surveillance, monitoring, inspection, maintenance, and flood-fighting of the facility are not adversely impacted, appropriate landscape planting (trees, shrubs, vines, forbs, and grasses) may be incorporated into the design of all flood damage reduction projects, subject to the limitations in the vegetation policy guidelines. Landscape planning design should also consider both human use and the environmental processes and characteristics of the entire area influenced by the project. As a result of the Water Resources Development Act of 2014, the USACE is reconsidering its vegetation policy.

6A.2.2.3 USACE Permitting

The following sections provide an overview of USACE's regulatory responsibilities that apply to navigable waters and construction within the ordinary high water mark of other waters of the United States.

6A.2.2.3.1 Flood Control Act of 1936

The Flood Control Act of 1936 established a nationwide policy that flood management on navigable waters or their tributaries is in the interest of the general public welfare and is, therefore, a proper activity of the federal government in cooperation with states and local entities. The 1936 Act, its amendments, and subsequent legislation specify details of federal participation. Projects are either specifically authorized through legislation by Congress or through a small projects blanket authority. Typically, a feasibility study is done to determine federal interest before authorization or construction. USACE has a Delta feasibility study underway. A study under the American River Common Features authority is studying additional flood protection for the City of Sacramento that could involve alteration to Sacramento River levees or the Yolo Bypass in the Delta. The planned Lower San Joaquin River Feasibility Study will evaluate more flood protection for the City of Stockton and vicinity. The West Sacramento Feasibility Study is evaluating flood protection for the City of West Sacramento. USACE constructs local flood and risk management projects and navigation projects in the Delta. The USACE is also engaged in design and construction of South Sacramento Streams which is also partially in the Legal Delta boundary.

6A.2.2.3.2 The Clean Water Act

The Clean Water Act established the basic structure for regulating discharges of pollutants into waters of the United States and gave the U.S. Environmental Protection Agency the authority to implement pollution control programs such as setting wastewater standards for industry. The Clean Water Act sets water quality standards for all contaminants in surface waters and allows the U.S. Environmental Protection Agency to delegate some of its authority for enforcing such standards to states (the California State Water Resources Control Board, and associated Regional Boards, is the agency that helps enforce water quality standards in California).

Section 404 of the Clean Water Act regulates the discharge of dredged and fill material into waters of the United States, including wetlands. Activities in waters of the United States that are regulated under this program include fills for development, water resource projects (e.g., dams and levees), infrastructure development (e.g., highways and airports), and conversion of wetlands to uplands for farming and forestry. USACE has jurisdiction over all waters of the United States including, but not limited to, perennial and intermittent streams, lakes, ponds, as well as wetlands and marshes, wet meadows, and side hill seeps. Clean Water Act Section 404(b)(1) guidelines provide environmental criteria and other guidance used in evaluating proposed discharges of dredged materials into waters of the United States. For proposed discharges of dredged or fill material to comply with the guidelines, they must satisfy four requirements found in Section 230.10. Among these requirements are that those discharges of dredged or fill material do not result in significant degradation of the aquatic ecosystem and that all practicable means be used to minimize adverse environmental impacts.

Under Section 401 of the Clean Water Act, every applicant for a federal permit or license for any activity that may result in a discharge to a water body must obtain state certification that the proposed activity will comply with state water quality standards, typically from the Regional Water Quality Control Board.

6A.2.2.3.3 Rivers and Harbors Act of 1899

33 United States Code 408 (Section 14 of the Rivers and Harbors Act of 1899 [RHA]) provide that the Secretary of the Army, on the recommendation of the Chief of Engineers, may grant permission for the temporary occupation or use of any sea wall, bulkhead, jetty, dike, levee, wharf, pier, or other work built by the United States. This permission will be granted by an appropriate real estate instrument in accordance with existing real estate regulations. This provision is used by USACE as the legal authority to require permission to modify federal project levees or other federal flood control facilities.

Sections 9 and 10 of RHA authorize USACE to regulate the construction of any structure or work over, under, or within navigable waters. The RHA authorizes USACE to regulate the construction of infrastructure such as wharves, breakwaters, or jetties; bank protection or stabilization projects; permanent mooring structures, or marinas; intake or outfall pipes; canals; boat ramps; aids to navigation; or other modifications affecting the course, location condition, or capacity of navigable waters.

6A.2.3 Role of the Central Valley Flood Protection Board

The CVFPB, previously known as the Reclamation Board, was created in 1911. The CVFPB has jurisdiction throughout the Sacramento and San Joaquin valleys, which is synonymous with the drainage basins of the Central Valley, and includes the Sacramento-San Joaquin Drainage District.

The CVFPB's mission is:

- To control flooding along the Sacramento and San Joaquin rivers and their tributaries in cooperation with the USACE.
- To cooperate with various agencies of the federal, state, and local governments in establishing, planning, constructing, operating, and maintaining flood management works.
- To maintain the integrity of the existing flood management system and designated floodways through its regulatory authority by issuing permits for encroachments.

The CVFPB is a major partner for federal flood management works in the Central Valley. The CVFPB shares costs with the federal government and the local districts and provides land easements and rights-of-way for federal projects. The CVFPB assumes responsibility for operation and maintenance for a completed project only after a local maintenance agency has agreed to assume ultimate responsibility for the operation and maintenance.

The CVFPB issues encroachment permits for projects that the CVFPB determines will not interfere with the integrity of the flood control system. Projects as small as installing a boat dock or a fence near a levee must obtain an encroachment permit. The CVFPB also approves or denies plans for reclamation, dredging, or improvements that alter any project levee. It has authority to approve or deny any plan (related to public works) or flood protection that involves excavation near rivers and tributaries, and has legal responsibility for oversight of the entire Central Valley flood management system.

The CVFPB also adopts floodway boundaries and approves uses within those floodways. The purpose of the designated floodway program is to control encroachments and development within the floodways and to preserve floodways to protect lives and property. Various uses are permitted in the floodways, such as agriculture, canals, low dikes and berms, parks and parkways, golf courses, sand and gravel mining, structures that will not be used for human habitation, and other facilities and activities that will not be substantially damaged by the base flood event and will not cause adverse hydraulic impacts that will raise the water surface in the floodway. A permit from CVFPB is required for most activities other than normal agricultural practices within the boundaries of designated floodways.

California Water Code Section 8500 et. seq. outline the authority and responsibilities of the CVFPB. The CVFPB's regulations are published in Title 23 of the California Code of Regulations and explain the CVFPB's processes and standards. The regulations are comprehensive and include topics such as standards for construction, the permitting process, and the enforcement action process.

The CVFPB exercises jurisdiction over the levee section, the waterward area between project levees, a minimum 10-foot-wide strip adjacent to the landward levee toe, within 30 feet of the top of the banks of unleveed project channels, and within designated floodways adopted by the Board. Activities outside of these limits that could adversely affect the flood control project are also under CVFPB jurisdiction. Such activities include the following that may:

1. Jeopardize directly or indirectly the physical integrity of levees or other works;
2. Obstruct, divert, redirect, or raise the surface level of design floods or flows, or the lesser flows for which protection is provided;
3. Cause significant adverse changes in water velocity or flow regimen;
4. Impair the inspection of floodways or project works;
5. Interfere with the maintenance of floodways or project works;
6. Interfere with the ability to engage in flood fighting, patrolling, or other flood emergency activities;
7. Increase the damaging effects of flood flows;
8. Be injurious to, or interfere with, the successful execution, functioning, or operation of any adopted plan of flood control; or
9. Adversely affect the SPFC, as defined in the Water Code (California Code or Regulations, Title 23, Waters. Division 1).

6A.3 State of Flood Control in the Delta

6A.3.1 Breakdown of State Plan of Flood Control vs. Non-Project Levees in the Delta

The CVFPP describes over 80 potential flood management actions that could be undertaken to address the SRFCP facilities and other flood facilities in the Central Valley. The plan indicates that about 50% of the 300 miles of urban levees evaluated do not meet engineering design criteria for projected design water surface elevations based on criteria published in *Design and Construction of Levees Engineering Manual 1110-2-1913* (U.S. Army Corps of Engineers 2000) and *Interim Levee Design Criteria for Urban and Urbanizing Areas in the Sacramento Valley, Version 4* (California Department of Water Resources 2010b). The plan also indicates that about 60% of the 1,230 miles of non-urban levees have a high potential for failure at the projected design water surface elevations, based upon an analysis that correlated geotechnical data with levee performance history, but not relative to specific design criteria. The plan further notes that about 50% of the 1,016 miles of channels evaluated had potentially inadequate capacity to convey design flows; none of the 32 hydraulic structures and 11 pumping plants inspected were rated “unacceptable,” but many were approaching the end of their design life; and 2 of the 10 bridges that were inspected required repairs (California Department of Water Resources 2011). This analysis only applies to the project levees in the Delta.

The SPFC is only a portion of the larger system that provides flood protection for the Central Valley. In addition, the state and federal governments have invested in California flood protection projects outside of the Central Valley. The SPFC relies on many other features that do not technically meet the definition of the SPFC. For example, non-SPFC reservoirs provide substantial regulation of flows to levels that SPFC facilities can mostly handle – without these reservoirs, flows could overwhelm SPFC facilities frequently. In addition, private levees, locally operated drainage systems, and other state, federal, and local facilities work in conjunction with SPFC facilities. Management practices such as emergency response, floodplain management, and other practices are part of the overall flood protection system. All parts of the system, including the SPFC and other facilities and management practices, depend on all parts of the system to operate as a unit.

As described above, a majority of the levees protecting the Delta (approximately 65 percent) are not within the federal-state Sacramento Flood Control Project system and are constructed and maintained by island landowners or local reclamation districts. These levees are generally built to an agricultural standard and may be somewhat less stable than those constructed and maintained to protect urban areas. Improvement and maintenance of these “non-project” levees can be very challenging. The natural peat deposits that made the Delta such a fertile farming location make poor building materials for levees and/or their foundations. Oxidization of these peat soils has led to island and levee subsidence, which has increased the burden on the levee system. Another way that the Delta levees are distinguished from levees along rivers such as the Sacramento is that they are constantly exposed to water, making them more comparable to dams. However, unlike dams, they are not constructed or regulated to the same high engineering standards. Delta levees need to withstand the daily cycle of tides, wind and boat wakes. Levees in the west Delta receive the strongest impact from tidal influences; soils there are the least stable and most susceptible to consolidation, under seepage, through seepage, and liquefaction. Burrowing animals further threaten levees, because they can weaken levees before they are detected.

6A.3.2 Existing Levee Funding and Monitoring Programs

6A.3.2.1 Proposition 1E and 84

See discussion above on Propositions 1E and 84.

6A.3.2.2 Proposition 1

In addition to Proposition 1E and 84, Proposition 1 (Water Bond), approved in 2014, enacted the Water Quality, Supply, and Infrastructure Improvement Act of 2014. The Water Bond focuses on water quality improvement programs, water conservation and recycling, water storage projects, and ecosystem protection and restoration, among others. The Water Bond also includes funding towards statewide flood management projects. Flood management agencies, including the Central Valley Flood Management Board, will have the opportunity to use Proposition 1 funds towards eligible flood control projects in the future.

6A.3.2.3 Delta Levees Flood Protection Program

The Delta Levees Office of DWR administers the Delta Flood Protection Program as authorized by the California Water Code, Sections 12300–12318 and 12980–12995. This is a financial assistance program that works with more than 60 reclamation districts in the Delta and Suisun Marsh to maintain and improve the flood control system and provide protection to public and private investments in the Delta including water supply, habitat, and wildlife. The program, through its two major components (Delta Levees Maintenance Subventions Program and Delta Levees Special Flood Control Projects), works with the local agencies to maintain, plan, and complete levee rehabilitation projects.

6A.3.2.3.1 Delta Levees Maintenance Subvention Program

The Delta Levees Maintenance Subvention Program is a state cost-sharing program in which participating local levee maintaining agencies receive funds for the maintenance and rehabilitation of eligible Project and non-project levees in the Delta. The program's goal is to reduce the risk to water supply, infrastructure, and ecosystem from catastrophic breaching of Delta levees

There is a statewide interest in levee maintenance in the Delta because the islands' levees maintain flow velocities in the sloughs and channels that combat saltwater intrusion. The program is authorized in the Water Code, Sections 12300–12315 and 12980–12995. In 1988, with the passage of the Delta Flood Protection Act, financial assistance was increased through the Delta Levees Subvention Program. The intent of the program is key to preserving the Delta physical characteristics of levees defining the waterways and producing the adjacent islands. Thus, funds necessary to maintain and improve the Delta's levees to protect the physical characteristics should be used. As of 2015, the subventions program has reimbursed more than $175 million of eligible levee maintenance and rehabilitation work. More information on the Delta Levees Maintenance Subventions Program is available:
http://www.water.ca.gov/floodsafe/fessro/deltalevees/subventions/.

