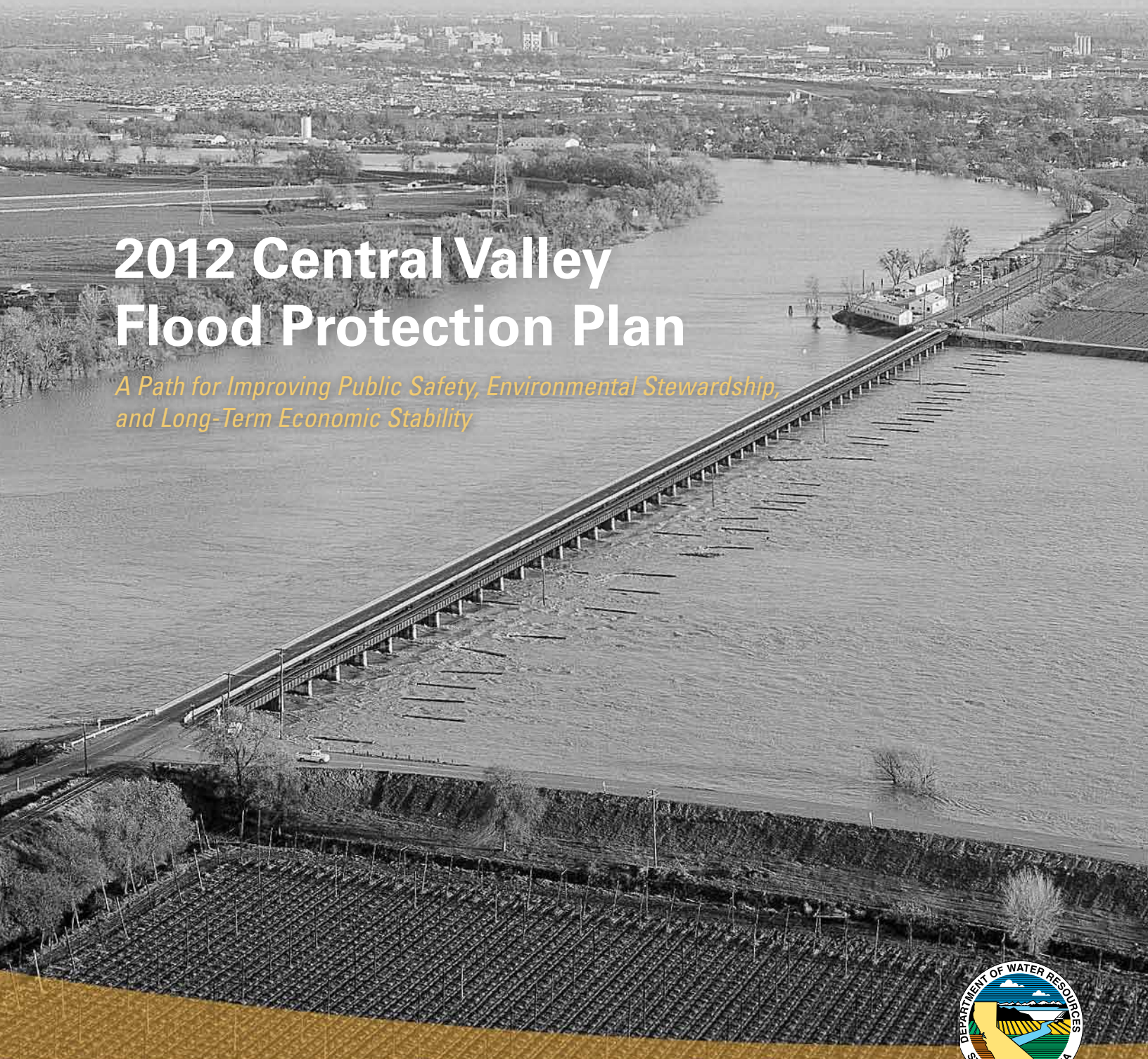
CENTRAL VALLEY
FLOOD MANAGEMENT
PLANNING PROGRAM

FloodSAFE
CALIFORNIA

Section 3.0: State Systemwide Investment Approach Only

June 2012



2012 Central Valley Flood Protection Plan

A Path for Improving Public Safety, Environmental Stewardship, and Long-Term Economic Stability

DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

PUBLIC SAFETY ENVIRONMENTAL STEWARDSHIP ECONOMIC STABILITY

3.0 STATE SYSTEMWIDE INVESTMENT APPROACH

The State Systemwide Investment Approach (SSIA) reflects the State's strategy for modernizing the SPFC to address current challenges and affordably meet the CVFPP Goals described in Section 1. The preliminary approaches, described in Section 2, suggested a broad range of physical and institutional flood damage reduction actions to improve public safety and achieve economic, environmental, and social sustainability. The SSIA is an assembly of the most promising, affordable, and timely elements of the three preliminary approaches.

The State Systemwide Investment Approach provides guidance for future State participation in projects and programs for integrated flood management in the Central Valley.

Physical elements for the SSIA are organized into regional and system elements:

- **Urban, small community, and rural-agricultural improvements** – These are physical actions or projects to achieve local and regional benefits.
- **System improvements** – These are projects and modifications to the SPFC that provide cross-regional benefits, improving the overall function and performance of the SPFC, and are generally large system improvements, such as bypass expansions. The State will provide leadership in developing and implementing these components.

The regional and system elements require detailed analyses to refine how elements may complement each other and to develop appropriate justification for future selection of on-the-ground projects. The SSIA reflects a broad vision for SPFC modernization; therefore, element refinements, additions, and deletions can be expected as a result of future feasibility studies.

Section 2 introduced elements of the SSIA. The following sections provide a more detailed description of the SSIA, its estimated cost, residual risk management needs, and a preliminary presentation of expected performance. Section 4 describes how the SSIA is expected to be implemented and managed over the next several decades.

3.1 Major Physical Improvements in Sacramento and San Joaquin River Basins

Existing SPFC facilities in the Sacramento River Basin are much more extensive and protect larger populations and assets than SPFC facilities in the San Joaquin River Basin. In addition, peak floodflows from the Sacramento River Basin can be about 10 times higher than those from the San Joaquin River Basin. Therefore, physical improvements included in the SSIA are more extensive within the

Sacramento River Basin than within the San Joaquin River Basin. Table 3-1 shows important characteristics of the Sacramento and San Joaquin river basins.

Table 3-1. Key Characteristics of Sacramento and San Joaquin River Basins

CHARACTERISTICS	SACRAMENTO RIVER BASIN	SAN JOAQUIN RIVER BASIN
Land Area Within 500-Year (0.2% annual chance) Floodplain (acres)	**1,217,883**	**697,465**
Population at risk[1] (people)	*762,000*	*312,000*
Replacement value of assets at risk ($ millions)	*53,000*	*16,000*
Total SPFC Levees (miles)	**1,054**	**448**
SPFC Levees with identified threat factors[2] (miles)	*852*	*354*
Total Potential 2-Year (50% annual chance) Floodplains (acres)	**235,000**	**85,000**
Currently connected to river (acres)	*93,000*	*26,000*
Currently connected and in native/natural habitat (acres)	*50,000*	*19,000*
Total Reservoir Capacity[3] Tributary to Area (thousand acre-feet)	**10,477**	**7,100**
Reserved Flood Storage Space	*3,066*	*1,881*

Notes:

[1] Estimated population (from 2000 U.S. Census data) within 500-year floodplain.

[2] Source: *Flood Control System Status Report* (DWR, 2011). Includes Urban Levee Evaluations Project classifications "Marginal" and "Does Not Meet Criteria," and Non-Urban Levee Evaluations Project categories B (Moderate) and C (Low).

[3] Only includes reservoirs with dedicated flood storage space.

Key:

SPFC = State Plan of Flood Control

CENTRAL VALLEY FLOOD PROTECTION PLAN OF 2008

California Water Code Section 9614. "The Plan shall include…

(i) A description of both structural and nonstructural methods for providing an urban level of flood protection to current urban areas where an urban area means the same as set forth in subdivision (k) of Section 5096.805 of the Public Resources Code. The description shall also include a list of recommended next steps to improve urban flood protection."

Major physical (capital improvement) elements included in the SSIA are shown in Table 3-2 and in the schematics in Figures 3-1 and 3-2 for the Sacramento and San Joaquin river basins. The following sections provide more description of urban, small community, rural-agricultural, and system improvements.

3.2 Urban Flood Protection

Consistent with legislation passed in 2007, the SSIA proposes improvements to urban (populations greater than 10,000) levees to achieve protection from the 200-year (0.5% annual chance) flood, at a minimum. With some exceptions, existing SPFC levees in urban areas are often located immediately adjacent to houses and business, leaving few opportunities for setting levees back or making improvements that enlarge levee footprints. Therefore, reconstruction of existing urban levees is generally the method for increasing flood protection. The State is already supporting many SPFC urban levee improvement projects through its Early Implementation Program grants program and other FloodSAFE efforts, including some setback levees.

Table 3-2. Major Physical and Operational Elements of Preliminary Approaches and State Systemwide Investment Approach

FLOOD MANAGEMENT ELEMENT	PROJECT LOCATION OR REQUIRED COMPONENTS	ACHIEVE SPFC DESIGN FLOW CAPACITY	PROTECT HIGH RISK COMMUNITIES	ENHANCE FLOOD SYSTEM CAPACITY		STATE SYSTEMWIDE INVESTMENT APPROACH
Bypasses						
New Bypass Construction and Existing Bypass Expansion	• Feather River Bypass • Sutter Bypass expansion • Yolo Bypass expansion • Sacramento Bypass expansion • Lower San Joaquin River Bypass (Paradise Cut) Components potentially include land acquisition, conservation easements, levee improvements, new levee construction			YES	→	YES
Reservoir Storage and Operations						
Forecast-Coordinated Operations/Forecast-Based Operations	Fifteen reservoirs within Sacramento River Basin and San Joaquin River Basin	YES	YES	YES		YES
Reservoir Storage/Enlarge Flood Pool[1]	• Oroville • New Bullards Bar • Don Pedro • McClure • Friant			YES	→	
Easements	• Sacramento River Basin – 200,000 acre-feet • San Joaquin River Basin – 100,000 acre-feet			YES		
Flood Structure Improvements						
Major Structures	• Intake structure for new Feather River Bypass • Butte Basin small weir structures • Upgrade and modification of Colusa and Tisdale weirs • Sacramento Weir widening and automation • Gate structures and/ or weir at Paradise Cut • Upgrade of structures in Upper San Joaquin bypasses • Low level reservoir outlets at New Bullards Bar Dam • Fremont Weir widening and improvement • Other pumping plants and small weirs			YES	→	YES
System Erosion and Bypass Sediment Removal Project	• Cache Creek Settling Basin sediment management • Sacramento system sediment remediation downstream from weirs			YES		YES
Urban Improvements						
Target 200-Year Level of Protection	Selected projects developed by local agencies, State, federal partners		YES	YES	→	YES
Target SPFC Design Capacity	Urban Levee Evaluations Project results	YES[2]				

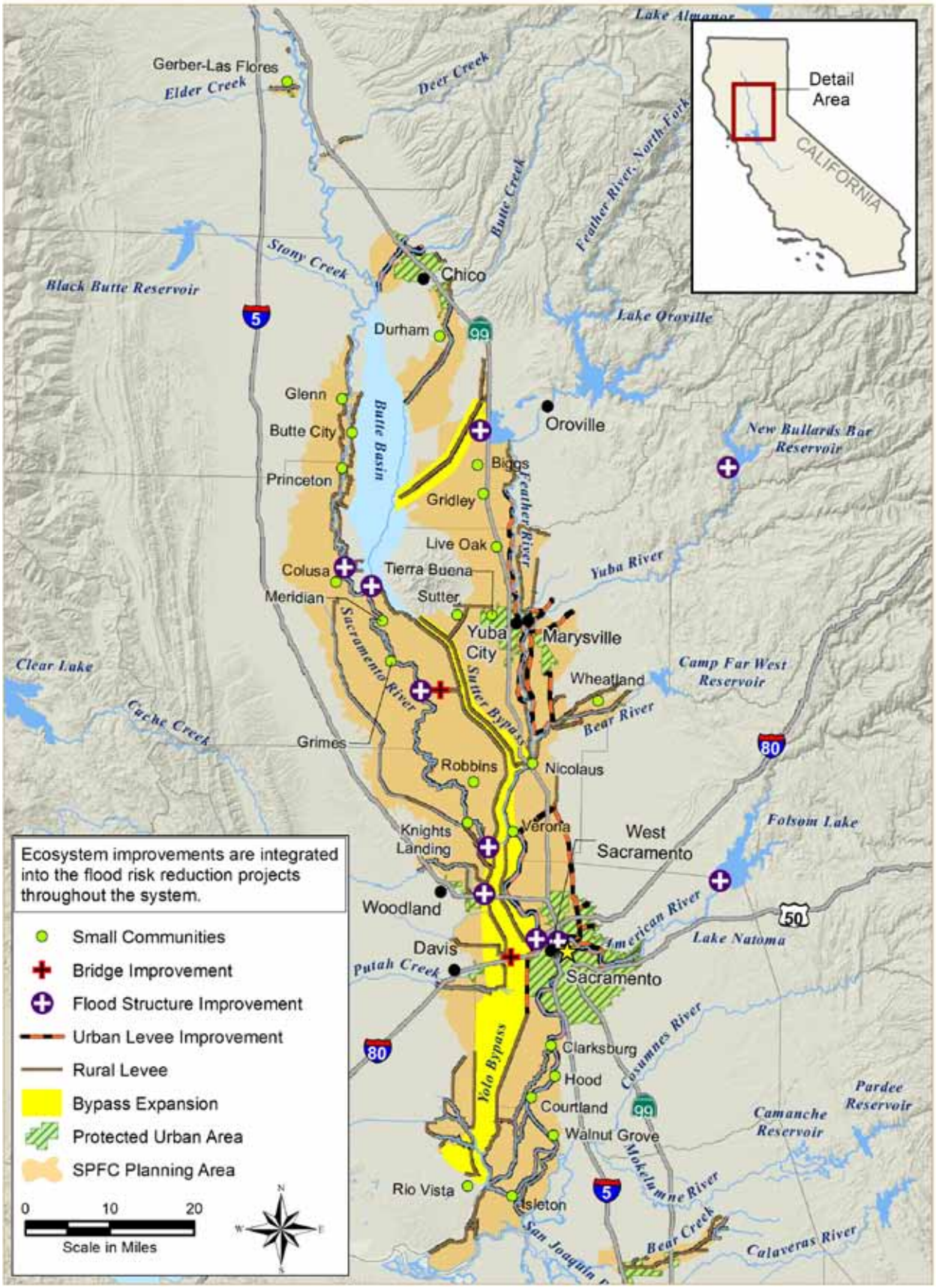
Table 3-2. Major Physical and Operational Elements of Preliminary Approaches and State Systemwide Investment Approach (cont'd.)

FLOOD MANAGEMENT ELEMENT	PROJECT LOCATION OR REQUIRED COMPONENTS	ACHIEVE SPFC DESIGN FLOW CAPACITY	PROTECT HIGH RISK COMMUNITIES	ENHANCE FLOOD SYSTEM CAPACITY		STATE SYSTEMWIDE INVESTMENT APPROACH
Non-SPFC Urban Levee Improvements	Includes approximately 120 miles of non-SPFC levees that are closely associated with SPFC urban levees. Performance of these non-SPFC levees may affect the performance of SPFC levees.	YES	YES	YES		YES
Small Community Improvements						
Target 100-Year Level of Protection	Small communities protected by the SPFC		YES[3]	YES[3]	→	YES[4]
Target Design Capacity	Non-Urban Levee Evaluations Project results	YES[2]		YES[2]		
Rural-Agricultural Improvements						
Site-Specific Rural-Agricultural Improvements	Based on levee inspections and other identified critical levee integrity needs				→	YES
Target Design Capacity	Non-Urban Levee Evaluations Project results	YES[2]		YES[2]		
Ecosystem Restoration						
Fish Passage Improvements	• Tisdale Bypass and Colusa Bypass fish passage • Fremont Weir fish passage improvements • Deer Creek			YES	→	YES
Ecosystem Restoration and Enhancement	For areas within new or expanded bypasses, contributing to or incorporated with flood risk reduction projects			YES		YES
River Meandering and Other Ecosystem Restoration Activities	At selected levee setback locations in Sacramento and San Joaquin river basins			YES		YES (at select locations)

Notes:

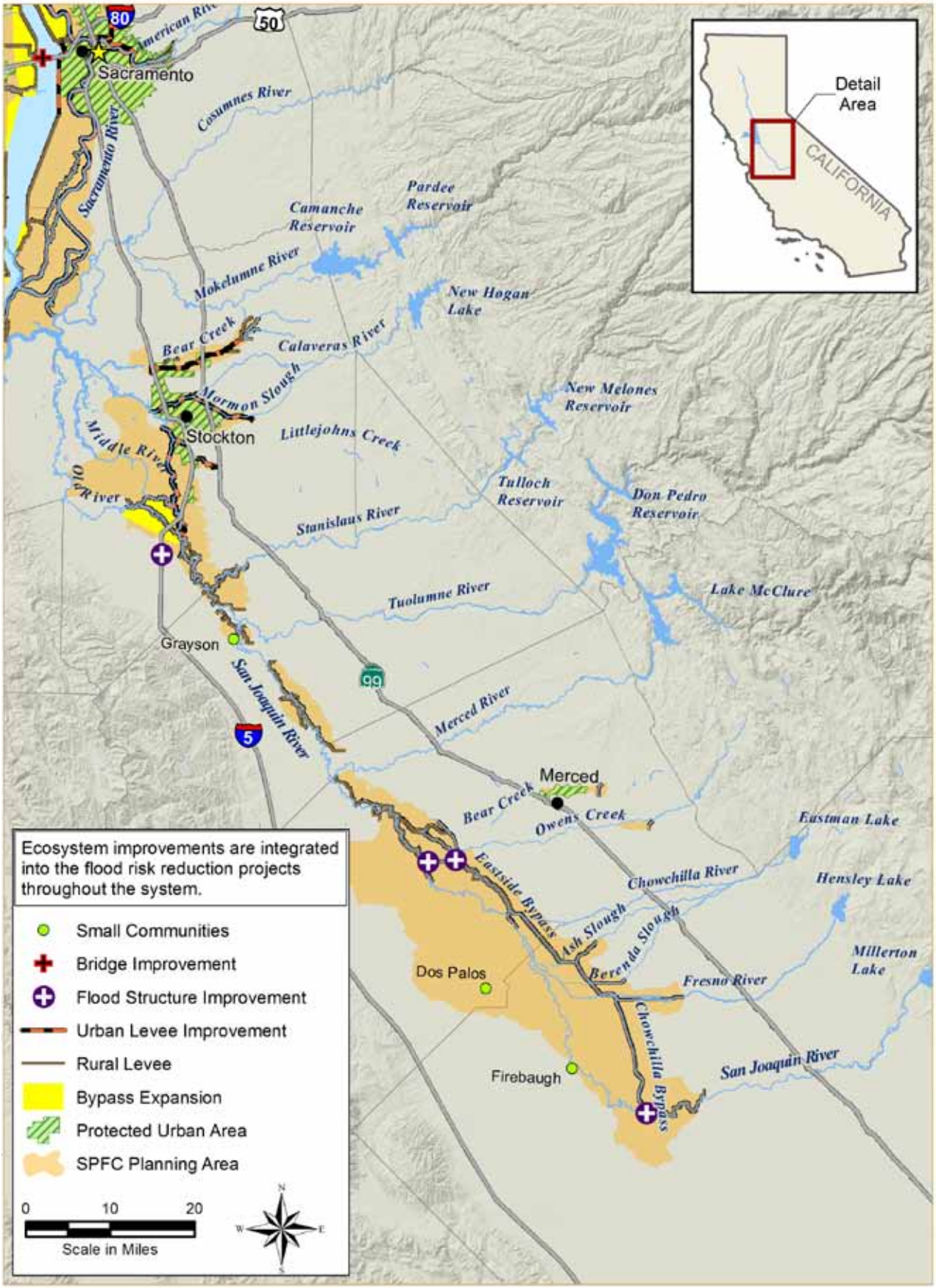
[1] All preliminary approaches and State Systemwide Investment Approach include Folsom Dam Raise, as Congress authorized.
[2] Actual level of protection varies by location.
[3] Includes all small communities within the SPFC Planning Area.
[4] Includes selected small communities within the SPFC Planning Area.

Key:
SPFC = State Plan of Flood Control
State = State of California



Key: SPFC = State Plan of Flood Control

Figure 3-1. State Systemwide Investment Approach – Sacramento River Basin Major Capital Improvements under Consideration



Key: SPFC = State Plan of Flood Control

Figure 3-2. State Systemwide Investment Approach – San Joaquin River Basin Major Capital Improvements under Consideration

Improvements to urban levees or floodwalls should follow DWR's ***Urban Levee Design Criteria***, at a minimum. The State strongly supports consideration of features that offer greater system resilience, such as levees that can withstand overtopping without catastrophic breaching. Another example is to build compartmentalized floodplains (the use of secondary levees, berms, or elevated roadways within protected areas to reduce the geographic extent of flooding when a failure occurs).

Levee projects in urban areas should consider setbacks, to the extent feasible, based on the level of existing development and the potential benefits. These projects should also preserve and/or restore, at minimum, shaded riparian habitat corridors along the waterside toe of levees. Other improvements will consider incorporating ecosystem preservation, restoration, and enhancements in project designs. Urban improvements should also be implemented and maintained consistent with the State's vegetation management approach (see Section 4.2 and Attachment 2 – Conservation Framework).

In addition to urban area levees, other system and regional elements included in the CVFPP, such as reservoir operational changes and new or expanded bypasses, have the potential to contribute to achieving an urban level of flood protection. These elements could potentially reduce the need for urban area levee improvements, and/or provide additional system flexibility and resiliency in accommodating hydrologic uncertainty, including climate change.