6A.3.2.3.2 Delta Levees Special Flood Projects Program

The Delta Levees Special Flood Control Projects provides financial assistance to local maintaining agencies for levee rehabilitation in the Delta. The program was established by the California

Legislature under SB 34 in 1988. Since the inception of the program, more than $200 million has been provided to local agencies in the Delta for flood management and related habitat projects. For example, some levees were raised above the 1-% annual chance water surface elevations, such as on Webb Tract, Bouldin Island, Empire Tract, King Island, Ringe Tract, and Canal Ranch (California Central Valley Flood Control Association 2011).

6A.3.2.4 Early Implementation Program

The Flood Projects Office administered the Early Implementation Program (EIP), which was created as a result of the passage of Proposition 1E and Proposition 84. These Propositions authorized the DWR to make funds available to Local Agencies for, among other things, flood protection work. These funds have been used for repair, rehabilitation, reconstruction or replacement of levees, weirs, bypasses and facilities of the SPFC. This program applies only to certain portions of the Central Valley and certain adjacent areas. $3,000,000,000 has been made available for projects under this program.

6A.3.2.5 USACE Delta Levee Funding

The Water Supply, Reliability, and Environmental Improvement Act of 2004 (Public Law 108-361) authorizes the USACE to design and construct levee stability projects for purposes such as flood damage reduction, ecosystem restoration, water supply, water conveyance, and water quality objectives as outlined in the CALFED Bay-Delta Program, Programmatic Record of Decision (CALFED ROD) (CALFED Bay-Delta Program 2000). Furthermore, Section 103(f)(3)(B) of this Act authorizes the USACE to undertake the eight following activities.

- Reconstruct Delta levees to a base level of protection (also known as the ‘‘Public Law 84-99 standard’’).
- Enhance the stability of levees that have particular importance in the system through the Delta Levee Special Improvement Projects Program.
- Develop best management practices to control and reverse land subsidence on Delta islands
- Develop a Delta Levee Emergency Management and Response Plan that will enhance the ability of federal, state, and local agencies to rapidly respond to levee emergencies.
- Develop a Delta Risk Management Strategy after assessing the consequences of Delta levee failure from floods, seepage, subsidence, and earthquakes.
- Reconstruct Delta levees using, to the maximum extent practicable, dredged materials from the Sacramento River, the San Joaquin River, and the San Francisco Bay.
- Coordinate Delta levee projects with flood management, ecosystem restoration, and levee protection projects of the lower San Joaquin River and lower Mokelumne River floodway improvements and other projects under the Sacramento-San Joaquin Comprehensive Study.
- Evaluate and, if appropriate, rehabilitate the Suisun Marsh levees.

The Act directed the USACE to identify and prioritize levee stability projects that could be carried out with federal funds. An initial amount of $90 million was authorized, with another $106 million authorized in the 2007 Water Resources Development Act of 2007. The USACE initially solicited proposals for various levee improvement projects and received 68 project proposals totaling more than $1 billion. In the short-term, the USACE plans to proceed with implementation of high-priority improvements that can be constructed with the limited funds appropriated to date.

The USACE also is proceeding with a Delta Islands and Levees Feasibility Study to develop long-term plans for flood-risk management, water quality, water supply, and ecosystem restoration. In addition, the USACE is working on a Lower San Joaquin Feasibility Study to determine whether there is a federal interest in providing flood risk management and ecosystem restoration on the lower San Joaquin River.

6A.3.2.6 Delta Plan

Required by the 2009 Delta Reform Act, the Delta Plan is a comprehensive, long-term management plan for the Delta, which will create new rules and recommendations to further the state's coequal goals of improving statewide water supply reliability and protecting and restoring the Delta ecosystem. Included in the Delta Plan are policies and recommendations to reduce flood risk and improve flood protection in the Delta. Policy RR P1, *Prioritization of State Investments in Delta Levees and Risk Reduction* covers any proposed action that involves discretionary state investments in Delta flood risk management, including levee funding. The Delta Stewardship Council, in consultation with DWR, the CVFPB, and the California Water Commission, developed priorities for interim funding that include emergency preparedness, response, and recovery, as well as Delta levees funding. This policy prioritizes localized flood protection for existing urban areas; protecting water quality and water supply conveyance in the Delta; and protecting existing and providing for a net increase in habitat.

6A.4 Emergency Response

6A.4.1 Potential for Abrupt Disruptions in Water Supply

The construction of levees in the Delta began about 150 years ago. Delta levees are vulnerable to failure because they continuously hold back water and most were built with soils dredged from nearby channels and were not subject to modern engineering standards. Because the land on many Delta islands is currently 25 feet or more below sea level, deep flooding could occur at any time due to a levee failure event. Such an event could degrade the quality and disrupt the availability of Delta water (California Department of Water Resources 2012).

According to the Delta Risk Management Strategy (DRMS), Phase 1: Risk Analysis (URS Corporation and Benjamin & Associates 2008b), the risk of levee failure in the Delta is significant. Since 1900, 158 levee failures have occurred (URS Corporation and Benjamin & Associates 2009). Some islands with restricted levees have been flooded and recovered multiple times. A few islands, such as Franks Tract, have never been recovered.

Levee failures may be isolated events that affect only a single island, or they may involve multiple islands at the same time. The potential for a single-island event to affect conveyance depends on the location of the island, the conditions in the Delta, and timing of the event. The failure of an island located along current conveyance routes (e.g., Old and Middle rivers) could have a much greater effect on Delta water exports than a failure at some other locations. In addition, because the operation of the export pumps varies over the course of a year, the effects of a single-island levee failure event on conveyance would vary from no effect to disruption of pumping for several days or weeks, according to the time of year at which it occurred.

Sea-level rise could result in an increased risk of levee failure if the levees are not maintained and improved to accommodate the additional load. However, the state has programs and partners in the local agencies to support necessary levee improvements to minimize any increase in risk. It will be important to continue supporting these programs and to provide funds for the improvement of the levees in order to minimize the potential for inundation of the Delta islands. Without the programs and funding, the potential effects on Delta water supplies could be very significant.

Various analyses have been undertaken to understand the risk and probability of a more widespread levee failure event, and to determine the potential impact to conveyance of water across the Delta. This included DRMS, an action envisioned by the CALFED ROD in 2000, which provided data to meet the requirements of Assembly Bill (AB) 1200 (California Department of Water Resources and California Department of Fish and Game 2008). Adopted by the legislature in 2005, AB 1200 amended the California Water Code to require that DWR conduct an analysis of the potential for impacts on Delta water supplies from subsidence, earthquakes, floods, and changes in precipitation, temperature, and ocean levels. For further discussion on seismic risks and climate change see Appendix 3E, *Potential Seismic and Climate Change Risks to SWP/CVP Water Supplies*.

Appendix 5B, *Responses to Reduced South of Delta Water Supplies*, discusses the potential responses of urban and agricultural water users to abrupt disruptions in Delta water supplies. As discussed more fully therein, urban water user responses could include increased reliance on reservoir storage, expanded groundwater reliance, increased water transfers from agricultural uses to urban uses, increased use of recycled water, and water use restrictions. Responses from agricultural water users could include increased reliance on reservoir storage, expanded groundwater reliance, and water conservation measures.

6A.4.1.1 Examples of Levee Failures in the Project Area

Levee failure can result from many causes, including the combination of high river inflows, high tide, and high winds, or seismic events. Levees can also fail in fair weather—even in the absence of a flood or seismic event—in a so-called “sunny day event.” Damage caused by rodents, piping (in which a pipe-like opening develops below the base of the levee), or foundation movement can cause sunny-day levee breaches (California Department of Water Resources 2012).

A breach of one or more levees and the associated island flooding could affect Delta water quality, and SWP and CVP operations. Depending on the hydrology and the size and locations of the breaches and flooded islands, salt water may be pulled into the interior Delta from Suisun and San Pablo bays. When certain islands are flooded, Delta exports may need to drastically decrease or even cease to avoid drawing saline water toward the Banks and Jones pumping plants.

Although the condition of the Delta levees is improving due to the investment of state funds, the failure of an individual levee could happen at any time because the Delta islands are below sea level. Such a sunny day failure occurred in 2004 on Middle River, which flooded Upper and Lower Jones Tract, inundating 12,000 acres of farmland with about 160,000 acre feet (AF) of water. Following the levee break, Delta export pumping was curtailed for several days to prevent the intrusion of saline water into the Delta. Water shipments down the California Aqueduct were continued through unscheduled releases from San Luis Reservoir. Also, Shasta and Oroville reservoir releases were increased to provide for salinity control in the Delta (URS Corporation and Benjamin & Associates

2008a). After the Jones Tract levee failure occurred, Governor Schwarzenegger declared a state of emergency for San Joaquin County. The declaration allowed state funds to be used for repairing the breach. DWR assisted in the emergency response. The total cost of island and damage recovery was nearly $90 million (California Department of Water Resources 2008).

6A.4.2 Role of the State

6A.4.2.1 DWR Division of Flood Management

DWR established the Division of Flood Management in November 1977, though flood forecasting and flood operations have been integral functions of the Department and its preceding agencies for about a century. The Department itself was created following severe flooding across Northern California in December 1955.

Today, the functions of statewide flood forecasting, flood operations, and other key flood emergency response activities are the primary missions of the Division's Hydrology and Flood Operations Office. Other components of the Division include the Delta Levees Office, the Flood Projects Office, the Levee Repairs and Floodplain Management Office, and the Flood Maintenance Office.

The Division of Flood Management, among several others, is carrying out the work of the Department's FloodSafe California Program which partners with local, regional, state, tribal, and federal officials in creating sustainable, integrated flood management and emergency response systems throughout California.

6A.4.2.2 Flood Emergency Response Program

DWR is the lead state agency for flood emergency response, including flood fight assistance, in California. The Flood Operations Center serves as DWR's Emergency Operations Center and leads the flood emergency operations response. While the California Emergency Services Act reaffirms the authority of the Governor's Office of Emergency Services to "coordinate and supervise State action upon a declaration of a State emergency," California Water Code Section 128(a) describes DWR's separate, permissive authority.

The California Emergency Services Act, specifically Government Code Section 8607, provides DWR with broad authority to fully participate in all aspects of emergency response within the Standardized Emergency Management System structure.

The Hydrology and Flood Operations Office has developed the following two projects under the Flood Emergency Response Program (an element of the FloodSAFE Program):

- Updated Hydrology with Climate Change and System Re-Operation
- Delta Flood Preparedness, Response, and Recovery

Emergency preparedness and response is primarily a local responsibility, although state assistance is available after local entities have reached their capacity to respond. The federal government may also have an interest due to public safety, environmental and socioeconomic concerns.

In the past several years, DWR, USACE, the Delta Protection Commission, and local agencies have worked to improve the response to an in-Delta flood emergency, such as a levee failure. As a result, DWR and local agencies are better prepared to respond effectively through improved planning and coordination and the stockpiling of materials. Thus, in the event of a threatened levee breach, local agencies will respond immediately and will notify the County Office of Emergency Services and DWR Flood Center of an event. If needed, additional supplies and support are available.

6A.4.2.3 Delta Flood Emergency Preparedness, Response and Recovery Program

The Delta Flood Emergency Preparedness, Response and Recovery Program (Delta ER Program) was established under Proposition 1E, which made $135 million available to DWR for essential emergency preparedness supplies and projects. The Legislature recognized the vital role that the Delta plays in California's water supply and the effects that a major flood event could have on that supply.

The objectives of the program are to:

- Protect the lives, property, and infrastructure critical to the functioning of both the Sacramento-San Joaquin Delta and California.
- Protect water quality and restore water supply for both Delta and export water users.
- Reduce the recovery time of California's water supply from catastrophic flood to less than six months.
- Minimize impacts on environmental resources.

Table 6A-1 identifies agencies are involved in developing the Delta ER Program components: 1) Analysis and evaluation tools; 2) Informative studies; 3) Emergency response facilities; and 4) The DWR-wide Delta Emergency action plan:

Table 6A-1. Agencies Involved in the Delta Flood Emergency Preparedness, Response and Recovery Program

Local and Regional Stakeholders	State	Federal
Five County Operation Area Managers	California Emergency Management Agency	U.S. Army Corps of Engineers
Local Reclamation Districts and Levee Districts	Central Valley Flood Protection Board	California-Nevada River Forecast Center
State Water Contractors, Public Utilities	Delta Stewardship Council	National Oceanic and Atmospheric Administration
Delta Protection Commission	California Coast Guard	Federal Emergency Management Agency
	State Parks and Recreation	Bureau of Reclamation

6A.4.2.4 FloodSAFE

As part of FloodSAFE, DWR has initiated a robust flood emergency response program to reduce the consequences of flooding when it occurs. The components of the flood emergency response include working with local emergency response agencies to improve planning, preparedness, readiness, and response to flood emergencies.

DWR has initiated work with local agencies to improve flood emergency preparedness and response throughout California. An important component of the flood emergency preparedness and response are Local Flood Emergency Preparedness and Response Programs. Guidelines have been prepared to provide the framework for supporting local agency activities who are working with DWR and other agencies in improving flood emergency preparedness and response within their jurisdictions.

6A.4.3 Federal Assistance

6A.4.3.1 FEMA

FEMA coordinates the federal government's role in preparing for, preventing, mitigating the effects of, responding to, and recovering from all domestic disasters, whether natural or man-made. Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-707, signed into law November 23, 1988; amended the Disaster Relief Act of 1974, Public Law 93-288. It created the system in place today by which a presidential disaster declaration of an emergency triggers financial and physical assistance through FEMA. The Act gives FEMA the responsibility for coordinating government-wide relief efforts. It is designed to bring an orderly and systemic means of federal natural disaster assistance for state and local governments in carrying out their responsibilities to aid citizens. Congress' intention was to encourage states and localities to develop comprehensive disaster preparedness plans, prepare for better intergovernmental coordination in the face of a disaster, encourage the use of insurance coverage, and provide federal assistance programs for losses due to a disaster.

6A.4.3.2 Emergency Flood Control Funds Act of 1955

In addition to regulatory activities, USACE has a number of projects and functions that can potentially affect activities in the Delta. The Emergency Flood Control Fund Act, Public Law 84-99, authorizes emergency funding and response for levee repairs and flood preparation. USACE can provide flood fighting readiness within hours; however, this action is supplemental to services provided by local reclamation districts and state agencies. USACE and DWR have a working relationship through a memorandum of understanding originally drafted in 1955 and amended since then (U.S. Army Corps of Engineers 2005).

6A.4.4 Levee Standards and Criteria

6A.4.4.1 Flood Control and Coastal Emergency Act (PL 84-99)

USACE also has authority under PL 84-99, Flood Control and Coastal Emergencies (FCCE) (33 U.S.C. 701n) (69 Stat. 186) for emergency management activities. Under PL 84-99, the Chief of Engineers, acting for the Secretary of the Army, is authorized to undertake activities including disaster preparedness, Advance Measures, emergency operations (Flood Response and Post Flood Response), rehabilitation of flood control works threatened or destroyed by flood, protection or repair of federally authorized shore protective works threatened or damaged by coastal storm, and provisions of emergency water due to drought or contaminated source.

To be eligible to enter the Rehabilitation and Inspection Program, agricultural levees (those protecting predominantly agricultural areas or agribusinesses) must be built to provide at least a 5-year level of protection. Urban levees (those protecting land with residences, public or commercial buildings, industrial facilities, etc.) must provide at least a 10-year level of protection. Drainage channels that were designed and constructed for flood control are required to have capacity for a 10 year flood event and must additionally provide drainage to an area 1.5 square miles or greater and have a drainage capacity greater than 800 cfs.

6A.4.4.2 Hazard Mitigation Plan Criteria

The State of California Multi-Hazard Mitigation Plan, also known as the State Hazard Mitigation Plan (SHMP), represents the state's primary hazard mitigation guidance document, and provides an updated and comprehensive description of California's historical and current hazard analysis, mitigation strategies, goals and objectives. More importantly, the SHMP reflects the state's commitment to reduce or eliminate potential risks and impacts of natural and human-caused disasters in keeping our families, homes and communities better prepared and more disaster resilient.

The State Flood Hazard Mitigation Plan was developed through a multi-agency collaborative effort that involved all levels of government, the private sector, and other stakeholders. The plan identifies high flood hazard areas and outlines mitigation strategies to address flood risk. FEMA initially approved the plan in 1996 on the condition that the state complete community profiles and state agency capability assessments. These two additional sections were approved by FEMA in 1997. Elements of the plan were updated through the FloodSAFE California initiative and other recently initiated Delta area levee retrofit programs (Governor's Office of Emergency Services 2013).

For agricultural levees, the short-term mitigation plan cited in Water Code Section 12984(a) and set forth in the Flood Hazard Mitigation Plan for the Sacramento-San Joaquin Delta, prepared by the Department of Water Resources for the Office of Emergency Services, dated September 15, 1983, or as amended, contains levee criteria that include the following:

(1) Minimum freeboard of 1 foot above the 100-year flood frequency elevations determined by the Corps of Engineers.

(2) Minimum crown width of 16 feet with an all-weather access road.

(3) Waterside slopes no steeper than 1.5 horizontal to 1 vertical, with revetment in areas where erosion has been a problem. The size of the revetment material to be appropriate for the slope.

(4) Landside slopes no steeper than 2 horizontal to 1 vertical, with flatter slopes in the lower portion of the levee in areas where soil stability or seepage have been a problem.

More information on levee criteria under the Delta Levees Maintenance Subventions Program Guidelines can be found at: http://www.water.ca.gov/floodsafe/fessro/docs/subventions_guidelines.pdf.

6A.4.4.3 DWR Bulletin 192-82

The Way Bill (1973) authorized the creation of the Delta Levees Maintenance Subvention Program, which is a cost-sharing program in which participating local levee maintenance agencies receive funds for the maintenance and rehabilitation of non-project levees in the Delta. The Act stipulated that levee maintenance and rehabilitation activities that are part of the program must build to a minimum of the Bulletin 192-82 criteria. DWR publication Bulletin 192-82, Delta Levees Investigation, dated December 1982, contains criteria that include the following:

(1) Minimum freeboard for levees protecting agricultural and urban land consists of 1.5 feet and 3.0 feet respectively above the 300-year flood frequency elevations determined by the Corps of Engineers.

(2) Typical levee section has a crown width of 16 feet, a waterside slope of 2 horizontal to 1 vertical, and a landside slope that varies with depth of peat (range 3:1 to 7:1).

(3) Landside berms should be constructed where necessary to help provide stability for weak, highly compressible, peat foundations. Slopes on landside berms to be as flat as 15 horizontal to 1 vertical where required.

(4) In deep peat areas, staged construction consisting of periodic raising of the levee crown, back slope, and the landside berm may be required to compensate for continuing subsidence.

(5) Construction of levees on a new alignment (levee setback) to have a minimum crown width of 12 feet and slopes of 2 horizontal to 1 vertical on both the land and watersides.

6A.4.4.4 CVFPP Levee Design Criteria

California Water Code Section 9614 states that the CVFPP "shall include an evaluation of the structural improvements and repairs necessary to bring each of the facilities of the SPFC to within its design standard." One of the CVFPP preliminary approaches focuses on reconstructing SPFC facilities to meet current engineering criteria without making major changes to the footprint or operation of those facilities. This approach includes major remedial actions to address medium and high threats to facilities of the SPFC. The primary objectives of these remedial actions is to improve the levee system to convey SPFC design flows with a high degree of reliability, based on current engineering design and construction criteria. Other approaches include modifying the existing footprint and function of the flood management system primarily to increase the overall conveyance capacity and floodwater storage, and to provide opportunities for ecosystem restoration and water resources benefits. This approach also protects high risk communities and fixes levees in place in rural-agricultural areas to achieve design flow capacity. Regardless of the approach, levee building and repair activities as part of the CVFPP will be consistent with applicable levee design standards and criteria.

6A.4.4.5 RFMP Local Emergency Response Plan

The RFMPs present local agencies' perspectives of flood management with a prioritized list of projects that need to be implemented to reduce flood risks in each region. Each plan presents an assessment of the costs and benefits for proposed projects while considering their potential contribution to an integrated multi-benefit and basin-wide solution. Regional planning is a locally-led process. However, DWR supports regional collaboration by providing technical information and financial assistance through a directed funding program. The level of DWR's involvement has varied depending on the region and the availability of resources at the local level.

Though the 2012 CVFPP identifies nine regions (Upper Sacramento, Mid-Sacramento, Feather River, Lower Sacramento, Delta-North, Delta-South, Lower San Joaquin, Mid-San Joaquin, and Upper San Joaquin), some regions have partnered together to form six regions: Upper/Mid-Sacramento River, Feather River, Lower Sacramento River/Delta North, Lower San Joaquin River/Delta South, Mid-San Joaquin River, and Upper San Joaquin River. Each of the six planning regions has organized a working group led by a local agency that consists of representatives from flood management agencies, land use agencies, flood emergency responders, permitting agencies, environmental and agricultural interests, and other interested parties. In each sub-region, the RFMP describes the status of emergency response readiness and may provide recommendations to improve emergency response efforts. Agency roles and responsibilities, including potential funding sources and multi-agency coordination during emergency planning and response, are also defined and discussed. Typically, local agencies are the first responders to emergency events in California; however, locally based state agencies can also provide initial response, if the emergency is within their jurisdiction.

6A.5 Climate Change, Sea Level Rise, and Seismic Events

The following is a summary of potential impacts of climate change, sea level rise, and earthquakes on Delta levees and the flood management system. The risks to levees associated with each of these are present regardless of implementation of the proposed project. For more information on potential effects to the Delta from climate change, sea level rise, and earthquakes, please see Appendix 3E, *Potential Seismic and Climate Change Risks to SWP/CVP Water Supplies*, and Appendix 5B, *Responses to Reduced South of Delta Water Supplies*.

6A.5.1 Overview of Climate Change Effects on the Delta

Climate is commonly defined as the weather averaged over a long period of time. Although the climate has changed, in the past in response to natural drivers, recent changes in climate appear to be occurring at a faster rate than historical changes have occurred, appear to be accelerating, and have been unequivocally linked to human activities (Intergovernmental Panel on Climate Change [IPCC] 2007). Climate change has already increased temperatures around the world, raised sea levels, and changed snowpack and runoff patterns in mountainous regions like the Sierra Nevada. These changes have already had an impact on water management in the Delta and are projected to make management of the Delta even more challenging in the future.

6A.5.1.1 Projected Climate-Change Related Effects to the Delta

Hydrologic conditions in the Delta are largely determined by tidal influences, precipitation (amount, form, and timing) in the Sierra Nevada and in other watersheds that supply the Delta, and water management upstream of the Delta (reservoir releases, diversions, operation of weirs, etc.). The amount and timing of rainfall directly in the Delta typically has a minor effect on flow conditions. Climate change-related effects on the Delta include:

- changes in precipitation within and upstream of the Delta,
- increased sea levels with a corresponding increase in seawater and brackish water entering the Delta from the west, and
- changes in weather patterns that could affect the frequency and magnitude of storms and storm-related flooding.

Climate change impacts to the Delta due to shifts in hydrology and rising sea levels are discussed in more detail in the following sections.

6A.5.1.2 Hydrology

Delta inflows are mainly driven by precipitation and runoff in the vast watershed that drains into the Delta (not by precipitation falling on the Delta itself). The watershed that drains into the Delta is the largest in California, encompassing roughly 45 percent of the state's surface area and stretching from the eastern slopes of the Coastal Range to the western slopes of the Sierra Nevada (Lund et al. 2007). The Delta watershed encompasses high mountain areas up to 14,000 feet of elevation and the vast Central Valley of California. Areas of the watershed above 5,000 feet typically accumulate snow between October and March. The snow typically remains frozen high in the watershed until March when it begins to melt. Snowmelt runoff usually continues into July.

Snowpack accumulation and storage are important components of Delta inflow hydrology. Snowpack accumulation during winter storm events reduces the amount of precipitation that runs off directly during the storm, reducing peak stream flow volumes. Snowpack storage keeps water high in the watershed during winter when reservoirs are at their maximum storage levels and releases it in the spring and summer when the water can be stored in reservoirs or released downstream for use.

Increased temperatures in the upper watershed due to climate change threaten to disrupt this delicate balance. Warmer temperatures mean higher snowlines and more precipitation falling as rain instead of snow, which then contributes to direct runoff, increases peak stream flows and raises the risk of levee failures and flooding. Warmer temperatures also mean that the remaining snow will melt earlier, releasing more of the water during winter when it cannot be stored because reservoirs are operated for flood control and leaving less to melt in spring and summer when it is needed for water supply. (Huang et al. 2012)

Climate change may also result in changes in the amount, timing, and intensity of precipitation and storm events in the Delta watershed. Projections of future precipitation conditions for the Delta watershed vary from significant increases in annual precipitation to significant decreases with the models more or less evenly split between wetter conditions and dryer conditions. Other research looking at extreme precipitation events indicates that the Delta watershed will likely see increasing numbers and intensity of large storm events in the future, particularly those associated with the Atmospheric River phenomenon (the "pineapple express" is one well known manifestation of an Atmospheric River) (Dettinger 2011).