The CVFPP does not include improvements that may be needed to address interior drainage or other local sources of flooding. The State could pursue improvements to non-SPFC levees (see Section 3.6) that protect some urban areas even though the State has no responsibility over these levees at this time. The decision to add these levees to the SPFC would require Board action. Alternatively, the State may choose to participate in funding levee reconstruction or improvements, if found to be feasible.

LEVEE RESILIENCY

Reducing the risk of catastrophic system failure is an important aspect of flood risk reduction. Levee breaches increase flood losses and recovery costs, and lengthen the time needed to rebuild. USACE estimates that at least half of the direct losses from Hurricane Katrina may have been averted, had catastrophic breaching not occurred (Building a Stronger Corps: A Snapshot of How the Corps is Applying Lessons Learned from Katrina (USACE, 2009)).

Designing facilities to withstand overtopping and incorporating resiliency into overall system design not only help to reduce flood losses, but also provide flexibility to accommodate changing climate conditions, floodplain uses, and technical standards.

DWR will evaluate and participate in projects (in-place and with setbacks, if appropriate) that contribute to achieving an urban level of flood protection through reconstructing, rehabilitating, or improving SPFC facilities for the following urban areas in the Central Valley:

- **City of Chico** – Improvements include reconstruction of existing SPFC urban levees bordering the City of Chico to provide protection from flooding along local tributaries.

- **Yuba City and City of Marysville** – Improvements for this metropolitan area and adjacent existing urbanizing corridor (along Highway 99 north of Yuba City, and along Highway 70 within and south of Marysville) include the following:
    - » *Continue work to reconstruct and/or improve SPFC levees to urban design criteria along the Feather and Yuba rivers immediately adjacent to Marysville, consistent with ongoing local efforts. The State is supporting ongoing work to achieve an urban level of flood protection for the City of Marysville as part of the Yuba Basin Project. This project encompasses four phases of levee improvements and other actions, with an ultimate goal of protecting Marysville from a 250-year (0.4% annual chance) flood event.*
    - » *Continue to work with Sutter Butte Flood Control Agency to develop and implement projects to achieve an urban level of flood protection for Yuba City and adjacent existing urbanizing areas. This includes reconstructing and/or improving SPFC levees to urban design criteria along the right bank of the Feather River, adjacent to and upstream from Yuba City, as part of the Feather River West Levee Project.*
- **Sacramento Metropolitan Area** – Improvements for this area include the following:
    - » *Reconstruct and/or improve SPFC levees protecting urban areas along the Sacramento and American rivers to urban design criteria, as needed, to complete ongoing urban flood protection improvements within Sacramento County (includes the Laguna portion of Elk Grove). The State has supported the Sacramento Area Flood Control Agency's urban flood protection projects through cost sharing and grant funding under the FloodSAFE Early Implementation Program. Completed work that supports the SSIA includes levee improvements along the American River under the American River Watershed Common Features Project, and elements of the South Sacramento County Streams Project. Ongoing work includes levee improvements under the Natomas Levee Improvement Program and construction of an auxiliary spillway at Folsom Dam as part of the Folsom Dam Joint Federal Project.*
    - » *Reconstruct and/or improve SPFC levees to complete ongoing urban protection improvements for the City of West Sacramento. The State has supported urban levee improvements by the West Sacramento Area Flood Control Agency through the FloodSAFE Early Implementation Program grants program. Locally planned work, for potential State participation, includes levee reconstruction and raising, cutoff walls, setback levees, and erosion protection features.*

Levee Improvements in Natomas

  - *Evaluate the potential benefits of widening, automation, and operational changes to the Sacramento Weir and Bypass for the purpose of reducing peak flood stage along the Sacramento and American rivers, in combination with expansion of the Yolo Bypass (described later under System Improvements). Weir automation and other improvements have the potential to improve operational safety and flexibility.*

- **Cities of Woodland and Davis** – Continued participation in the Lower Cache Creek, Yolo County Woodland Area Feasibility Study, which considers modifications to the Cache Creek Settling Basin and other facilities to determine their feasibility and contribution toward achieving urban and rural-agricultural flood improvement in the area. Also evaluate the Cache Creek Settling Basin to identify a long-term program for managing sediment and mercury to maintain the flood conveyance capacity of the Yolo Bypass.

- **City of Merced** – Continued support of the Merced County Streams Project, which is contributing to improving flood protection for the City of Merced.

- **Stockton Metropolitan Area** – Improvements for this area include the following:
  - *Improve SPFC levees along the San Joaquin River and tributary channels.*
  - *Evaluate the potential benefits of and State interest in local floodgates and control structures, as they relate to facilities of the SPFC in and around Stockton, and contribute to achieving an urban level of flood protection.*

- **Other Areas** – For urban areas also protected by non-SPFC levees, the State may evaluate its interest in participating in levee improvements under other State programs.

3.3 Small Community Flood Protection

Many small communities in the SPFC Planning Area are expected to receive increased flood protection through implementation of system elements and improvements focused on adjacent urban areas, although some of these improvements may take many years to implement. The State will evaluate investments to preserve small community development opportunities without providing urban level of protection. However, some small communities adjacent to existing urban areas may achieve a 100-year level of flood protection or higher as a result of improvements for the adjacent urban areas. Additional State investments in small community protection will be prioritized based on relative community flood threat levels, considering factors such as population, likelihood of flooding, proximity to flooding source, and depth of flooding. Other factors considered in prioritizing small community flood improvements include financial feasibility and achievement of the CVFPP Goals with respect to integrating multiple benefits.

In general, the State will consider the following structural and nonstructural options for protecting small communities in the SPFC Planning Area from a 100-year (1% annual chance) flood:

- Protecting small communities "in-place" using ring levees, training levees, or floodwalls when improvements do not exceed a certain predetermined cost threshold. For planning purposes for the SSIA, DWR used a preliminary cost threshold of $100,000 per house protected, an approximate value for elevating or flood proofing a house. When estimated costs exceed the threshold, nonstructural means for flood protection will be considered. DWR will further evaluate this threshold during future studies.
- Reconstructing or making improvements to adjacent SPFC levees.
- Implementing nonstructural improvements, such as raising/elevating structures, flood proofing, willing seller purchases, and/or relocating structures, when the in-place improvements described above are not feasible.

In some cases, small communities may achieve flood protection as part of adjacent urban area improvements.

Based on planning level estimates, 15 small communities would receive 100-year (1% annual chance) flood protection from about 80 miles of levee improvements or new levee construction. A new levee is one constructed from the ground up, not a levee that has been repaired in place. Another five small communities would receive 100-year (1% annual chance) flood protection, at minimum, through implementation of urban and system improvements included in the SSIA. Seven small communities would receive flood protection through floodplain management actions such as flood proofing or raising structures.

Improvements to small communities should also be implemented and maintained consistent with the State's vegetation management approach (Attachment 2 – Conservation Framework). Other improvements will consider incorporating ecosystem preservation, restoration, and enhancements in project designs.

3.4 Rural-Agricultural Area Flood Protection

Rural-agricultural area levee improvements included in the SSIA are not as extensive as for urban areas and small communities, reflecting the lower levels of development within these floodplains.

3.4.1 State Plan of Flood Control Levees

The State recognizes that federal engineering guidance and design standards may result in cost-prohibitive levee repairs for many rural-agricultural areas. The State will work with rural-agricultural communities to develop applicable rural levee critera repair for SPFC levees (see Section 4). The State will also evaluate investments to preserve rural-agricultural activities that discourage incompatible development, and encourage compatible development, within floodplains.

The State's participation in rural-agricultural SPFC facility reconstruction projects may also require inclusion of nonstructural measures to manage risks in adjacent floodplains, such as purchasing agricultural conservation easements from willing landowners, where consistent with local land use plans. In addition to improving flood management, project designs will consider restoring shaded riparian aquatic habitat, wetlands, or other habitat. This includes protection and enhancement of existing healthy ecological communities, in addition to the enhancement/restoration of degraded ecosystem services and functions. Flood risk reduction projects in rural-agricultural areas that can achieve multiple resource benefits will be preferable to single purpose projects, and are likely to be encouraged through enhanced State and federal cost-sharing.

In general, the State will consider the following rural-agricultural flood protection options, with a focus on integrated projects that achieve multiple benefits:

- SPFC levee improvements in rural-agricultural areas will focus on maintaining levee crown elevations and providing all-weather access roads to facilitate inspection and floodfighting.
- Levee improvements, including setbacks, may be used to resolve known performance problems (such as erosion, boils, slumps/slides, and cracks). Projects will be evaluated that reconstruct rural SPFC levees to address identified threat factors, particularly in combination with small community protection, where economically feasible.
- Agricultural conservation easements that preserve agriculture and prevent urban development in current agricultural areas may be purchased, when consistent with local land use plans and in cooperation with willing landowners.

The State, in consultation with local entities, will prioritize available funding among all-weather roads and other important investments, addressing the greatest need first.

3.4.2 Hydraulic Structure Upgrades

In addition to hydraulic structures mentioned as part of urban and system improvements, existing hydraulic structures in the upper San Joaquin River Basin need to be upgraded because of facility age or operational problems. In some cases, gates do not operate properly, new automation is needed, or the structures are otherwise deteriorated.

3.4.3 Local Non-State Plan of Flood Control Levees

During future feasibility studies, the State will evaluate projects to maintain the function of local levees (not part of the SPFC) if they contribute to the effective operations and maintenance of the SPFC. The State may be able to participate through existing programs on feasible projects.

3.4.4 Removal of State Plan of Flood Control Facilities

The State will evaluate potentially removing (physically or administratively) facilities of the SPFC in rural areas, including rock revetment, levees, and other facilities,

consistent with criteria presented in Section 4. Removing small portions of the SPFC that are no longer functioning would reduce the State's responsibility and costs for operations and maintenance. Facilities that may be evaluated for potential removal from the SPFC include the following:

- A two-mile long segment of the Feather River right-bank levee, upstream from the Thermalito Afterbay, which was replaced by an embankment constructed to create Thermalito Afterbay (on its southeast side).
- Approximately seven miles of levee included in the Lower San Joaquin River and Tributaries Project, which is currently being physically breached and removed. This effort is part of a nonstructural project modification, under the authority of Public Law 84-99, following damage during the 1997 floods.
- Intermittent SPFC levees along reaches of the San Joaquin River and in the vicinity of the Mariposa Bypass and Deep Slough. If pursued, removal projects should consider integration of wetland, riparian, and floodplain habitat restoration.
- Some existing, intermittent bank protection sites along the Sacramento River between Red Bluff and Chico Landing, now unconnected with the active river channel and believed to no longer provide a flood management function by erosion control.
- Levees and pumping plants from the Middle Creek Project at the west end of Clear Lake, for which removal is currently underway. Facilities removal was authorized by Congress in the Water Resources Development Act of 2007.

Floodflow over the Moulton Weir

3.5 System Improvements

System elements include physical actions or improvements with the potential to provide benefits across large portions of the flood management system, and improve the overall function and performance of the SPFC in managing large floods. These actions enhance the system's overall ability to convey and attenuate flood peaks through expansion of bypass capacity and storage features. System improvements provide flood protection benefits to urban, small community, and rural-agricultural areas by lowering flood stages.