Projections of future climate change indicate that warming in the Delta watershed is highly likely to continue and changes in precipitation patterns, while less certain, are also likely. These changes will increase the risk of Delta water supply degradation including reduced water quality and water supply reliability and increase the risk of interruptions in the ability to export water through the Delta and divert water from within the Delta. Reductions in snowpack accumulation and storage will result in reduced spring and summer Delta inflows and reduced operational flexibility. These reduced inflows combined with sea level rise (described in the following section) will result in increasing operational challenges and decreasing ability to export water from the Delta. Increases in extreme precipitation events, combined with increasing temperatures that raise the snow line causing more of the precipitation to fall as rain instead of snow, will result in larger peak inflows into the Delta. Larger peak inflows will increase the risks of levee failures within the Delta. Flooding of Delta islands due to a levee breach could cause seawater to be drawn into the Delta severely reducing water quality and potentially causing Delta export operations to be halted for extended periods of time.

6A.5.1.3 Sea Level Rise

Rising mean sea level is expected as a result of global warming. As much as 167 cm (66 inches) of sea level rise is projected for the California coast and Delta region by 2100 (National Research Council 2012). Sea level is neither constant nor uniform everywhere, but changes continually as a result of interacting processes that operate on timescales ranging from hours (e.g., tides) to millions of years (e.g., tectonics). Processes that affect ocean mass, the volume of ocean water, or sea-floor topography cause sea level to change on global scales. A warming climate causes sea level to rise by warming the oceans, which causes seawater to expand and increases ocean volume. Warmer temperatures also accelerate melting of land ice, which transfers water to the ocean. Human activities also affect sea level, albeit to a much more limited degree. Withdrawing water from aquifers, which eventually reaches the ocean, causes sea level to rise. Conversely, storing water behind dams that would have otherwise reached the ocean results in reductions in sea-level (National Research Council 2012). At more localized scales, apparent or relative changes in sea level can occur from vertical motion of land (e.g., subsidence, isostatic rebound [the rise of land masses previously depressed by the huge weight of ice sheets, and tectonic uplift]). Short-term localized conditions can also result in large variations in sea levels. Astronomical tides, variations in atmospheric pressure, variations in the local density of seawater due to short term climate fluctuations (such as El Niño) and changing winds (URS Corporation/Jack R. Benjamin & Associates, Inc. 2008a) can all result in substantial changes in short-term localized sea level.

A rising sea level will impact the Delta in two important ways: 1) increase the risk of overtopping and other forms of levee failure and 2) increased saline/brackish tidal pressure, which if not counteracted by increases in freshwater outflows will lead to increased salinity intrusion and higher salinity levels in the Delta.

Higher sea levels increase the risk of levee failure by producing higher hydrostatic loads against levees and by increasing internal seepage gradients. Most of the land in the Delta is below sea level as a consequence of ongoing subsidence. Rising sea levels would place more pressure on the Delta's already fragile levee system, and as a consequence could increase the risk of levee breeches. High water events such as storm surges and seasonal high tides could further increase the risks of levee failure. Since sea level rise increases the mean sea level, it raises not just the level of the highest sea stands but also increases the amount of time that levees are exposed to higher sea stands as described below.

Higher sea levels also increase the hydrostatic pressure of seawater flowing in from the Pacific Ocean and San Francisco Bay. This higher pressure can increase salinity in the Delta's inland waterways if not counteracted by increased outflows of freshwater. Greater inflows to the Delta of freshwater would likely be achieved by releasing greater amounts of water from upstream reservoirs. This would reduce the amount of water available for other uses as this additional water would end up as Delta outflow to the ocean. However, even if freshwater inflows to the Delta were increased to counteract the effect of sea level rise, increased salinity intrusion could still occur in deeper more stratified channels by increasing density driven-flows (Fleenor et al. 2008). Conversely, if freshwater inflows were not increased to counteract higher hydrostatic pressures applied by increased sea level, additional saline water would flow deeper into the Delta and would increase the salinity in areas of the Delta that are already brackish. The X2 position would move east and water quality for in Delta water uses and south Delta exports would be diminished (Department of Water Resources 2009a).

For details on how the EIR/EIS modeling incorporated future effects of climate chance and sea level rise into the project alternatives, please see Appendix 5A, *BDCP/California WaterFix FEIR/FEIS Modeling Technical Appendix*.

6A.5.2 Seismic Risks

The Delta and vicinity are within a broad, seismically active region that is potentially subject to substantial hazards associated with moderate to large earthquake events. Specifically, geologic and seismic conditions in the Delta area are controlled primarily by interactions along the boundary between the North American and Pacific crustal (tectonic) plates. This boundary exhibits predominantly strike-slip (lateral) movement in the Delta vicinity, with the Pacific Plate moving in a northwestern direction relative to the North American Plate. In much of California this boundary is marked by the San Andreas Fault System, which incorporates numerous active and potentially active nearby faults including the active San Andreas, Hayward-Rodgers Creek, Calaveras, Concord-Green Valley and Greenville faults. Active faults are defined as those exhibiting historic seismicity or displacement of Holocene-age materials, while potentially active faults have no historic seismicity and displace Pleistocene but not Holocene strata (with pre-Quaternary faults designated as "inactive" and exhibiting a low probability for earthquake activity). Portions of several local active faults are also designated as Earthquake Fault Zones (EFZs) by the California Geological Survey, including segments of the Cordelia, Concord-Green Valley, Greenville, Calaveras and Hayward-Rodgers Creek faults. The described EFZ designations are generally intended to "[r]egulate development near active faults so as to mitigate the hazard of surface fault rupture" (California Geological Survey 2008).

6A.5.2.1 Potential for Seismic-related Levee Failure

The Delta area is subject to a number of potential hazards related to geologic and seismic conditions. Based on these analyses, ground shaking and related effects (e.g., liquefaction) represent the most significant potential seismic hazards in the Delta area. These potential hazards are particularly applicable to the existing levee system. The occurrence of levee failures, or breaches, results in flooding of the associated islands located behind the levee structures, with related implications for issues including damage to homes and agricultural activities, as well as water quality conditions (i.e., from the influx of seawater).

Historically, there have been at least 166 Delta and Suisun Marsh levee failures leading to island inundations since 1900 (Fleenor et al. 2008). None of these failures is attributable to seismic events, but Delta levees have not experienced the greatest potential seismic shaking at their current size and configuration. The largest earthquakes experienced in the Delta region over the last century include the 1906 Great San Francisco Earthquake and the 1989 Loma Prieta Earthquake. The epicenter of the 1906 Great San Francisco Earthquake (magnitude 7.8) was approximately 60 miles from the center of the Delta, and the earthquake occurred early in the era of Delta island reclamation, when the levees were in their early stages of construction and were much smaller and less extensive than today. The epicenter of the 1989 Loma Prieta earthquake (magnitude 6.9) occurred approximately 80 miles from the center of the Delta. Although the levee system was similar to existing conditions at that time, the smaller magnitude and more distant Loma Prieta earthquake did not cause perceptible damage to the levees. Because of the geologically recent reclamation of Delta islands, combined with the sporadic nature of major seismic events, the historical response of Delta levees to major earthquakes lacks predictive value. Seismologists predict that large seismic events will affect the Delta area in the future and such events would be expected to represent more substantial hazards to the levee system than observed in the noted historical earthquakes.

6A.5.2.2 Ground Rupture

Seismic ground rupture is not considered a major hazard in the Delta area. The potential for ground rupture hazards is greatest in the western Delta/Suisan Marsh area due to the presence of active crustal faults. Specifically, portions of the Pittsburg-Kirby Hills, Concord-Green Valley and Cordelia faults are located within the western Delta/Suisan Marsh, with maximum estimated ground rupture offsets identified for the Pittsburg-Kirby Hills and Concord-Green Valley faults ranging from approximately 13.4 to 63 inches. This level of offset could potentially result in substantial breaching and/or failure of associated levee structures, and is considered a significant potential hazard in the associated locations. The potential for seismic ground rupture in other portions of the Delta area is much lower due to the absence of known active crustal faults and the depth to known blind thrust faults. Accordingly, associated potential ground rupture hazards in these areas are considered less than significant, although as previously noted the descriptions of local thrust faults and related conclusions regarding the potential for seismic ground rupture are based on limited geologic data.

6A.5.2.3 Ground Shaking/Liquefaction and Related Effects

The Delta area is subject to potential peak ground acceleration (PGA)/Spectral Acceleration (SA; i.e., ground motion of buildings or structures) values that could generate moderate to severe hazards, including structural deformation and related effects to the existing levee system. Earthquake-generated levee deformations can result in liquefaction-induced flow slides, inertia-induced seismic deformation in non-liquefiable cases, or a combination of the two. Other potential seismically induced modes of failure include overtopping as a result of crest slumping and settlement, internal piping and erosion caused by earthquake-induced differential deformations (varying degrees of deformation occurring over relatively short distances), sliding blocks and lateral spreading resulting in transverse cracking, and exacerbation of existing seepage problems due to deformations and cracking (with existing seepage associated with the fact that Delta levees are mostly non-engineered and in contact with water 100 percent of the time, as previously described). Unlike flood-related (or other conventional-type) breaches, which typically affect a few hundred feet, seismically induced levee failures often extend for thousands of feet or more (Department of Water Resources 2009b). In addition, levees damaged or weakened, but not physically breached, during a major earthquake event may be subject to failure during subsequent wet seasons if not repaired. These conclusions are based on evaluation of historical levee failures associated with major seismic events, including the 1995 Kobe, 1940 Imperial Valley, 1989 Loma Prieta, and 1971 San Fernando earthquakes (Department of Water Resources 2009b).

The DRMS analyses, mentioned in Section 6A.4.1, identified zones with similar levee failure potential (i.e., vulnerability classes [VCs]), based on historical events and site-specific data for the Delta area. A total of 24 vulnerability classes (22 in the Delta and 2 in Suisun Marsh) were identified and subsequently evaluated to reflect a number of additional variables, including ground motion (PGA and SA), seismic deformation characteristics, and material properties. VCs were determined by the presence/location of liquefiable material in levees, levee geometry, and soil composition (presence of peat), among other factors. More information on the VCs, and DRSM modeling simulations of historical seismic events can be found in Appendix 3E, *Potential Seismic and Climate Change Risks to SWP/CVP Water Supplies*.

6A.6 Potential Impacts of the California WaterFix

6A.6.1 Compliance with Rules/Regulations

6A.6.1.1 Rules and Regulations

Various federal and state polices are applicable to the proposed project in the Plan Area, as it relates to flood management and levees, and implementation of the project, including construction, maintenance, and operations, will be consistent with the standards associated with these policies. Project proponents will coordinate with the appropriate agencies and include design features into the project to ensure any modifications to the flood management system will not increase flood risk to the surrounding areas. Project proponents would be required to comply with the requirements of the USACE, CVFPB, and DWR to avoid increased flood potential. For a list of guiding policies and regulations, please see Section 6A.2 in this appendix and the *Regulatory Setting* sections in Chapter 6, *Surface Water*, and Chapter 9, *Geology and Seismicity*, of this Final EIR/EIS.

6A.6.1.2 Public Safety

State and federal design codes and standards will regulate construction of the many structures that are part of the proposed project. These codes and standards establish minimum design and construction requirements, including design and construction of concrete and steel structures, levees, tunnels, pipelines, canals, buildings, bridges and pumping stations. They also establish construction requirements for temporary activities such as shoring of excavations and site grading. The codes and standards are intended to ensure structural integrity and to protect public health and safety. The codes and standards are developed by federal and state agencies with the participation of engineering boards or associations, and professional engineering societies. They are based on the performance history of structures under real conditions, including surface and subsurface geologic conditions and variable regional conditions such as flooding and seismic events. Federal codes and standards will dictate the minimum design and construction requirements for the various elements of the water conveyance facilities and the structural aspects of the other environmental commitments and conservation measures. The minimum design and construction requirements act as performance standards for engineers and construction contractors. Because the design and construction parameters of these codes and standards are intended to reduce the potential for structural damage or risks to human health due to the geologic and seismic conditions that exist within the Plan Area and the surrounding region, their use is considered an environmental commitment of the agencies implementing the proposed project. For more information on design codes and standards, please see Appendix 3B, *Environmental Commitments, AMMs, and CMs*, and Chapter 9, *Geology and Seismicity*.