These actions also present significant opportunities to improve ecosystem functions and continuity on a systemwide level. System improvements should also be implemented and maintained consistent with the State's vegetation management approach (see Section 4.2 and Attachment 2 – Conservation Framework).

The following sections describe system elements included in the SSIA.

3.5.1 Weir and Bypass System Expansion

The Sutter and Yolo bypasses, in combination with their appurtenant control features – the Moulton, Colusa, Tisdale, Fremont, and Sacramento weirs/bypasses – function as the central backbone of the Sacramento River Flood Control Project. This weir and bypass system redirects damaging floodflows away from the main channels of the Sacramento, Feather, and American rivers, conveying up to 490,000 cubic feet per second during large flood events. The considerable capacity of the bypass system also slows the movement of floods, effectively attenuating flood peaks and metering flows into the Delta. For initial planning purposes, technical evaluations are based on construction of all bypass expansions and extensions described below.

Bypass expansions would increase the overall capacity of the flood system to convey large flood events. Peak flood stages would be reduced along the Sacramento River and, to a lesser extent, along its tributaries. The lower stages throughout the system benefit flood management in urban, small community, and rural-agricultural areas. Floods from storms centered within different watersheds of the Sacramento River Basin have different characteristics, and bypass system expansion would contribute to greater system flexibility in managing these different flood events.

Improvements would be designed and operated in consideration of ecosystem restoration features and benefits, including conservation and restoration of aquatic and floodplain habitats and continued compatible agricultural land uses within the bypass. Improvements may include contouring and channelizing to facilitate proper draining and to lessen the possibility of entraining fish. Contouring may also increase the frequency of floodplain activation in places to promote wetland and riparian habitat success. When consistent with local land use plans, and in cooperation with willing landowners, the State will consider purchasing agricultural conservation easements adjacent to the Sutter and Yolo bypasses to preserve agriculture and prevent urban land uses.

Sutter Bypass Expansion

Future studies to refine specific project elements related to bypass expansion should consider increasing the capacity of the Sutter Bypass to convey large flood events. Expansion would likely require building a new levee for about 15 miles along one side of the bypass to widen the bypass for increased flow capacity. Although the required width of the bypass has not been determined, DWR used a 1,000-foot increase in the bypass width for planning purposes. The evaluations for planning purposes were initially based on 75 percent of the new width allocated to agricultural use and 25 percent allocated to habitat restoration.

Modifications to the Colusa and Tisdale weirs and the Butte Basin overflow areas from the Sacramento River will be considered as part of the expansion. The expansion may require rebuilding some SPFC facilities, such as weirs and pumping stations.

Yolo Bypass Expansion

Future studies to refine specific project elements related to bypass expansion should consider the following:

- Lengthening and/or lowering the Fremont Weir and incorporating features to facilitate fish passage through the upper bypass and at the weir.
- Increasing capacity in the upper portion of the Yolo Bypass (upstream from the Sacramento Bypass) by setting back levees and/or purchasing easements.
- As described under Section 3.2, evaluate the Cache Creek Settling Basin to identify a long-term program for managing sediment and mercury to sustain the flood conveyance capacity of the Yolo Bypass.
- Expanding the lower end of the Yolo Bypass upstream from Rio Vista by setting back levees.

About 42 miles of new levee could potentially be required to expand the Yolo Bypass.

Sacramento Bypass Expansion

As part of urban elements to reduce flood risks to the Sacramento/West Sacramento metropolitan area, future studies to refine specific project elements related to bypass expansion (also described under Section 3.2) will consider the following:

- Widening the Sacramento Weir
- Automating the weir or eliminating gates
- Widening the Sacramento Bypass by constructing about two miles of new levee
- Making operational changes to the Sacramento Weir and Bypass, as necessary

3.5.2 New Bypasses

Two new bypasses are included in the SSIA. While they would primarily provide benefits to the urban areas of Yuba City/Marysville and Stockton, they are described here with other system improvements because of their complexity and long lead time for construction.

Feather River Bypass

Evaluate the feasibility of constructing a new bypass from the Feather River to the Butte Basin to further contribute to improving overall urban, small community, and rural-agricultural flood protection in the planning area. The new bypass would require construction of about 16 miles of new levee on one side of the Cherokee Canal. A new bypass would have the potential to reduce flood stages by as much as

one foot at Yuba City and Marysville during a 100-year (1% annual chance) flood. A new bypass would also provide greater system resiliency in accommodating future hydrologic changes in the planning area, including those due to climate change, and would be a relief path when Feather River flows are greater than 200-year (0.5% annual chance). The State will consider findings of ongoing studies by local entities when evaluating the potential system benefits of the bypass.

Lower San Joaquin Bypass

Evaluate the construction of a new bypass in the south Delta (expansion of Paradise Cut and/or other south Delta waterways), primarily for the purpose of reducing peak flood stages in the Stockton area. A south Delta bypass would include habitat components. A gate structure or weir at Paradise Cut will be considered as part of the project. The new bypass would require construction of about eight miles of new levee. In combination with the bypass, the State will consider purchasing easements in the south Delta from willing sellers to provide floodwater storage and reduce peak flood stages along the San Joaquin River.

3.5.3 Flood System Structures

Several flood system structures will require rehabilitation, rebuilding, or modifications. These structures are primarily associated with the bypass expansions and new bypasses described above. Flood structures and related actions include the following:

- Intake structure for the new Feather River Bypass
- Butte Basin small weir structures
- Upgrade and modification of Colusa and Tisdale weirs
- Modifications to bridges to reduce or eliminate flow constrictions
- Sacramento Weir widening and automation or elimination of gates
- Gate structures and/or weir for new Lower San Joaquin Bypass
- Low-level reservoir outlet at New Bullards Bar Dam to facilitate changes in reservoir operations
- Other pumping plants and small weirs, such as those associated with the Sutter Bypass

In addition, opportunities to expand fish passage at SPFC structures will be considered.

3.5.4 Flood Storage

Preliminary systemwide analyses have identified potential benefits and opportunities for reservoir flood storage and operational changes for flood management in the Sacramento River and San Joaquin river basins.

Flood storage may reduce the need for some types of downstream actions, such as levee improvements, and can offset the hydraulic effects of system improvements on downstream reaches. Additional flood storage can also provide greater flexibility in

accommodating future hydrologic changes, including climate change, and provide greater system resiliency (similar to that provided by freeboard on levees) in the face of changing downstream conditions.

New Reservoir Storage

The only new surface water storage included in the SSIA is the Folsom Dam Raise, which is already authorized. During future feasibility studies, the State may consider partnering with other willing agencies on expanding existing reservoir storage.

Transitory Storage

The SSIA has not identified specific floodplain transitory storage, but may consider such storage on a willing-seller basis where consistent with local land use plans, all affected land owners support such storage, and the new flood storage area can be safely isolated from adjacent areas (easements or fee title).

3.5.5 Conjunctive Use and Groundwater Recharge

Capturing and using floodflows for groundwater recharge has been considered as a component of integrated flood and water management for the SSIA. Conjunctive water management through use of floodwater for recharge has been practiced for many years, especially in the San Joaquin Valley. The State supports programs that use flood flows for groundwater recharge to improve water management throughout California. However, the State also recognizes the limitations of direct groundwater recharge in lowering flood stage and reducing flood risks, especially in the Sacramento River Basin. These limitations are due to inadequate groundwater storage capacity, except in the American River Basin, and low recharge rates in comparison with large floodflows. More substantial recharge capacities cannot be achieved without significant investments in off-stream recharge facilities or regional infrastructure to facilitate in-lieu recharge, such as those North of the American River in the Sacramento metropolitan area. Consistently, these facilities are developed by local agencies with emphases on water supply purposes. Considering these limitations, the SSIA provides opportunities for in-channel groundwater recharge and, although not recommending any specific recharge projects at this time, encourages exploring recharge opportunities in the San Joaquin River Basin, especially for capturing a portion of high flows from snowmelt, where feasible.

3.5.6 Operational Changes

Operational changes to SPFC facilities can benefit both flood risk reduction and the ecosystem. Initial concepts for operational changes are described below for existing reservoirs and bypasses.

Coordinated Reservoir Operations

Most major reservoirs in the Central Valley have been designed and built to meet multiple purposes, including water supply, recreation, and flood control. These multipurpose reservoirs have defined water conservation space for capturing winter and spring runoff for water supply purposes, and designated flood control space to capture, manage floodflows to reduce flood releases downstream.

The Forecast-Coordinated Operations (F-CO) Program seeks to coordinate flood releases from the reservoirs located in various tributaries of a major river to optimize the use of downstream channel capacity, the use of total available flood storage space in the system, and eventually to reduce overall peak floodflows downstream from these reservoirs. The management process and partnerships, formed during early development of the F-CO Program, contribute significantly to enhanced coordination of reservoir operations during flood events.

Implementing Forecast-Based Operations (F-BO) of Central Valley reservoirs is the next logical step in advancing the F-CO Program. The intended F-BO would involve the use of improved long-term runoff forecasting and operating within the parameters of an existing flood control diagram. Proactive reservoir management through the use of more flexible flood control diagrams would require extensive studies of the most feasible diagrams, environmental documentation for changing reservoir operations, and Congressional approval for new dynamic flood control diagrams. The SSIA includes implementation of both F-CO and F-BO for all reservoirs in the Central Valley.

Water Flowing from Sacramento River to Yolo Bypass Through Sacramento Weir and Bypass

As part of early FloodSAFE implementation, operators at Lake Oroville and New Bullards Bar Reservoir have begun coordinating flood operations to better manage downstream flows on the Yuba and Feather rivers. The coordinated operation of New Bullards Bar Reservoir with Lake Oroville will require construction of an outlet to accommodate early releases of floodflows from New Bullards Bar Dam; preliminary evaluations indicate that a new outlet with a capacity of about 20,000 cubic feet per second should be considered.

In addition, DWR will consider willing partnerships with other reservoir operators to accomplish F-BO and overall F-CO program objectives.

Weir and Bypass Operational Changes

The State proposes to investigate modifying the function and operation of weirs that spill floodwater to the bypasses in the Sacramento River Basin. The concept is to physically lower crests of overflow weirs and modify operations so that bypasses carry flows earlier and for longer durations during high river stages. These changes would reduce river stages and flood risks along main rivers. Depending on timing, duration, and a host of related hydraulic factors, the more frequently activated floodplain in the bypasses would potentially provide a more productive rearing habitat for juvenile salmonids and other native fish and may provide riparian habitat.

One potential change in operations is for the Sacramento Weir, which is currently opened when the Sacramento River water surface elevation reaches 27.5 feet at the I Street Bridge. Evaluation may show that opening the weir when the river stage

reaches 25 feet provides improvements in both flood management and ecosystem function. Similarly, the crest of the Fremont Weir may be lowered or other modifications made to provide flow to the Yolo Bypass below its current spill stage. Other structures that would be subject to assessment and potential operational modifications include Moulton, Colusa, Tisdale, and Paradise Cut weirs.