As discussed above, implementation of the proposed project would be required to be flood neutral, as it relates to flood risks. The proposed project would not result in an increase to exposure of people or structures to flooding due to construction and operations of the conveyance facilities and restoration actions because the project proponents would be required to comply with USACE, CVFPB, and DWR requirements to avoid increased flood potential and levee failure. Project proponents will work and coordinate with applicable agencies, including the USACE, to obtain necessary permits for construction work that may modify the existing flood control system, in addition to ensuring operations will not increase flood risk to the surrounding area. Additionally, project proponents would consult with local reclamation districts to ensure that construction activities would not conflict with reclamation district flood protection measures and routine maintenance.

CVFPB exercises jurisdiction over the SPFC, including SRFCP and flood control projects in the Sacramento River and San Joaquin River watersheds. Under the various project alternatives, constructed facilities will be located within the facilities addressed in the SPFC, including the Yolo Bypass, levees along the Sacramento River between American River confluence and Decker Island, Sutter Slough levees, Steamboat Slough levees, Georgiana Slough levees, and San Joaquin River and Old River levees near the Head of Old River. North Delta Intakes and facilities to be constructed along the levees would be designed to provide flood neutrality during construction and operations. Facilities located along the levees, including coffer dams at the intake locations, would be designed to provide continued flood management at the same level of flood protection as the existing levees; or if applicable, to a higher standard for flood management engineering and permitting requirements if the standards are greater than the existing levee design. New facilities would be designed to withstand the applicable flood management standards through construction of flood protection embankments or construction on engineered fill to raise the facilities to an elevation above the design flood elevation for that specific location. The levee design criteria would consider the most recent criteria, including new guidelines for urban and rural levees (California Department of Water Resources 2013, 2014).

6A.6.2 Overarching Issues

While DWR has authority to use any state property necessary for the State Water Project (Water Code Section 11130), if that state property is already dedicated to public use, then such use must be in accordance with the terms and conditions of an agreement to be entered into by DWR and the state agency having jurisdiction or control and management of the property (Water Code Section 11131). Therefore, DWR will need to enter into an agreement with the CVFPB, as the CVFPB owns various real property interest associated with the Project levees and the SPFC that would be affected by the proposed project. DWR will also seek to enter agreements with local flood control maintenance entities whose flood management activities may be affected by the project. Project proponents will assume responsibility for the maintenance of SPFC facilities in any specific area necessary for construction or operations the proposed project.

6A.6.2.1 Capacities to Move Flood Waters

The surface water analysis provides the basis for determining impacts to flood water conveyance and capacity. This analysis addresses changes to surface waters affected by changes in SWP/CVP operations in the Delta Region and Upstream of the Delta Region caused by implementation of water conveyance facilities (CM1) and other conservation measures and environmental commitments. The potential for changes in flood management operations as a result of the project alternatives were determined through a qualitative evaluation of CALSIM II model results. Impacts were analyzed based on a comparison between project alternatives and existing and no action alternative baseline conditions, including changes in highest peak monthly flows when flood potential is high in the Sacramento River at various locations, if monthly flows exceeded flood capacity, and changes in reservoir storage, among others. For a complete description of the methods for analysis and determination of effects, please see Chapter 6, Groundwater, Sections 6.3.1 and 6.3.2.

Overall, the proposed project will be designed to have minimal effects to reservoir storage and would not increase the potential for flood risk compared to baseline conditions. The project would not increase flood potential on the Sacramento River, San Joaquin River, Trinity River, American River, Feather River, Yolo Bypass, and in the Delta. In addition, the proposed project would include measures to address issues associated with alterations to drainage patterns, stream courses, and runoff and potential for increased surface water elevations in the rivers and streams during construction and operations of facilities. Reservoir storage levels under the proposed project are expected to be similar to modeled baseline conditions. Similarly, high flow conditions during times when flood potential is high would be similar under the proposed project compared to modeled baseline conditions.

It is anticipated that detailed flood risk analysis will be included in a supplemental environmental document that may be needed to support USACE's decision making for Section 408 permission, including hydraulic modeling results appended to the environmental document for full public disclosure and review.

Reservoir storage levels and river flows at various locations in the Delta under the No Action Alternative and Existing Conditions can be found in Chapters 5 and 6, of this Final EIR/EIS, respectively. For a detailed analysis on impacts to flood water management, please see Section 6.3.3 in Chapter 6, *Surface Water*, of this Final EIR/EIS.

6A.6.2.1.1 Encroachments

Encroachments such as boat docks, structures or farming practices on or close to the levee can adversely affect the levee if the structures are not constructed or maintained in accordance with the requirements of federal, state, and local agencies. Examples are irrigation pipes through the levee which can lead to increased seepage or instability. Obstructions such as fences and gates can interrupt access that is important for inspection, maintenance, and fighting floods. Another example is human intervention, such as off-road vehicle use, which can reduce the integrity of the levee crown and slopes. An encroachment on a project levee must obtain an encroachment permit from CVFPB.

Several construction activities associated with the proposed project, including levee modifications and in-water cofferdam installations, would normally require encroachment permits. As discussed above, the CVFPB has jurisdiction to maintain the integrity of the existing flood management system and designated floodways through its regulatory authority by issuing permits for encroachments. The CVFPB issues encroachment permits for projects that the CVFPB determines will not interfere with the integrity of the flood control system. However, the State Water Project is exempt from obtaining a permit from the CVFPB (Water Code Section 8536). Project proponents will consult with the CVFPB regarding an agreement to ensure consistency with applicable regulations and guidelines, including incorporating necessary protective measures into the project design to maintain flood neutrality. Furthermore, project proponents will consult with local reclamation districts to ensure that construction activities would not conflict with applicable encroachment policies.

6A.6.2.1.2 Levee Maintenance

Maintenance activities include actions necessary to maintain the capacity and operational features of the existing water diversion and conveyance facilities. Levee systems must be maintained to provide reasonable assurance of protection from the design flood, and in accordance with an officially adopted maintenance plan. Maintenance activities include periodic addition of waterside armoring material, which may necessitate access and work either from the levee crest (e.g., using an excavator to place riprap) or from the water (e.g., using a barge and crane to place riprap). Levee maintenance may also include operations designed to prevent and repair damage from animal burrowing within the levee. Vegetation control measures will be performed as part of levee maintenance.

Levee maintenance activities will vary between project levees (levees that are or will be part of a federal flood control project) and non-project levees (levees that will not be part of a federal flood control project).

For segments of project levees constructed or modified by a project alternative, project proponents will pay for operations and maintenance, either directly or indirectly through agreements with local agencies. All applicable operations and maintenance standards and manuals will apply, including, but not limited to, FEMA requirements for maintenance pursuant to agency authority under the National Flood Insurance Plan, and USACE requirements pursuant to Public Law 84-99.

For non-project levees constructed or modified by a project alternative, construction or modification will meet USACE Delta-specific Public Law 84-99 design standards. Project proponents will pay for operation and maintenance, either directly or indirectly through agreements with local agencies. All applicable operations and maintenance standards and manuals will apply, including, but not limited to, FEMA requirements for maintenance pursuant to agency authority under the National Flood Insurance Plan, and USACE requirements pursuant to Public Law 84-99. In addition, construction plans may need to be reviewed and approved by Reclamation District engineers.

All levee maintenance activities must be under the jurisdiction of a federal or state agency, local public agency, an agency created by the federal or state law, or an agency of a community participating in the National Flood Insurance Program that assumes ultimate responsibility for maintenance. The plan must document the formal procedure that ensures that the stability, height, and overall integrity of the levee and its associated structures and system are maintained. At a minimum, maintenance plans shall specify the maintenance activities to be performed, the frequency of their performance, and the person, by name or by title, responsible for their performance.

For the environmental restoration components of an alternative, each reserve unit management plan for areas containing levees will incorporate levee maintenance procedures. All levee maintenance that involves ground-disturbing activities will implement relevant measures described in Appendix 3B, *Environmental Commitments, AMMS*, and *CMs*, to avoid and minimize adverse effects on natural communities and covered species. Levees in the reserve system will be maintained in a manner that balances wildlife and habitat needs with the need to maintain the structural integrity of the levees. Levee maintenance managers are generally concerned that uncontrolled vegetation on levees is a potential hazard. Trees with extensive root systems may create pathways for the piping of water through the levee, potentially leading to levee failure. If large trees are toppled by the wind, they may dislodge large segments of the levee with their fall. Dense vegetation may impair visual inspection of levees. Burrowing animals such as beavers, muskrats, and ground squirrels can pose a direct threat to levee stability. Wildlife values will be maximized on levees in the reserve system while recognizing these constraints.

Levee maintenance procedures specified in reserve unit management plans will incorporate the following considerations.

- Trees and shrubs will naturally establish and grow on the faces of levees. Typically, a minimum 16-foot-wide gravel road is maintained on the crest of a levee to provide access to gates and allow for levee repairs. Specific sites with known erosion potential may also need to be kept clear of trees, but ecological function is best met by encouraging dense, natural revegetation of native varieties of trees and shrubs, particularly waterward of levees. Vegetated areas above the intertidal zone provide important habitat functions, including decreased bank erosion and increased bank stability.
- Recent evidence demonstrates that frequent stripping, burning, mowing, grazing, or other practices creating large areas of sparse vegetation actually encourage rather than discourage ground squirrel populations. Increasing vegetative cover for predator hiding and perching may be more effective in controlling ground squirrels on levees.
- Rodent control may kill non-target species; reduces burrow availability for burrowing owls, amphibians, and reptiles; and removes a food source for Swainson's hawk, white-tailed kite, giant garter snakes, and other predators.
- Vegetation burning or nonselective herbicide use may affect elderberry shrubs required by the valley elderberry longhorn beetle. More selective methods are preferred. For example, managed goat grazing may be an effective and biologically preferred vegetation management method along levees (with goat herds used to limit grazing on desirable species).

Levee maintenance practices will vary depending on the covered species being conserved near the levee. For example, levees adjacent to giant garter snake aquatic habitat will be kept clear of riparian vegetation and will instead be maintained with low-growing grasses and herbaceous vegetation.

6A.6.2.1.3 Consistency with SPFC

The SPFC Planning Area, defined as the geographic area that includes the lands currently receiving protection from the SPFC, encompasses the watershed areas of the two major river systems of the Central Valley – the Sacramento and the San Joaquin rivers with a combined drainage area of more than 45,000 square miles. Areas outside the watersheds of the Sacramento and San Joaquin rivers are excluded from the SPFC. The existing state-federal flood management system in the SPFC Planning Area influences flooding and flood management on more than 2.2 million acres (3,400 square miles) of land within the Central Valley. Local and regional flood management facilities and projects reduce flooding to additional valley land in both urban and rural areas. The geographic area that includes land subject to flooding under the current facilities and operation of the Sacramento-San Joaquin River Flood Management System is referred to as the Systemwide Planning Area.

As discussed above, the CVFPB exercises jurisdiction over the SPFC (in addition to the Sacramento and San Joaquin Rivers and their tributaries), including SRFCP and flood control projects in the Sacramento River and San Joaquin River watersheds. Facilities constructed under each of the project alternatives will be located within the facilities addressed in the SPFC. Construction and operational components of the project that could result in modifications to SPFC facilities will be consistent with CVFBP requirements and the CVFPP. Facilities to be constructed along the levees would be designed to provide flood neutrality during construction and operations. Facilities located along the levees, including coffer dams at the intake locations, would be designed to provide continued flood management at the same level of flood protection as the existing levees; or if applicable, to a higher standard for flood management engineering and permitting requirements if the standards are greater than the existing levee design. New facilities would be designed to withstand the applicable flood management standards through construction of flood protection embankments or construction on engineered fill to raise the facilities to an elevation above the design flood elevation for that specific location. The levee design criteria would consider the most recent criteria, including new guidelines for urban and rural levees (California Department of Water Resources 2013, 2014).

6A.6.3 Water Conveyance Facilities Construction and Operations

6A.6.3.1 Sediment Loading

Although the current trend is for decreasing sediment supply to the Plan Area, the uncertainty in change in sediment supply in coming decades is high (Wright and Schoellhamer 2004; Cloern et al. 2011). Change in the timing and volume of flow patterns due to climate change has the potential to alter sediment supply and the timing of the supply, as spring snowmelt sediment concentrations are lower than first flush events at the same flow rates (Schoellhamer et al. 2007). The timing of the bulk of sediment deposition may affect resuspension during the seasonal period of high winds. Since newly deposited sediment is more easily re-suspended, earlier deposition of sediment due to earlier snowmelt may result in less resuspension in the summer and a seasonal increase in water clarity (Ganju and Schoellhamer 2010).

Sediment supply could increase due to climate-change induced changes in land use patterns from urbanization, shifts in agriculture, grazing, and logging. Sediment supply to the Plan Area could decrease with upstream removal of levees or replacement of armored levees with set-back levees, as deposition would then occur along upstream reaches. Overall, Schoellhamer et al. (2007) have concluded that those factors that modify the flow regime alone, such as climate change, are less likely to affect sediment supply to the Plan Area than factors that change both flow regime and upstream supply.

The great majority of Sacramento River sediment (more than 80%) enters the Plan Area episodically during high flow events in the wet periods, with sediment concentrations that are generally higher during first flush events (Schoellhamer et al. 2007). Wright and Schoellhamer (2005) estimated that during the four year period 1999–2002, this accounted for about 31% of the total time. In comparing the proportion of the available sediment actually deposited, about 69% of the available sediment was deposited during wet periods, in comparison with about 56% of the available sediment deposited during dry periods. In other words, conditions are more conducive to sediment deposition during the wet season than during the dry season.

Operation of the north Delta intakes (water conveyance facilities) is estimated to result in around 8 to 9% less sediment entering the Plan Area from the Sacramento River, the main source of sediment for the Delta and downstream sub-regions. However, environmental commitments have been incorporated (see Disposal and Reuse of Spoil, Reusable Tunnel Material and Dredged Material plan in Appendix 3B, *Environmental Commitments, AMMs, and CMs*) into the project that would lessen this potential effect. The Sacramento River water diverted at north Delta intakes would pass through sedimentation basins before being discharged to water conveyance structures. The commitment states that sediment collected in these basins would be periodically removed and reused, to the greatest extent feasible, in the study area for a number of purposes, including marsh restoration, levee maintenance, subsidence reversal, flood response, and borrow area fill.

Construction of water conveyance facilities would have the potential to result in localized and temporary increases in sedimentation at various river locations. Construction activities, such as pile driving during cofferdam installation and barge facility construction, could result in incremental suspension of river bed sediments. However, these impacts are expected to be isolated and minimal. Potential sedimentation effects will be further minimized by limiting the duration of in- water construction activities and through implementing the environmental commitments described in Appendix 3B, *Environmental Commitments AMMs, and CMs*, including the commitment to Develop and Implement Erosion and Sediment Control Plans to control short-term and long-term erosion and sedimentation effects and to restore soils and vegetation in areas affected by construction activities following construction. To address potential erosion and sedimentation impacts from barge facility construction, the project proponents will ensure that a Barge Operations Plan is developed and implemented for facility construction. The requirements for the Barge Operations Plan are described in Appendix 3B. This plan will be developed and submitted by the construction contractors per standard DWR contract specifications. In addition, project proponents will obtain water quality certification from the Regional Water Quality Control Board.

6A.6.3.2 Erosion and Levee Stability

Slope instability (e.g., landslides, soil creep, and debris flow) can occur as a result of gravity loads or in combination with earthquake loads. Analysis focused on areas where past instability had occurred or where water saturates slope materials to estimate the potential for slope instability. In areas where facilities may be built, new cut-and-fill slopes were identified and evaluated for stability. A qualitative slope stability evaluation was performed based on slope inclination, soil type, and groundwater conditions. For areas where adequate soil and site data were available, slope stability was evaluated using a two-dimensional slope model and the limit-equilibrium method.

Construction of the water conveyance facilities could have effects to levee stability and potentially increase risks of levee slope failures. To mitigate potential effects, all levee reconstruction/building pad construction would conform to applicable state and federal flood management engineering and permitting requirements, including engineering standards discussed in Appendix 3B, *Environmental Commitments, AMMs, and CMs*. The level of flood protection will be the same as required for the modified levee without the new facilities. The reconstruction of levees would improve levee stability over existing conditions due to improved side slopes, erosion countermeasures (geotextile fabrics, rock revetments, riprap, or other material), seepage reduction measures, and overall mass.

The proposed project would involve excavation that creates new cut-and-fill slopes and construction of new embankments and levees. As a result of ground shaking and high soil-water content during heavy rainfall, existing and new slopes that are not properly engineered and natural stream banks could fail and cause damage to facilities. The potential effect could be substantial because levee slopes and stream banks may fail, either from high pore-water pressure caused by high rainfall and weak soil, or from seismic shaking. Structures built on these slopes could be damaged or fail entirely as a result of slope instability. As discussed above, the proposed project would be designed and operated in a way to not increase flood management risk to the surround area. During project design, a geotechnical engineer would develop slope stability design criteria (such as minimum slope safety factors and allowable slope deformation and settlement) for the various anticipated loading conditions. The design criteria would be documented in a detailed geotechnical report prepared in accordance with state guidelines, in particular Guidelines for Evaluating and Mitigating Seismic Hazards in California (California Geological Survey 2008). Increased risk of channel bank scour would be low because peak monthly flows under the proposed project in the locations considered were similar to or less than those that would occur under existing conditions. Since flows would not be substantially greater, the potential for increased rates of levee damage are low. In addition, and as part of Environmental Commitment 4, could be dredged to create a larger cross-section that would offset increased tidal velocities.

Two types of ground settlement could be induced during tunneling operations: large settlement and systematic settlement. Large settlement occurs primarily as a result of over-excavation by the tunneling shield. The over-excavation is caused by failure of the tunnel boring machine to control unexpected or adverse ground conditions (for example, running, raveling, squeezing, and flowing ground) or operator error. Large settlement can lead to the creation of voids and/or sinkholes above the tunnel. In extreme circumstances, this settlement can affect the ground surface, potentially causing loss of property or personal injury above the tunneling operation.

Systematic settlement usually results from ground movements that occur before tunnel supports can exit the shield and the tunnel to make full contact with the ground. Soil with higher silt and clay content tend to experience less settlement than sandy soil. Additional ground movements can occur with the deflection of the tunnel supports and over-excavation caused by steering/plowing of the tunnel boring machine at horizontal and vertical curves. A deeper tunnel induces less ground surface settlement because a greater volume of soil material is available above the tunnel to fill any systematic void space.

The potential effect could be substantial because ground settlement could occur during the tunneling operation. During detailed project design, a site-specific subsurface geotechnical evaluation would be conducted along the alignment to verify or refine the findings of the preliminary geotechnical investigation. The tunneling equipment and drilling methods would be reevaluated and refined based on the results of the investigations, and field procedures for sudden changes in ground conditions would be implemented to minimize or avoid ground settlement. The primary exploration methods for these investigations include soil borings and cone penetration tests (California Department of Water Resources 2014), which could potentially result in the settlement of dewatered sediments or liquefaction, respectively. However, these effects would be reduced with implementation of the project proponent's environmental commitments and Avoidance and Minimization Measures (see Appendix 3B, *Environmental Commitments, AMMs, and CMs*). A California-registered civil engineer or California-certified engineering geologist would recommend measures to address these hazards, such as specifying the type of tunnel boring machine to be used in a given segment. As required by the project proponent's environmental commitments (Appendix 3B).

Settlement of excavations could occur as a result of dewatering at construction sites with shallow groundwater. Soil excavation in areas with shallow or perched groundwater levels would require the pumping of groundwater from excavations to allow for construction of facilities. This can be anticipated at all intake locations (Sites 2, 3, and 5) and the pumping plant sites adjacent to the Sacramento River, where 70% much of the dewatering would take place. All of the intake locations and the adjacent pumping plants are located on alluvial flood basin deposits, alluvial floodplain deposits and natural levee deposits. Similar dewatering may be necessary where intake and forebay pipelines cross waterways and major irrigation canals east of the Sacramento River and north of the proposed intermediate forebay.

The hazard of settlement and subsequent collapse of excavations would be evaluated by assessing site-specific geotechnical and hydrological conditions at intake locations and adjacent pumping plants, as well as where intake and forebay pipelines cross waterways and major irrigation canals. A California-registered civil engineer or California-certified engineering geologist would recommend measures in a geotechnical report to address these hazards, such as seepage cutoff walls and barriers, shoring, grouting of the bottom of the excavation, and strengthening of nearby structures, existing utilities, or buried structures. As described in Section 9.3.1, *Methods for Analysis*, of Chapter 9, *Geology and Seismicity*, the measures would conform to applicable design and building codes, guidelines, and standards, such as the California Building Code and USACE's Engineering and Design—Structural Design and Evaluation of Outlet Works, DWR Division of Flood Management FloodSAFE Urban Levee Design Criteria, USACE Engineering and Design – Settlement Analysis, EM 1110-1-1904, and California Code of Regulations, Title 8, Sections 1509 and 3203, California Code of Regulations.

Seepage issues at the Intermediate Forebay and the expanded Clifton Court Forebay will be minimized by complying with the requirements of the Division of Safety of Dams (DSOD) which include design features intended to minimize seepage under the embankments. In addition, the forebays will include a seepage cutoff wall installed to the impervious layer and a toe drain around the forebay embankment, to capture water and pump it back into the forebay. Any potential vertical seepage under the smaller Intermediate Forebay would also be captured by the toe drain.

Construction of the water conveyance facilities will require an increased volume of truck traffic that may occur at some of these locations. There is the potential for some effect on levee integrity at various locations depending on the site specific levee conditions along access routes. Some of the potential levee effects that could occur during the construction process in the absence of corrective measures may include rutting, settlement, and slope movement. As with the effects related to design of conveyance facilities, potential construction traffic effects on levees would be assessed prior to project construction to determine specific geotechnical issues related to construction traffic loading. Based on the initial assessment from field reconnaissance, geotechnical exploration and analyses would be performed for levee sections that need further evaluations. Should the geotechnical evaluations indicate that certain segments of existing levee roads need improvements to carry the expected construction truck traffic loads, project proponents are committed to carry out the necessary improvements to the affected levee sections or to find an alternative route that would avoid the potential deficient levee sections.

For more information on potential water conveyance facility impacts to levee stability and erosion, please see Chapter 10, *Soils,* Chapter 9, *Geology and Seismicity*, and Chapter 7, *Groundwater,* of this Final EIR/EIS.

6A.6.3.3 Drainage and Runoff

Construction of the water conveyance facilities would involve excavation, grading, stockpiling, soil compaction, and dewatering that would result in temporary and long-term changes to drainage patterns, drainage paths, and facilities that would in turn, cause changes in drainage flow rates, directions, and velocities. Although intakes have been designed and located on-bank to minimize changes to river flow characteristics, some localized water elevation changes would occur upstream and adjacent to each cofferdam at the intake sites due to facility location within the river. These localized surface elevation changes would not exceed an increase of 0.10 feet at any intake location even under flood flow conditions. Although minimal localized effects could occur, construction of cofferdams could impede river flows at the location of the intakes but would not increase water surface elevations upstream by more than 0.10 feet during flood events. Early on in the Intake location planning process, DWR conducted a study (Department of Water Resources 2010a) to determine the location of intakes at which effects to river hydraulics would be the least. The results of the study indicated on-bank intakes, as proposed under the California WaterFix, would have minimal impacts on river hydraulics.

The proposed project would not result in an impedance or redirection of flood flows or conditions that would cause inundation by mudflow due to construction or operations of the conveyance facilities or construction of the Environmental Commitments because the project proponents would be required to comply with the requirements of USACE, CVFPB, and DWR to avoid increased flood potential. Under existing regulations, USACE, CVFPB, and DWR would require measures to maintain existing flow capacity in the waterways during construction and operations, which would prevent unacceptable increases in river water surface elevations under flood-flow conditions. Potential effects could occur due to increased stormwater runoff from paved areas that could increase flows in local drainages, as well as changes in sediment accumulation near the intakes. To mitigate these potential effects, project proponents will implement mitigation to reduce runoff and sedimentation impacts. Project proponents will have to demonstrate no-net-increase in runoff or flood stage due to construction activities during peak flows. To achieve this, measures will be implemented to prevent an increase in runoff volume and rate from land-side construction areas and to prevent an increase in sedimentation in the runoff from the construction area as compared to Existing Conditions. To reduce the potential for impacts from large amounts of runoff from paved and impervious surfaces during construction, operations, or maintenance, the proponents will design and implement onsite drainage systems in areas where construction drainage is required. Drainage studies will be prepared for each construction location to assess the need for, and to finalize, other drainage-related design measures, such as a new onsite drainage system or new cross drainage facilities. Based on study findings, if it is determined that onsite stormwater detention storage is required, detention facilities will be located within the existing construction area.