Evaluations would also need to consider the extent of potential impacts from more frequent and longer durations of flooding in the bypasses. For example, some levees along the bypasses may not be as durable as levees along the main rivers – levee reliability could be lowered by longer duration wetting. Longer duration flooding of the bypasses would increase the duration of levee patrols. Also, extending the duration of bypass flooding could interfere with ongoing agricultural practices.

3.5.7 Features to Mitigate Potential Flood Stage Increases

Since future feasibility studies are needed to refine the SSIA, the ultimate configuration of facilities will likely vary from those presented in the SSIA. Only at that time will the State know the potential magnitude and extent of hydraulic impacts from planned improvements, if any, within the system. Cost estimates for the SSIA include an allowance for features to mitigate significant hydraulic impacts caused by project implementation.

A number of mitigation features may be used, depending on the hydraulic impacts throughout the system and downstream from SPFC facilities. Mitigation features may include the following:

- Levee enhancements for affected areas
- New surface storage partnerships with willing reservoir operators
- New transitory storage
- Modification of project designs to limit stage increases
- Other features that appear promising during feasibility studies

3.6 Non-State Plan of Flood Control Levees

Approximately 420 miles of private non-SPFC levees are closely associated with SPFC levees. Non-SPFC levees are those (1) that abut SPFC levees, (2) whose performance may affect the performance of SPFC levees, or (3) that provide flood risk reduction benefits to areas also being protected by SPFC features.

3.6.1 Non-State Plan of Flood Control Urban Levees

A total of about 120 miles of non-SPFC urban levees work in conjunction with SPFC levees to provide protection to urban areas within the SPFC Planning Area. Table 3-3 shows the distribution of non-SPFC levees for the various urban areas. Figure 3-3 shows the locations of these non-SPFC urban levees.

To achieve 200-year (0.5% annual chance) flood protection, improvements to both SPFC and non-SPFC levees will be needed. DWR has estimated that improving these non-SPFC urban levees to achieve this level of protection would cost approximately $1.2 billion in 2011 dollars. This cost is included in the SSIA costs.

Table 3-3. Non-State Plan of Flood Control Urban Levees

URBAN AREA	NON-SPFC LEVEES (miles)
Chico	0
Yuba City	0
Marysville	0
Sacramento	24
West Sacramento	30
Woodland	1
Davis	0
Stockton	65
Merced	0
Total	120

Key:
SPFC = State Plan of Flood Control

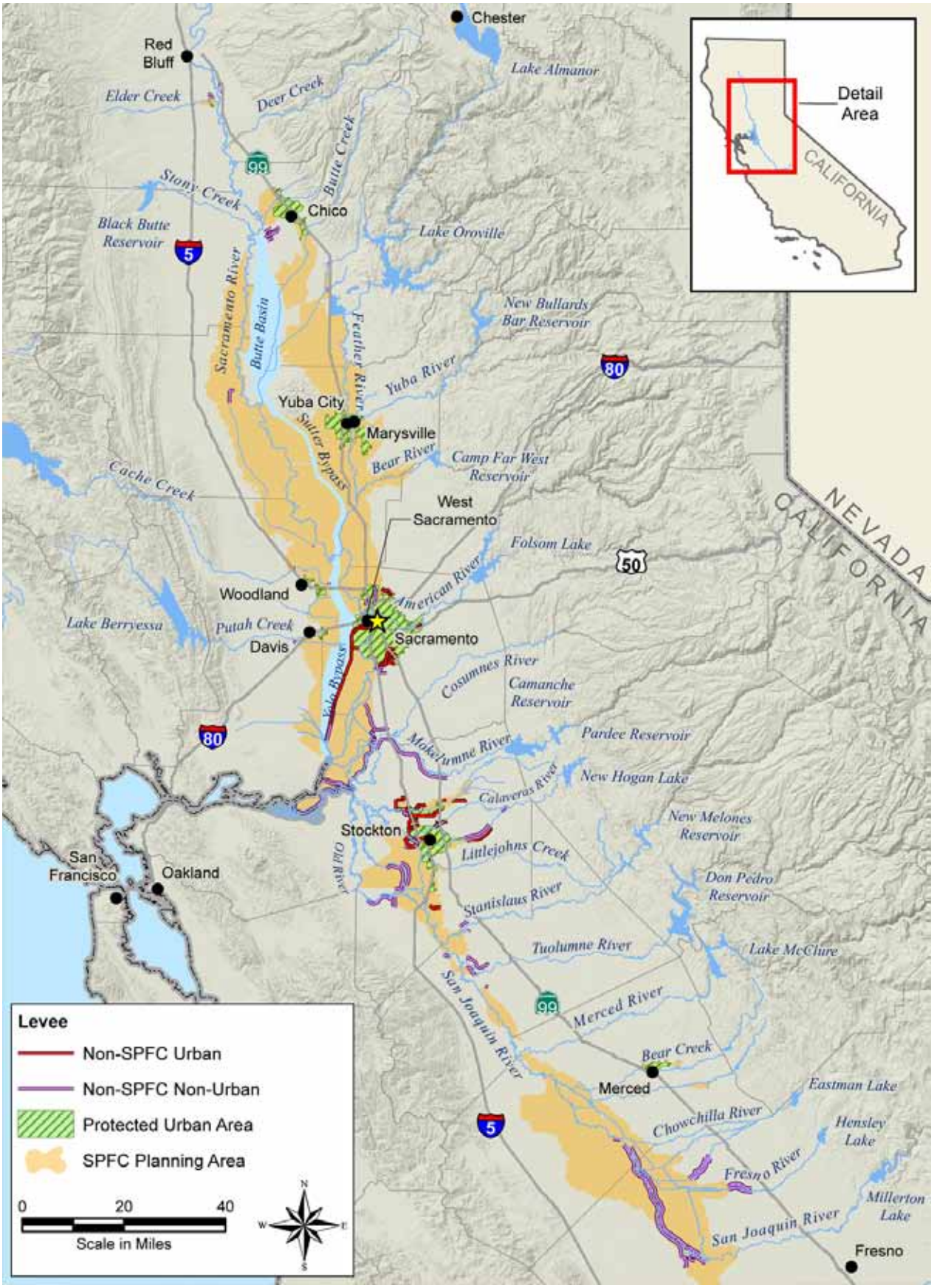
The State recognizes that for an urban area protected jointly by both SPFC and non-SPFC levees, the legislated requirement for an urban level of flood protection (200-year or 0.5% annual chance flood) requires improvement to both types of facilities. The Board may choose to treat some or all these non-SPFC levees in a similar manner to SPFC urban levees for State participation in levee improvements, and potentially add them to the SPFC. Alternatively, if the Board chooses not to add these levees to the SPFC, the State will consider participation in improvements to these levees under other State programs.

In addition, completed and ongoing Early Implementation Projects initiated since bond funding became available in 2007 will likely be added to the SPFC when final documentation is complete.

3.6.2 Non-SPFC Nonurban Levees

About 300 miles of non-SPFC nonurban levees work in conjunction with SPFC levees in rural areas. Most of these levees are along the upper San Joaquin River. Figure 3-3 shows the locations of non-SPFC nonurban levees that protect portions of the SPFC Planning Area. Non-SPFC Delta levees are not included since they do not protect the SPFC Planning Area.

Improving these levees to the same level as SPFC rural levees would cost about $300 million. This cost is not included in the costs for the SSIA. Portions of these non-SPFC nonurban levees may be candidates for being added to the SPFC after preparation of regional plans and feasibility studies (see Section 4), but DWR has not included them as part of the SSIA.



Key: SPFC = State Plan of Flood Control

Figure 3-3. Non-State Plan of Flood Control Levees Protecting Portions of State Plan of Flood Control Planning Area

3.7 Integrating Ecosystem Restoration Opportunities with Flood Risk Reduction Projects

While flood risk reduction (public safety) remains the primary goal of the CVFPP, early integration of other important resource management goals into the plan formulation process remains a premise of integrated flood management. Those supporting goals, along with the legislative objectives, are described in Section 1.6.2. This will help improve overall flood project delivery and may broaden public support for flood projects.

In taking an integrated flood management approach, the intent of the SSIA is to make progress on improving ecological conditions on a systemwide basis, using integrated policies, programs, and projects. This approach builds upon and advances on-going efforts and successes to incorporate environmental benefits into flood management projects. Integrating environmental stewardship early into policy and project planning, development, and implementation will help move beyond traditional project-by-project compensatory mitigation. This approach also creates the opportunity to develop flood management projects that may be more sustainable and cost-effective, and can provide ecological benefits while protecting public safety. Under the SSIA, ecosystem restoration opportunities are integral parts of system improvements, as well as urban, small community, and rural-agricultural area flood protection projects.

Attachment 2 to the CVFPP, the Conservation Framework, provides a preview of a long-term Central Valley Flood System Conservation Strategy (Conservation Strategy) that DWR is developing to support the 2017 update of the CVFPP. The Conservation Framework focuses on promoting ecosystem functions and multi-benefit projects in the context of integrated flood management for near-term implementation. The Conservation Framework provides an overview of the floodway ecosystem conditions and trends and key conservation goals that further clarify the CVFPP's ecosystem goal. The Conservation Framework also identifies opportunities for integrated flood management projects that can, in addition to improving public safety, enhance riparian habitats, provide connectivity of habitats, restore riparian corridors, improve fish passage, and reconnect the river and floodplain.

The long-term Conservation Strategy will be consistent with the Conservation Framework and provide a comprehensive, long-term approach for the State to achieve the objectives of the Central Valley Flood Protection Act and the

CENTRAL VALLEY FLOOD PROTECTION ACT OF 2008

California Water Code Section 9614.

"The Plan shall include…

(j) A description of structural and nonstructural means for enabling or improving Systemwide riverine ecosystem function, including, but not limited to, establishment of riparian habitat and seasonal inundation of available flood plains where feasible."

California Water Code Section 9616.

"The Plan shall meet…multiple objectives…including…

(7) Promote natural dynamic hydrologic and geomorphic processes.

(9) Increase and improve the quantity, diversity, and connectivity of riparian, wetland, flood plain, and shaded riverine aquatic habitats, including the agricultural and ecological values of these lands.

(11) Promote the recovery and stability of native species populations and overall biotic community diversity."

FloodSAFE and CVFPP goals. Flood protection projects that are integrated with environmental restoration components have the potential to increase federal and State cost-sharing for flood management projects and make improvements more affordable for local entities.