To avoid changes in the courses of waterbodies, the project proponents will design measures to prevent a net increase in sediment discharge or accumulation in water-bodies compared to Existing Conditions to avoid substantially affecting river hydraulics during peak conditions. A detailed sediment transport study for all water-based facilities will be conducted and a sediment management plan will be prepared and implemented during construction. The sediment management plan will include periodic and long-term sediment removal actions.

Prior to use of existing stormwater channels, drainage ditches, or irrigation canals for conveyance of dewatering flows, a hydraulic analysis of the existing channels will be completed to determine available capacity for conveyance of anticipated dewatering flows. If the conveyance capacity is not adequate, new conveyance facilities or methods for discharge into the groundwater will be developed. In accordance with National Pollutant Discharge Elimination System requirements and requirements of the Storm Water Pollution Prevention Plan (SWPPP), water quality analyses of the dewatering flows will be conducted to avoid water quality contamination. Facilities to be constructed along the levees would be designed to provide flood neutrality during construction and operations. Facilities located along the levees, including cofferdams at the intake locations, would be designed to provide continued flood management at the same level of flood protection as the existing levees; or if applicable, to a higher standard for flood management engineering and permitting requirements if the standards are greater than the existing levee design. New facilities would be designed to applicable flood management standards through construction of flood protection embankments or construction on engineered fill to raise the facilities to an elevation above the design flood elevation for that specific location. The levee design criteria would consider the most recent criteria, including new guidelines for urban and rural levees (California Department of Water Resources 2013, 2014).

To include the potential for sea level rise to affect project-modified levees and flood management activities, determination of design flood elevation will consider the effects of sea level rise for the lifetime of the project, as determined by USACE, CVFPB, and DWR. A 200-year level of flood protection will be provided for all new facilities. For levee modifications, the level of flood protection will be the same as required for the modified levee without the new facilities.

For more information on potential impacts to drainage patterns, runoff, and flood management, please see Chapter 6, *Surface Water,* of this Final EIR/EIS.

6A.6.3.4 Ground Motion, Vibration, and Seismic Effects

Pile driving and other heavy equipment operations would cause vibrations that could initiate liquefaction and associated ground movements in places where soil and groundwater conditions are present to allow liquefaction to occur. To prevent liquefaction that could result in damage nearby structures and levees, the facility-specific potential for liquefaction would be investigated by a geotechnical engineer. The investigations are an environmental commitment (see Appendix 3B, *Environmental Commitments, AMMs, and CMs*). In areas determined to have a potential for liquefaction, the California-registered civil engineer or California-certified engineering geologist would develop design strategies and construction methods to ensure that pile driving and heavy equipment operations do not cause liquefaction which otherwise could damage facilities under construction and surrounding structures, and could threaten the safety of workers at the site.

Design measures to avoid pile-driving induced levee failure may include predrilling or jetting, using open-ended pipe piles to reduce the energy needed for pile penetration, using cast-in-drilled-hole piles/piers that do not require driving, or using pile jacking to press piles into the ground by means of a hydraulic system. Field data collected during design also would be evaluated to determine the need for and extent of strengthening levees, embankments, and structures to reduce the effect of vibrations. These construction methods would conform with current seismic design codes and requirements, as described in Appendix 3B. Such design standards include USACE's Engineering and Design—Stability Analysis of Concrete Structures and Soil Liquefaction during Earthquakes, by the Earthquake Engineering Research Institute.

Project Proponents have made the environmental commitment (see Appendix 3B), that the construction methods recommended by the geotechnical engineer are included in the design of project facilities and construction specifications to minimize the potential for construction-induced liquefaction. Project proponents also have committed to ensure that these methods are followed during construction.

Generally, the applicable codes require that facilities be built so that if soil in the foundation or surrounding area are subject to liquefaction, the removal or densification of the liquefiable material should be considered, along with alternative foundation designs. Additionally, any modification to a federal levee system would require USACE approval under 33 USC 408 (a 408 approval).

Seismically induced impacts to the proposed project could cause liquefaction, and damage pipelines, tunnels, intake facilities, pumping plant, and other facilities. The damage could disrupt the water supply through the conveyance system. In an extreme event, an uncontrolled release of water from the damaged conveyance system could cause flooding and inundation of structures. Project proponents would ensure that the hazard of liquefaction and associated ground movements would not create an increased likelihood of loss of property, personal injury or death of individuals from structural failure resulting from seismic-related ground failure along the proposed project conveyance alignment during operation of the water conveyance features.

In the process of preparing final facility designs, site-specific geotechnical and groundwater investigations would be conducted to identify and characterize the vertical (depth) and horizontal (spatial) extents of liquefiable soil. During final design, site-specific potential for liquefaction would be investigated by a geotechnical engineer. In areas determined to have a potential for liquefaction, a California-registered civil engineer or California-certified engineering geologist would develop design measures and construction methods to meet design criteria established by building codes and construction standards to ensure that the design earthquake does not cause damage to or failure of the facility. Such measures and methods include removing and replacing potentially liquefiable soil, strengthening foundations (for example, using post-tensioned slab, reinforced mats, and piles) to resist excessive total and differential settlements, and using in situ ground improvement techniques (such as deep dynamic compaction, vibro-compaction, vibro-replacement, compaction grouting, and other similar methods). The results of the site-specific evaluation and California-registered civil engineer or California-certified engineering geologist's recommendations would be documented in a detailed geotechnical report prepared in accordance with state guidelines, in particular Guidelines for Evaluating and Mitigating Seismic Hazards in California (California Geological Survey 2008). Conformance with these design requirements is an environmental commitment by the project proponents to ensure that liquefaction risks are minimized as the water conveyance features are operated (see Appendix 3B, *Environmental Commitments, AMMs, and CMs*).

Project proponents would ensure that the geotechnical design recommendations are included in the design of project facilities and construction specifications to minimize the potential effects from liquefaction and associated hazards. Project proponents would also ensure that the design specifications are properly executed during construction. Additionally, any modification to a federal levee system would require USACE approval under 33 42 USC 408 (a 408 Permit).

For more information on seismic effects and ground motion and vibration effects, please see Chapter 9, *Geology and Seismicity*, of this Final EIR/EIS.

6A.6.4 Environmental Commitments and Conservation Measures

Implementation of Environmental Commitments and Conservation Measures associated with the proposed project (Environmental Commitments) and other project alternatives (Conservation Measures), specifically relating to habitat restoration and enhancement, would have the potential to alter/modify existing flood management facilities (i.e., levees) and flood flow conveyance. It should be noted that the new proposed project has substantially reduced the amount of habitat restoration to be included in the conservation and restoration components of the project, including the removal of Conservation Measure 2 (*Yolo Bypass Enhancements*) and Conservation Measure 5 (Seasonally Inundated Floodplain Restoration). As such, restoration-related impacts from the proposed project would be reduced in proportion to the reduction in extent of habitat restoration considered in the previous proposed project, Alterative 4. Nevertheless, habitat restoration projects in any alternative would be designed and implemented to USACE, CVFPB, and DWR standards to ensure flood neutrality, along with implementation of specific mitigation measures and environmental commitments to minimize and avoid impacts to the flood conveyance system.

6A.6.4.1 Setback Levees

Implementation of some of the environmental commitments could require the construction of setback levees, particularly Environmental Commitment 6, *Channel Margin Enhancement*. Under this commitment, project proponents would restore 4.6 linear miles of channel margin by improving channel geometry and restoring riparian, marsh, and mudflat habitats on the water side of levees along channels that provide rearing and outmigration habitat for juvenile salmonids. Linear miles of enhancement will be measured along one side or the other of a given channel segment (e.g., if both sides of a channel are enhanced for a length of 1 mile, this would account for a total of 2 miles of channel margin enhancement). While channel margin enhancement may involve levee setbacks in some cases, these setbacks will be relatively minor (setbacks on the order of a hundred feet or less) to provide for restoration of natural vegetation on the banks. Any restoration activities that include setback levees would be designed and operated in accordance with USACE, CVFPB, and DWR standards to ensure no net increase in flood risk. In addition, as part of the Section 408 permitting process, various environmental commitments with the potential to affect Delta hydraulics, including channel margin habitat enhancement, will be analyzed in the flood risk and hydraulic analysis.

6A.6.4.2 Levee Modifications

Implementation of several environmental commitments could involve breaching, modification or removal of existing levees and construction of new levees and embankments. Levee modifications, including levee breaching or lowering, may be performed to reintroduce tidal exchange, reconnect remnant sloughs, restore natural remnant meandering tidal channels, encourage development of dendritic channel networks, and improve floodwater conveyance. Levee modifications could involve the removal of vegetation and excavation of levee materials. Excess earthen materials could be temporarily stockpiled, then re-spread on the surface of the new levee slopes where applicable or disposed of offsite. Any breaching or other modifications would be required to be designed and implemented to maintain the integrity of the levee system and to conform to flood management standards and permitting processes. This would be coordinated with the appropriate flood management agencies. Those agencies may include USACE, DWR, CVFPB, and other flood management agencies.

Neighboring levees could require modification to accommodate increased flows or to reduce effects of changes in water elevation or velocities along channels following inundation of tidal marshes. Hydraulic modeling would be used during subsequent analyses to determine the need for such measures. New levees would be constructed to separate lands to be inundated for tidal marsh from non- inundated lands, including lands with substantial subsidence. Levees could be constructed as described for the new levees at intake locations. Any new levees would be required to be designed and implemented to conform to applicable flood management standards and permitting processes. Additionally, during project design, a geotechnical engineer would develop slope stability design criteria (such as minimum slope safety factors and allowable slope deformation and settlement) for the various anticipated loading conditions. Site-specific geotechnical and hydrological information would be used, and the design would conform with the current standards and construction practices, as described in Appendix 3B, *Environmental Commitments, AMMs, and CMs*. The project proponents would ensure that the geotechnical design recommendations are included in the design of embankments and levees to minimize the potential effects from slope failure. The project proponents would also ensure that the design specifications are properly executed during implementation.

Activities associated with conservation measures that could lead to accelerated water erosion include clearing, grubbing, demolition, grading, and other similar disturbances. Such activities steepen slopes and compact soil. These activities tend to degrade soil structure, reduce soil infiltration capacity, and increase runoff rates, all of which could cause accelerated erosion and consequent loss of topsoil. Gently sloping to level areas, such as where most of the restoration actions would occur, are expected to experience little or no accelerated water erosion because of the lack of runoff energy to entrain and transport soil particles. Graded and otherwise disturbed tops and sideslopes of existing and project levees and embankments are of greater concern for accelerated water erosion because of their steep gradients. Soil eroded from the disturbed top and water side of levees could reach adjoining waterways (if present), unless erosion and sediment control measures are implemented.

Conservation measures construction activities (e.g., excavation, filling, grading, and vehicle traffic on unimproved roads) that could lead to accelerated wind erosion are the same as those for water erosion. These activities may entail vegetation removal and degradation of soil structure, both of which would make the soil more subject to wind erosion. Removal of vegetation cover and grading increase soil exposure at the surface and obliterate the binding effect of plant roots on soil aggregates. These effects make the soil particles more subject to entrainment by wind.

These effects could potentially cause substantial accelerated erosion. However, as described in Chapter 10, *Soils*, Section 10.3.1, *Methods for Analysis*, and Appendix 3B, *Environmental Commitments, AMMs, and CMs*, project proponents would be required to obtain coverage under the General Permit for Construction and Land Disturbance Activities, necessitating the preparation of a SWPPP and an erosion control plan. The General Permit requires that SWPPPs be prepared by a Qualified SWPPP Developer (QSD) and requires SWPPPs be implemented under the supervision of a Qualified SWPPP Practitioner (QSP). The QSD would select erosion and sediment control best management practices (BMPs) such as preservation of existing vegetation, seeding, mulching, fiber roll and silt fence barriers, erosion control blankets, watering to control dust entrainment, and other measures to comply with the practices and turbidity level requirements defined by the General Permit. Partly because the potential effect on receiving waters depends on location of a work area relative to a waterway, the BMPs would be site-specific. The QSP would be responsible for day-to-day implementation of the SWPPP, including BMP inspections, maintenance, water quality sampling, and reporting to the State Water Board.

With the exception of the Suisun Marsh Restoration Opportunity Area (ROA), the ROAs are not in areas of high subsidence nor where the soils have a high organic matter content. Consequently, only the Suisun Marsh ROA would be expected to be subject to substantial subsidence. Based on its current elevation, the Suisun Marsh ROA has not experienced significant subsidence, despite the fact that the soils are organic and of considerable thickness.

Damage to or failure of the habitat levees could occur where these are constructed in soils and sediments that are subject to subsidence and differential settlement. These soil conditions have the potential to exist in the Suisun Marsh ROA. Levee damage or failure could cause surface flooding in the vicinity. This potential effect could be substantial because the facilities could be located on unstable soils that are subject to subsidence. However, as described in Chapter 10, Section 10.3.1, *Methods for Analysis*, and Appendix 3B, *Environmental Commitments AMMs, and CMs*, geotechnical studies would be conducted at all the ROAs to identify the types of soil stabilization that should be implemented to ensure that levees, berms, and other features are constructed to withstand subsidence and settlement and to conform to applicable state and federal standards. Such standards include the USACE *Design and Construction of Levee* and DWR *Interim Levee Design Criteria for Urban and Urbanizing Area State-Federal Project Levees*.

For more information on potential levee modifications, please see Chapter 9, *Geology and Seismicity*, and Chapter 10, *Soils,* of this Final EIR/EIS.

6A.6.4.3 Wind Fetch Impacts

Tidal marsh habitat, and channel margin habitat could increase flood potential due to impacts on adjacent levees. The newly flooded areas would have larger wind fetch lengths (unobstructed distance which wind can travel over water and potentially develop large waves caused by wind force not tidal force) compared to the existing fetch lengths of the adjacent leveed channels. An increase in fetch length would result in increases in wave height and velocities that reach the existing levees along adjacent islands and floodplains. These potential increases in wave action could also reach the land-side of the remaining existing levees around the restoration area.

In accordance with existing requirements of the USACE, CVFPB, and DWR, the proposed project would be designed to avoid increased flood potential. To further mitigate wind fetch impacts, measures will be implemented to prevent an increase in potential damage from wind-driven waves across expanded open water areas at habitat restoration locations. These measures will be designed based upon wind fetch studies that will be completed prior to construction of habitat restoration areas with increased open water in the Delta. To reduce the potential for adverse impacts from the increased open water areas during wind events, levees that would be subject to increased wind-driven waves will be strengthened and possibly raised to avoid levee damage from waves or water entering the landside of the levee due to high waves. Other mechanisms to reduce the effects of wind fetch will be considered to the extent feasible in the design of restoration areas.

6A.6.4.4 Drainage and Flood Flow Conveyance

Riparian habitat restoration is anticipated to occur primarily in association with the restoration of tidal marsh habitat, and channel margin habitat. The restored vegetation has the potential of increasing channel roughness, which could result in increases in channel water surface elevations, including under flood flow conditions, and in decreased velocities. Modified channel geometries could increase or decrease channel velocities and/or channel water surface elevations, including under flood flow conditions. Under existing regulations, the USACE, CVFPB, and DWR would require the habitat restoration projects to be flood neutral. Measures to reduce flood potential could include channel dredging to increase channel capacities and decrease channel velocities and/or water surface elevations. Other measures to minimize and avoid impacts to flood flow conveyance and drainage would be similar to those discussed in Chapter 7, *Surface Water*, Section 7.3.3.

For more information on flood management impacts from implementation of restoration projects, please see Chapter 6, *Surface Water,* of this Final EIR/EIS.

6A.6.4.5 Seismic Impacts

Various ROAs could be susceptible to seismic-related impacts, including earthquake fault ruptures, strong seismic shaking, and ground failure and liquefaction.

Movement of faults could damage levees and berms constructed as part of the restoration, which could result in failure of the levees and flooding of otherwise protected areas. Surveys would be used to verify fault depths where levees and other features would be constructed. Collection of this depth information would be part of broader, design-level geotechnical studies conducted by a geotechnical engineer licensed in the state of California to support all aspects of site- specific project design. The studies would assess site-specific conditions at and near all the project facility locations, including the nature and engineering properties of all soils and underlying geologic strata, and groundwater conditions. The geotechnical engineers' information would be used to develop final engineering solutions to any hazardous condition, consistent with the code and standards requirements of federal, state and local oversight agencies. Conformance with these design standards is an environmental commitment by the project proponents to ensure that risks from a fault rupture are minimized as levees for habitat restoration areas are constructed and maintained (see Appendix 3B, *Environmental Commitments, AMMs, and CMs*). The hazard would be controlled to a safe level by following the proper design standards.

To minimize and avoid impacts related to strong seismic shaking, site-specific geotechnical information would be used to further assess the effects of local soil on the operating basis earthquake and maximum design earthquake ground shaking and to develop design criteria that minimize the potential of damage. Design-level geotechnical studies would be prepared by a geotechnical engineer licensed in the state of California during project design. The studies would assess site-specific conditions at and near all the project facility locations and provide the basis for designing the levees and other features to withstand the peak ground acceleration caused by fault movement in the region. The geotechnical engineer's recommended measures to address this hazard would conform to applicable design codes, guidelines, and standards. Conformance with these design standards is an environmental commitment by the project proponents to ensure that strong seismic shaking risks are minimized as the conservation activities are implemented (see Appendix 3B).

The project proponents would ensure that the geotechnical design recommendations are included in the design of project facilities and construction specifications to minimize the potential effects from seismic events and the presence of adverse soil conditions. The project proponents would also ensure that the design specifications are properly executed during implementation.

Generally, the applicable codes require that facilities be built so that they incur minimal damage in the event of a foreseeable seismic event and that they remain functional following such an event and that the facility is able to perform without catastrophic failure in the event of a maximum design earthquake (the greatest earthquake reasonably expected to be generated by a specific source on the basis of seismological and geological evidence).

Earthquake induced ground shaking could cause liquefaction, resulting in damage to or failure of these levees and other features constructed at the restoration areas. The consequences of liquefaction are manifested in terms of compaction or settlement, loss of bearing capacity, lateral spreading (horizontal soil movement), and increased lateral soil pressure. Failure of levees and other structures could result in flooding of otherwise protected areas behind new setback levees along the Sacramento Rivers.

During final design of conservation facilities, site-specific geotechnical and groundwater investigations would be conducted by a geotechnical engineer to identify and characterize the vertical (depth) and horizontal (spatial) extent of liquefiable soil. In areas determined to have a potential for liquefaction, the engineer would develop design parameters and construction methods to meet the design criteria established to ensure that design earthquake does not cause damage to or failure of the facility. Conformance with these design standards is an environmental commitment by the project proponents to ensure that liquefaction risks are minimized as the conservation activities are implemented. Generally, the applicable codes require that facilities be built so that if soil in the foundation or surrounding area is subject to liquefaction, the removal or densification of the liquefiable material should be considered, along with alternative foundation designs.

For more information on seismic-related impacts to restoration components of the project, please see Chapter 9, *Geology and Seismicity*, of this Final EIR/EIS.

6A.7 California WaterFix and Overall Flood Approach

6A.7.1 How California WaterFix Coordinates with and Complements Existing Programs

Project proponents will coordinate with the appropriate flood agencies to ensure implementation of the proposed project is consistent with existing flood management programs and plans (see Section 6A.4.2 and Section 6A.2 for a brief description of relevant programs, plans, and policies), including the CVFPP and California Water Action Plan, and not increase flood risk or vulnerability of the current flood management system. The CVFPB and the USACE are primarily responsible for the levees along the Sacramento River. Under California Water Code Section 8536 and related regulations, the CVFPB has no jurisdiction or authority over the construction, operation, or maintenance of the CVP or SWP. However, project proponents will consult with these agencies to ensure that all construction of new structures or levee modifications within the waterways will not adversely affect the flood profile, and that the integrity of the levees is not degraded by structures that are constructed under, over, or through the levees. Project proponents will obtain approval from USACE for any impact to Federal project facilities. Project proponents will enter into an agreement with the CVFPB regarding the use of CVFPB-owned facilities and property. In addition, project proponents would consult with local reclamation districts to ensure that project activities would not conflict with reclamation district flood protection measures. Other coordination efforts may include consultations with DWR's Division of Flood Management and FloodSAFE program, among others. Consultations would be focused on meeting regulatory project design requirements, which would establish minimum design criteria and construction requirements for tunnels, canals, levees, pipelines, excavations and shoring, pumping stations, grading, and foundations, bridges, access roads, structures, and other facilities, will be followed by the project engineers, where applicable, in the design of project facilities and will be included as minimum standards in the construction specifications.

Implementation of the proposed project in combination with existing, past, and future programs that could affect flood flow conveyance is analyzed Chapter 6, Section 6.3.5, of this Final EIR/EIS. The cumulative projects considered in the analysis would either improve flood management conditions and reduce flood potential by increasing upstream storage capacity, levee improvements, expansion of the floodplain to reduce peak flood flows; diversion of additional water that could reduce peak flood flows (e.g., North Bay Aqueduct Alternatives Intake); or not substantially modify highest monthly flows in wet years, such as Dutch Slough Tidal Marsh Restoration Project, other California EcoRestore actions and the San Joaquin River Restoration Program.

As discussed earlier, the CVFPP is a comprehensive flood management effort designed to address flood risks in an integrated manner while concurrently improving ecosystem functions, operations and maintenance practices, and institutional support for flood management. As part of the strategy to incorporate ecosystem improvement and benefits into flood management projects, DWR is developing the CVFSCS, which is an integral component of the 2017 CFVPP update. Project proponents have been involved in coordination efforts with the CVFSCS team focusing on restoration efforts that can provide dual benefits of flood protection improvements and ecosystem enhancement, while achieving each program's goals and objectives. Project proponents will continue coordinating with the Division of Flood Management and CVFPB to ensure construction and operational elements of the project are consistent with the flood management approach and Conservation Strategy outlined in the CVFPP.

Implementing a dual conveyance system, as proposed under the California WaterFix, would complement other programs by adding additional flexibility to the way water is conveyed through the estuary. Levee improvement and habitat restoration projects focused on benefitting both ecosystems and flood conveyance under other programs could add additional flood protection. Project proponents will coordinate with the appropriate agencies involved in flood system improvement and maintenance activities to ensure the proposed project will not interfere with their abilities to achieve their programs' goals and objectives, and to maintain flood neutrality during implementation of the proposed project.

6A.7.2 Permitting Process (Flood and Levees)

Project proponents will comply with applicable laws and regulations pertaining to modifications of the existing flood management system, including obtaining necessary permits required for construction and operations of the proposed project. Table 1-1 in Chapter 1, *Introduction*, lists agencies with the potential to have review, approval, or other responsibilities during the permitting process. Project proponents will also engage with local reclamation districts to ensure that construction activities would not conflict with reclamation district flood protection measures. Modifications to the flood conveyance system due to construction and/or operations of the proposed project will be designed to meet CVFPB, DWR, and USACE design codes and standards to maintain flood neutrality.

Section 14 of the RHA (i.e., Section 408) requires permission from the Secretary of the Army, acting through USACE to alter an existing USACE civil works project. To grant permission under Section 408, USACE must determine that the proposed alteration does not impair the usefulness of the USACE project, and would not be injurious to the public interest. Specifically related to this project, the primary issue is to maintain the integrity of the SRFCP and SJRTP and their function for flood risk reduction. Section 408 review provides that alteration of any one part of the system would not substantially increase flood risk.

The informational requirements under the Section 408 process necessarily includes a detailed level of engineering design, as well as a detailed level of analysis related to effects on USACE's civil works projects and indirect hydraulic effects. The information contained in the current CEQA/NEPA documents will not fully meet this level of detail and additional informational submittals and analysis may be necessary. As a result of these submittals, prior to final 408 permission, additional NEPA compliance by USACE may be required. It is anticipated that a detailed flood risk analysis will be included in a supplemental environmental document to support USACE's decision making for Section 408 permission, including hydraulic modeling results appended to the environmental document for full public disclosure and review. As part of the flood risk analysis, project proponents will analyze a full range of flood events, including events with 1/10, 1/100 1/200, and 1/500 recurrence. The hydraulic analysis will also analyze changes in velocity, water surface elevation, flowage distribution, scour, sedimentation, and any up- or downstream effects as a result of constructing and operating the new water conveyance facilities, including the three new intake facilities and Head of Old River Barrier. Various environmental commitments with the potential to affect Delta hydraulics will also be analyzed in the flood risk analysis. Locations for channel margin habitat enhancement yet to be identified that may affect federal project levees will be disclosed and analyzed as part of the supplemental environmental document for Section 408 permission. For more information on the California WaterFix Section 408 permitting process, please see Appendix 1F, *Supplemental Information for USACE Permitting Requirements,* in this Final EIR/EIS.

6A.8 References

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