Consistent with the Conservation Framework, ecosystem restoration and enhancement opportunities of the SSIA include the following:

- **Regional improvements (urban, small community, and rural-agricultural areas)** – Flood protection projects will preserve important shaded riparian aquatic habitat along riverbanks and help restore the regional continuity/connectivity of such habitats. Planning and designs for flood risk reduction projects will consider opportunities to enhance ecosystem functions.
- **System improvements** – DWR, through its multiple programs, will continue to work on integrated flood management projects within the Systemwide Planning Area, and will evaluate and initiate other projects that benefit the SPFC. Sutter and Yolo bypass expansions (described previously) may increase the overall area of floodplain that would support wetland habitats.
- **Fish passage improvements** – Improve fish passage at SPFC weirs, bypasses, and other flood management facilities undergoing modification or rehabilitation to improve access to upstream aquatic habitat and facilitate natural flow routing. Possible candidates for fish passage improvements include the following:
    - *Big Chico Creek system*
    - *Tisdale and Colusa weirs*
    - *Cache Creek Settling Basin*
    - *Fremont Weir*
    - *Yolo Bypass*
    - *Willow Slough Weir in Yolo Bypass*
    - *Sacramento Weir*
    - *Sand Slough Control Structure*

DWR's goal in integrating ecosystem restoration and enhancement is to achieve overall habitat improvement, thereby reducing, or eliminating the need to mitigate for most ecosystem impacts. However, depending on the timing of improvements and implementation, some ecosystem mitigation may be required.

3.8 Climate Change Adaption Strategy

As mentioned in Section 1, climate change is likely to generate more extreme floods in the future. Development of flood hydrology that accounts for the potential effects of climate change is a complicated and time-consuming exercise that must account for many uncertainties. DWR, in partnership with the USACE, is in the process of developing new hydrology that includes the effects of climate change, but that hydrology will not be ready for use in system evaluation until late 2012. Therefore,

the new hydrology will be most useful in technical evaluations leading to the 2017 update of the CVFPP.

Even though climate change hydrology was not yet available, development of the SSIA included allowances for potentially higher flows due to climate change. Providing wider bypasses to lower floodwater surface elevations would increase flow-carrying capacity and flexibility to deal with higher flood flows that may occur because of climate change. Changes in reservoir operations from F-CO and F-BO can provide flexibility and adaptability to changes in extreme flood events. In addition, the SSIA includes the potential for the State to participate with others in reservoir expansion projects and in obtaining rights for floodplain transitory storage from willing landowners. These and other strategies to address the effects of climate change will be further evaluated for the 2017 update of the CVFPP.

The effects of sea level rise are important in the Sacramento-San Joaquin Delta, portions of which are protected by SPFC facilities. Sea level rise will affect levees within the Delta and for some distance upstream along the rivers. The estimated average sea level rise is currently under the review of the National Research Council. For the 2012 CVFPP, high tide conditions during the 1997 flood were used as the boundary conditions for hydraulic analysis and could be considered an initial, surrogate condition under climate change. This tide was about two feet higher than would normally be expected on the basis of solar and lunar gravitational forces that create tides. DWR will continue to coordinate with other DWR programs, Delta Stewardship Council's Delta Plan, and ongoing USACE feasibility studies to collectively address how sea level rise could contribute to potential estuary flooding in the Delta.

For the 2017 CVFPP update, improved sea level rise information will be used. DWR will develop approaches for addressing sea level rise that may vary depending on the expected range and rate of sea level rise. For example, these approaches may vary from abandoning some facilities to raising and strengthening affected levees. Some affected areas may be transformed to ecosystem uses. Other management approaches may be considered, as supported by technical analysis during the preparation of regional plans and feasibility studies.

DWR is developing a new methodology for estimating the impacts of climate change on flood hydrology. Typical climate change impact assessments for long-term water supply needs consider likely changes in average temperature and precipitation. However, climate change impacts on extreme events, such as floods, will not result from changes in averages, but from changes in local extremes. Therefore, DWR collaborated with the National Oceanic and Atmospheric Administration, U.S. Geological Survey, USACE, and Reclamation in developing a new methodology based on the intensity of "Atmospheric Rivers," which are fast-moving, concentrated streams of water vapor that can release heavy rains. Since the moisture source of

CLIMATE CHANGE

Climate change impacts for extreme events, such as flooding and droughts, will result not from changes in averages, but from changes in local extremes. DWR initiated a study to investigate a new approach to assessing impacts based on climate change indices more suitable for flood events – "Atmospheric Rivers."
Preliminary findings are promising for:

- Assessing climate change impacts on flood management and to communities receiving flood protection
- Identifying prudent system improvements that are resilient in climate change conditions

DWR intends to continue methodology development and application for the 2017 CVFPP Update.

water vapors is often the ocean southwest of the Hawaiian Islands, these storm events are often referred to as Pineapple Expresses.

Since available climate change information does not present probabilistic characteristics, DWR is working on the concept of prudent decision making that focuses on investments that could accommodate a broader range of climate change scenarios rather than optimizing investments within a few selective scenarios. The resulting Threshold Analysis Approach was applied to the Yuba-Feather system in a proof-of-concept pilot study. The results of the pilot study suggest that under the F-CO, New Bullards Bar Dam on the Yuba River has inadequate capacity to help respond to climate change, as compared to Oroville Dam on the Feather River, because of limited regulating capacities. This information provides guidance for the overall investment strategy for modifications such as enlarged outlets at New Bullards Bar Dam. DWR intends to fully develop the Threshold Analysis Approach for the 2017 Update with new Central Valley hydrology and improved Atmospheric River indices.

In summary, improved climate change information will allow more detailed evaluation of potential climate change impacts on the SPFC and refinement of approaches to manage higher floodflows and sea levels during preparation of regional plans and feasibility studies.

3.9 Considerations for Sacramento-San Joaquin Delta

Land uses in the Delta outside the SPFC Planning Area are primarily rural and dominated by agriculture and open space, with several dispersed small communities. Flood management facilities primarily include levees, which often protect lands at or below sea level. Flood management responsibilities in Delta areas outside the SPFC Planning Area reside with a variety of local agencies, supported by the State's Delta Special Flood Projects Program and Delta Levees Maintenance Subventions Program.

Restoration of ecosystem functions and aquatic habitats in the Delta have been, and continue to be, the focus of various State, federal, and local efforts, in addition to water supply and flood management planning. Major efforts include the Delta Stewardship Council's Delta Plan, the Delta Protection Commission's Economic Sustainability Plan, the Bay Delta Conservation Plan, and the Delta Habitat Conservation and Conveyance Program.

The CVFPP supports a financially and environmentally sustainable Delta. Depending on which elements of the SSIA are eventually implemented in upstream regions, there is a potential for hydraulic impacts in the Delta. The SSIA includes management actions (see Section 3.5.7), and a cost allowance, to lessen or mitigate these impacts compared with current conditions.

The State will continue to support Delta flood management improvements outside the SPFC Planning Area through existing programs and in coordination with ongoing multiagency Delta planning efforts. Existing programs include the Statewide

Flood Management Planning Program, Delta Levees Maintenance Subventions Program, Delta Special Flood Control Projects program, emergency planning and response support, and other residual risk management programs and support provided by the State.

3.10 U.S. Army Corps of Engineers Levee Vegetation Policy and Public Law 84-99 Eligibility

The USACE levee vegetation management policy affects implementation of the SSIA and its ability to maintain eligibility for federal Public Law 84-99 rehabilitation assistance in the event of flooding. The following provides context for the USACE policy and the State's resultant levee vegetation management strategy described in Section 4. A more detailed description of the levee vegetation management issue can be found in Attachment 2 – Conservation Framework.

3.10.1 U.S. Army Corps of Engineers Levee Vegetation Policy

In April 2007, USACE released a draft white paper, ***Treatment of Vegetation within Local Flood Damage Reduction Systems***, which clarified its nationwide policy regarding the removal of wild growth, trees, and other encroachments as a prerequisite for Public Law 84-99 eligibility. The USACE policy requires removal of all woody vegetation from levee slopes and toe areas. This policy is not consistent with the USACE "vegetation variance letter" dated August 3, 1949, which revised the Standard O&M Agreement to include the following text: "Brush and small trees may be retained on the waterward slope where desirable for the prevention of erosion and wave wash. Where practicable, measures shall be taken to retard bank erosion by the planting of willows or other suitable growth on areas riverward of the levees." The 2007 policy is also not consistent with the long-standing USACE practice of protecting trees while performing levee repairs on Central Valley levees, and requiring new tree planting in its levee designs, where feasible.

USACE has proposed the new levee vegetation policy to improve levee integrity and reduce flood risk. The ***Flood Control System Status Report*** includes DWR's assessment of the safety risks associated with trees and shrubs on, and adjacent to, levees. The report concludes that properly trimmed and spaced levee vegetation poses a low threat to levee integrity in comparison with other risk factors, and can help stabilize soils and reduce nearshore flow velocities. DWR does not believe that the presence of properly maintained woody vegetation on "legacy levees" constitutes a degree of risk that necessarily requires removing vegetation or constructing engineered works to address the perceived risk. Instead, DWR believes such "legacy levee vegetation" needs to be considered in a balanced recognition of its role to the ecosystem and to the levee's integrity.

A preliminary assessment by DWR has also concluded that the complete removal of existing woody vegetation along the 1,600-mile legacy Central Valley levee system would be enormously expensive, would divert investments away from more critical

threats to levee integrity, and would be environmentally devastating. Recent USACE research regarding the risks associated with trees on levees found that trees can slightly increase or decrease levee safety, depending on their location on the levee slope. While concluding that more research is needed, the research did not characterize levee vegetation as a major risk factor.

In the spirit of cooperation, DWR, USACE, local maintaining agencies, and key federal and State resources agencies, have been engaged in California Levees Roundtable discussions since August 2007. Early discussions regarding ways to address USACE's levee vegetation policy led to the ***California's Central Valley Flood System Improvement Framework*** (Framework Agreement), dated February 27, 2009. The Framework Agreement allows Central Valley levees to retain acceptable maintenance ratings and Public Law 84-99 rehabilitation eligibility as long as levee trees and shrubs are properly trimmed and spaced to allow for visibility, inspection vehicles, and flood-fight access. The Framework Agreement states that "…the eligibility criteria will be reconsidered based on the contents of the CVFPP."

Erosion along the Sacramento River

While the California Levees Roundtable discussions were underway, USACE issued Engineering Technical Letter (ETL) 1110-2-571, which finalized its ***Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures*** (April 10, 2009). These guidelines essentially established a woody vegetation-free zone on all levees and the adjoining ground within 15 feet of the levee on both sides, and are at odds with DWR's independent assessment described above. As an implementation directive for the ETL, USACE subsequently issued a draft Policy Guidance Letter (PGL), ***Variance from Vegetation Standards for Levees and Floodwalls*** (February 9, 2010). Congress, through the Water Resources Development Act of 1996, Section 202 (g), had mandated that USACE "address regional variations in levee management and resource needs" – but the February 2010 draft PGL did not address regional variations.

Before and following release of the draft PGL, DWR has recommended that USACE formulate a variance process that is workable on a systemwide scale, such as might be required for the Central Valley flood management system. DWR has recommended that such a variance process should allow for consideration of the geotechnical, hydraulic, environmental, and economic factors that DWR believes are important in formulating and prioritizing levee repairs and improvements. Because the February 2010 draft PGL was not workable from DWR's perspective, in May 2011, DWR proposed an alternative variance procedure for USACE consideration. Although USACE has stated their procedural inability to work individually with California (or collectively with several non-federal entities) to collaboratively develop a variance policy that recognizes and accommodates regional differences, DWR remains hope-

ful that USACE will issue a final vegetation variance PGL that will complement and be consistent with the CVFPP.

It is important to note that the large-scale removal of levee vegetation runs at odds with State and federal environmental requirements. State and federal resource agencies find that the ETL itself, and the potential impacts of widespread vegetation removal due to strict enforcement of that regulation, pose a major threat to fish and wildlife species, including protected species, and to their recovery. Similarly, local agencies are concerned about negative impacts to public safety from ETL compliance due to redirection of limited financial resources to lower priority risks. For this reason, widespread vegetation removal is unlikely to be a feasible management action for many of California's levees.

A further complication is the question of shared responsibility for activities to address woody vegetation. The USACE ETL and associated February 2010 draft PGL do not recognize that legacy levee vegetation exists for a wide variety of reasons (in many cases, because USACE itself placed the vegetation or encouraged its placement or retention), and instead treats all legacy levee vegetation as if it were "deferred maintenance" and solely a nonfederal responsibility. Consequently, USACE asserts through the ETL and draft PGL that all of the administrative and financial burdens for ETL compliance, or for obtaining a variance, should be placed on its nonfederal partners. The State continues to encourage USACE to accept shared responsibility for addressing levee vegetation issues, as appropriate – which would also facilitate USACE plan formulation as a partner in cost-shared flood risk reduction projects.

It is important to note that DWR's purpose in advocating for shared responsibility is not to commit federal funds toward the enormous cost of removing vegetation to achieve ETL compliance. Rather, DWR is advocating that such inordinate costs be avoided by having USACE partner with DWR and local agencies in addressing legacy levee vegetation issues, jointly considering the environmental and risk reduction implications of vegetation remediation within the context of prudent expenditure of limited public funds. DWR will continue to confer with USACE on plan formulation concepts that recognize shared responsibility for addressing vegetation issues (in parallel with traditional levee risk factors) within a systemwide risk-informed context that is intended to enable critical cost-shared flood system improvements to move forward.

A critical limitation of the USACE ETL is that it is written strictly in terms of new levee construction. It does not recognize and address the unique engineering and environmental attributes presented by well-established "legacy vegetation" as an integral aspect of many SPFC levees. While the CVFPP proposes to adhere to USACE vegetation policy for new levee construction, compatibility of the CVFPP levee vegetation management strategy with implementation of USACE national vegetation policy for "legacy levee vegetation" needs flexibility to recognize and accommodate regional differences – which could be achieved through a collaboratively developed variance policy that provides such regional flexibility.

3.10.2 Economics of Public Law 84-99 Eligibility for Rural-Agricultural Levees

Noncompliance with USACE vegetation policy may result in Public Law 84-99 ineligibility for rural-agricultural levees. However, compliance with the policy is costly and generally is not affordable for rural-agricultural maintaining agencies, nor is it practicable. Although the Public Law 84-99 Rehabilitation and Inspection Program can be helpful to nonfederal sponsors in rehabilitating damaged levees after a flood, its usefulness is limited in the Central Valley for the following reasons:

- Funding for Public Law 84-99 rehabilitation assistance is generally very limited. Public Law 84-99 rehabilitation assistance for significant damage repairs usually requires a special appropriation by Congress.
- There is no mechanism to obtain reimbursement or credit when a nonfederal sponsor performs the repairs, or pays USACE to perform the repairs.
- Increasingly stringent USACE maintenance requirements, especially for encroachments and vegetation, can be difficult to meet and are unaffordable.
- Rehabilitation projects need to be economically justified with a benefit-to-cost ratio of 1.0 or greater to justify federal involvement. In rural-agricultural areas of the Sacramento and San Joaquin river basins, this requirement can be difficult to achieve.

From a nonfederal perspective, the most critical concerns about implementing the USACE vegetation policy are the environmental impacts, the cost to comply with the policy, and the misallocation of scarce public funds for system improvement.

Based on USACE expenditures under Public Law 84-99 for declared flood events in 1995, 1997, 1998, and 2006, the preliminary estimate of annualized assistance of levee rehabilitation is approximately $30 million. This estimate is significantly influenced by the $120 million in assistance provided by USACE following the 1997 flood event – an amount not likely to be duplicated based on subsequent changes in USACE policy, such as their levee vegetation policy.

In April 2010, DWR developed a ***Fiscal Impact Report of the U.S. Army Corps of Engineers' Vegetation Management Standards and Vegetation Variance Policy for Levees and Flood Walls***. This report includes the cost estimates of applying the ETL to the 116 critical levee repairs performed from 2006 through 2008 and the cost estimate of applying the ETL to the entire 1,600 miles of project levee system by extrapolation. The estimated order of magnitude cost to comply with the USACE policy ranged from $6.5 billion to $7.5 billion. Annualizing this cost of compliance (over a 50-year project life at 6 percent) would yield an annual cost of over $400 million, more than ten times the $30 million annual assistance estimated above.

Therefore, the State interest is to follow the vegetation management strategy presented in Section 4. The local maintaining agencies may choose to comply with the USACE vegetation policy to maintain Public Law 84-99 eligibility; however, it would be very challenging for rural-agricultural maintaining agencies because of cost of compliance for eligibility. This is evident by the results of fall 2011 USACE periodic inspections, 39 of 116 local maintaining agencies have lost eligibility for

Public Law 84-99 rehabilitation assistance for reasons other than vegetation. In addition, removal of levee systems from "active status" under Public Law 84-99 based on noncompliant vegetation would be unfortunate and unnecessary. USACE Engineering Regulation 500-1-1 protects the federal government from bearing any of the cost of any levee rehabilitation work associated with "deferred or deficient maintenance." Thus, to protect the federal investment in SPFC levees, USACE would be justified in retaining "active status" for SPFC levee systems with noncompliant vegetation, assigning to the nonfederal partner any rehabilitation costs attributable to such vegetation.

3.11 Residual Risk Management

As elements of the SSIA are constructed over time, residual flood risk within the Central Valley should decrease. However, the potential for flooding in the Central Valley will always pose risks to life and property, particularly in areas of deep or rapid flooding. Table 3-4 illustrates estimated residual risk management needs for the SSIA. These can be compared with the residual risk needs estimated for the preliminary approaches in Table 2-2.

Table 3-4. Residual Risk Management for State Systemwide Investment Approach

FLOOD MANAGEMENT ELEMENT	PROJECT LOCATION OR REQUIRED COMPONENTS	INCLUDED IN SSIA IMPLEMENTATION
Enhanced Flood Emergency Response	All-weather roads on levee crown	YES
	Flood information collection and sharing	YES
	Local flood emergency response planning	YES
	Forecasting and notification	YES
	Rural post-flood recovery assistance program	YES (small)
Enhanced Operations and Maintenance	Identify and repair after-event erosion	YES
	Developing and implementing enhanced O&M programs and regional O&M organizations	YES
	Sacramento channel and levee management, and bank protection	YES
Floodplain Management	Raising and waterproofing structures and building berms	YES (large)
	Purchasing and relocating homes in floodplains	YES (large)
	Land use and floodplain management	YES
	Agricultural conservation easements	YES

Key:
Large = relatively high level of work to implement
O&M = operations and maintenance
Small = relatively low level of work to implement
SSIA = State Systemwide Investment Approach

Consequently, investments in residual risk management must continue, both during and after implementation of the SSIA. Policies and programs related to residual risk management are described in more detail in Section 4.

3.12 Estimated Cost of State Systemwide Investment Approach

Table 3-5 summarizes the preliminary estimate of costs for the SSIA, assuming all elements are ultimately completed. Estimates include costs for capital improvements and 25 years of ongoing annual work to maintain the system. Estimated costs are in 2011 dollars. Actual costs will vary from those in Table 3-5 because of a wide range of factors, including project justification by feasibility studies, project configuration, implementation time, future economic and contractor bidding conditions, and many others.

Specific project features ultimately implemented for the SSIA will depend on a host of factors. These factors include detailed project feasibility studies; designs and costs; environmental benefits and impacts; interaction with other local projects and system improvements; local, federal, and State agency participation in project implementation; and changing physical, institutional, and economic conditions.

The table also includes SPFC flood management investments that have already been expended or committed during the 2007 to 2011 period. Since passage of the 2007 flood legislation directing preparation of the CVFPP, the State has made substantial progress in reducing flood risks within the Central Valley by investing bond funds from Propositions 84 and 1E. These efforts encompass urban levee improvements, emergency repair projects, physical and operational changes to flood management reservoirs, emergency response planning, and improvements to operations and maintenance, emergency response, and floodplain management. These accomplishments over the past five years represent significant progress in achieving the CVFPP Goals.

The estimated amounts in Table 3-5 are total combined investments for State, federal, and local agencies. Section 4 provides further detail on cost-sharing proportions, and expenditures prior to adoption of the CVFPP. Consistent with traditional cost-sharing for flood management projects, DWR

STATE INVESTMENTS IN STATE PLAN OF FLOOD CONTROL FLOOD MANAGEMENT, 2007 – 2011

Flood Emergency Response

- Emergency exercises
- New water gaging
- Forecast-Coordinated Operations for Yuba/Feather
- Rock stockpiles in the Delta

Operations and Maintenance

- Over 220 levee sites repaired
- Sediment removal from bypasses
- Rehabilitation of 7 flood structures

Floodplain Management

- Approved building code amendment for single-family residential occupancy
- 300,000 flood risk notifications annually, since 2009
- Mapping of Central Valley Levee Flood Protection Zones

Capital Improvements

- 15 ongoing or completed projects

Assessments and Engineering

- 9,000 square miles of topographic data
- Urban and nonurban levee evaluations
- State Plan of Flood Control Descriptive Document
- Flood Control System Status Report
- CVFPP development
- Coordination with USACE on many ongoing evaluations

Ecosystem

- See Section 4 for ecosystem accomplishments

Table 3-5. Estimated Costs of State Systemwide Investment Approach ($ millions)

REGION	SYSTEM IMPROVEMENTS Low High	URBAN IMPROVEMENTS Low High	RURAL-AGRICULTURAL IMPROVEMENTS Low High	RESIDUAL RISK MANAGEMENT Low High	TOTAL COST Low High
1 – Upper Sacramento	$109 - $180	$120 - $144	$154 - $168	$95 - $114	$480 - $610
2 – Mid-Sacramento	$234 - $340	$0 - $0	$360 - $379	$261 - $333	$860 - $1,050
3 – Feather River	$1,695 - $2,139	$891 - $1,048	$282 - $289	$170 - $212	$3,040 - $3,690
4 – Lower Sacramento	$1,627 - $1,962	$3,549 - $4,283	$77 - $88	$138 - $169	$5,390 - $6,500
5 – Delta North[1]	$754 - $924	$144 - $192	$604 - $634	$266 - $311	$1,770 - $2,060
6 – Delta South[1]	$427 - $549	$0 - $0	$47 - $52	$110 - $135	$580 - $740
7 – Lower San Joaquin	$7 - $8	$626 - $809	$17 - $19	$82 - $97	$730 - $930
8 – Mid-San Joaquin	$60 - $102	$0 - $0	$48 - $55	$81 - $96	$190 - $250
9 – Upper San Joaquin	$229 - $297	$166 - $199	$183 - $189	$308 - $396	$890 - $1,080
TOTAL	$5,140 to $6,500	$5,500 to $6,680	$1,770 to $1,870	$1,510 to $1,860	$13,920 to $16,910

Notes:
[1]SPFC Facility costs only
Costs in $ millions. All estimates in 2011 dollars.

Key:
SPFC = State Plan of Flood Control

estimates that the State's share of costs included in Table 3-5 will be $6,400 million to $7,700 million, including already expended or committed investments, if all elements of the SSIA are ultimately constructed. Section 4 also shows cost estimates over a more certain time period of 10 years that will allow near-term projects to be constructed as longer term projects are under additional evaluation.

3.13 Performance of State Systemwide Investment Approach

Based on the evaluations, the SSIA could effectively improve management of flood risk for urban, small community, and rural-agricultural areas given differing population, assets at risk, and other State interests. The SSIA reflects a cost-justifiable approach to effectively meet the legislation requirements and the CVFPP Goals, and provides a road-map for more detailed studies and designs leading to site-specific capital improvements.

The following sections summarize the additional performance benefits that could be achieved through implementing the SSIA. The following sections compare the performance of the SSIA to current conditions for several key parameters: changes in flood stage, sustainability, contributions to the CVFPP Goals, and relative efficiency. For analysis purposes, the current or No Project condition represents conditions consistent with the Notice of Preparation for the PEIR. It is also important to note that Early Implementation Projects and other FloodSAFE initiatives implemented since bond funding became available in 2007, which are considered part of the SSIA, have already provided benefits.

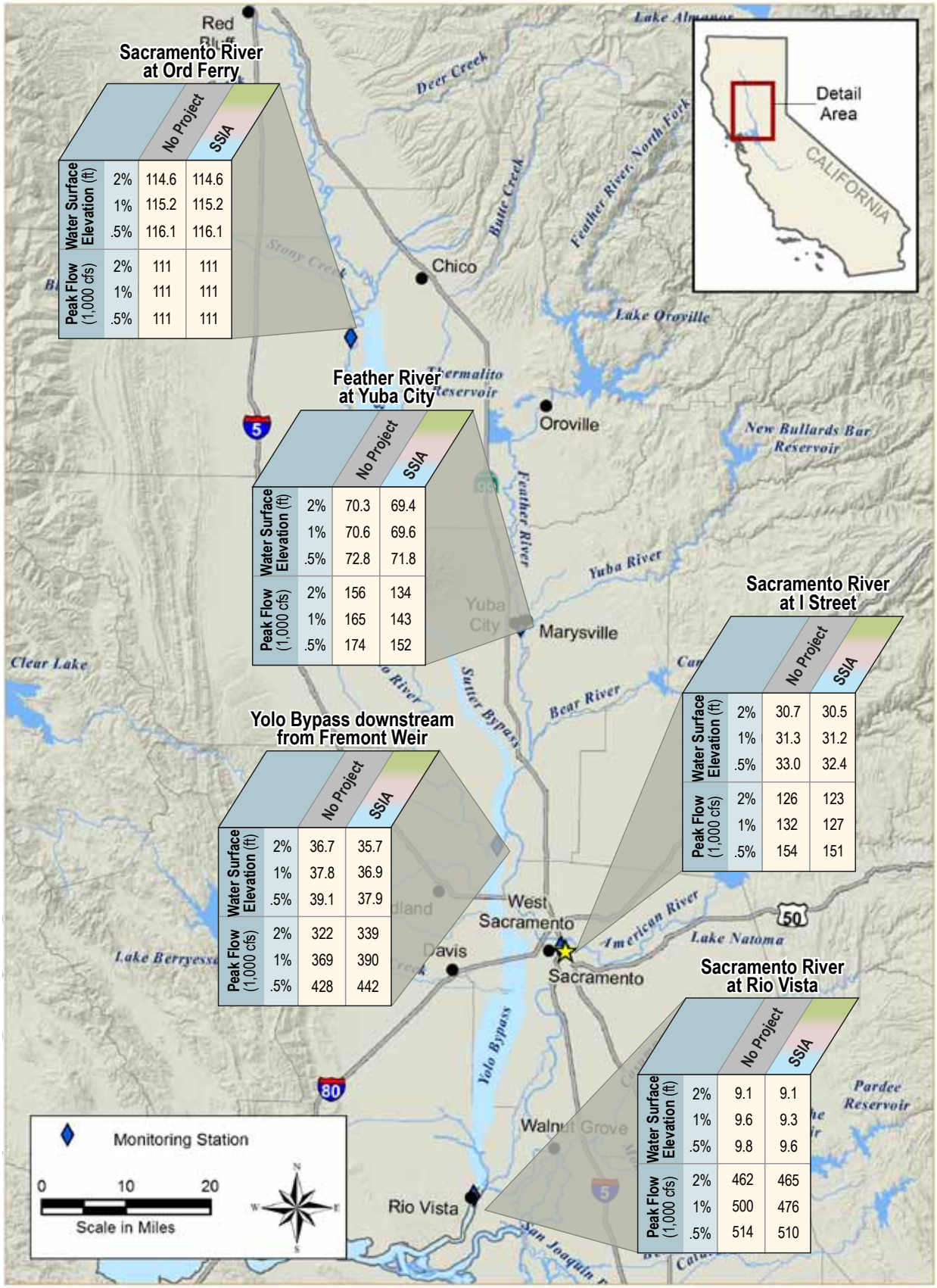
3.13.1 Stage Changes

STATE SYSTEMWIDE INVESTMENT APPROACH STAGE PERFORMANCE

Although peak floodflows may increase locally (over current conditions) in certain reaches, expansion of conveyance capacity proposed by the SSIA would result in reduced peak flood stages throughout the system.

Figures 3-4 and 3-5 illustrate performance of the SSIA with respect to systemwide peak floodwater surface elevations (stages) compared to current conditions. In most areas along the rivers in the Sacramento River Basin, stages are lower than current conditions because of the proposed bypass expansions. Flood stages in the San Joaquin River Basin would not change much with respect current conditions because large bypass expansions were not included, except near the Delta. Flood stages entering the Delta may be higher by a few tenths of a foot. If stage changes result in significant hydraulic impacts, features to mitigate the impacts may be used.

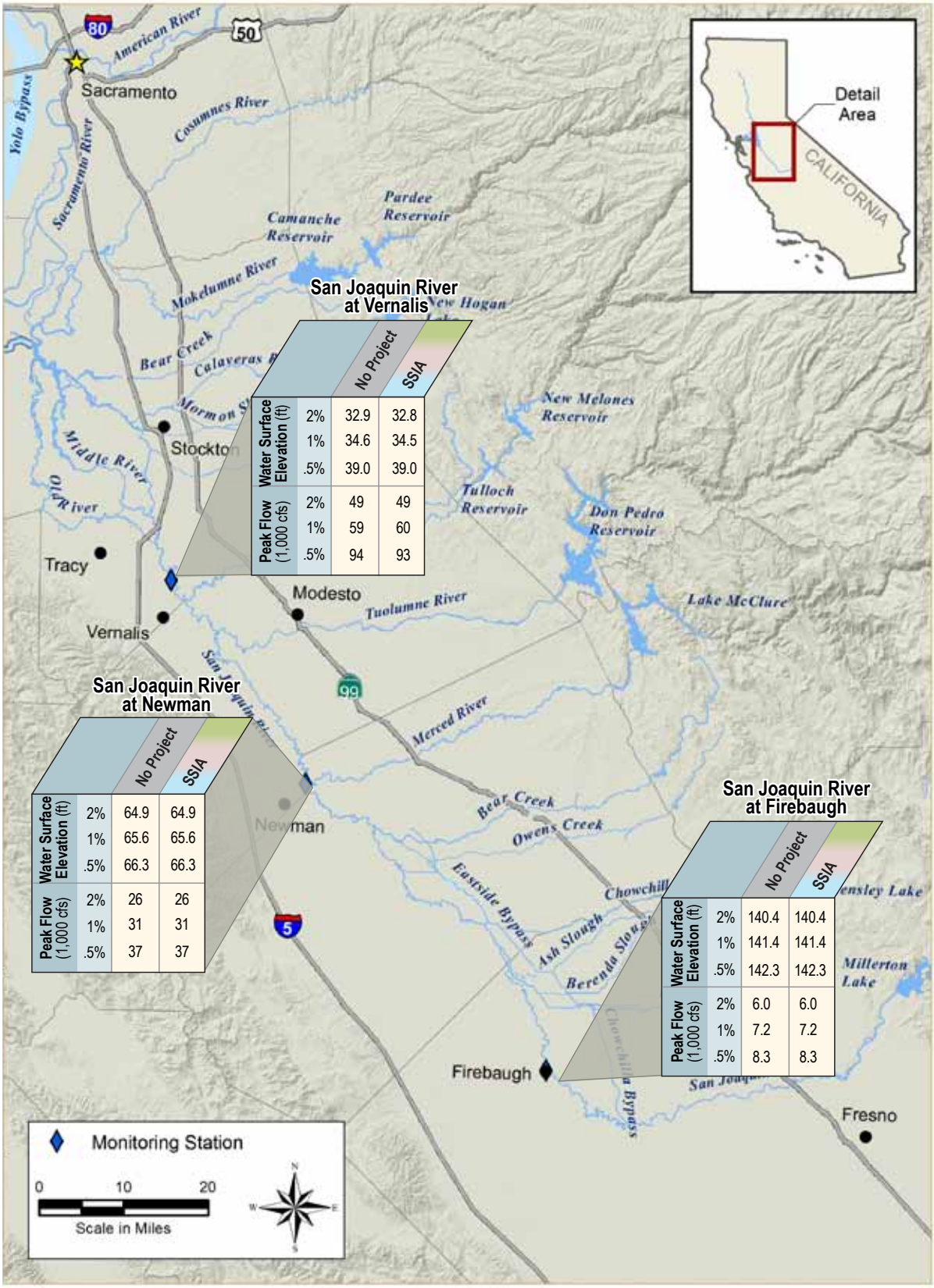
Sequencing improvements along the river corridors may cause temporary water stage impacts and or hydraulic impacts. Sequencing improvements from downstream to upstream may eliminate these temporary impacts, but may not be practical considering the wide range of improvements that need to be made.



Note: Figure presents peak flow and water surface elevation estimates for various frequency flood events (represented as percent chance exceedence, e.g., 1%) at selected monitoring locations in the Sacramento River Basin.

Key: cfs = cubic feet per second ft = feet SSIA = State Systemwide Investment Approach

Figure 3-4. Changes in Peak Floodflows and Stages – No Project Versus State Systemwide Investment Approach for Various Storm Events – Sacramento River Basin



Note: Figure presents peak flow and water surface elevation estimates for various frequency flood events (represented as percent chance exceedence, e.g., 1%) at selected monitoring locations in the San Joaquin River Basin.

Key: cfs = cubic feet per second ft = feet SSIA = State Systemwide Investment Approach

Figure 3-5. Changes in Peak Floodflows and Stages – No Project Versus State Systemwide Investment Approach for Various Storm Events – San Joaquin River Basin

3.13.2 Sustainability

Table 3-6 summarizes the financial, environmental, and social sustainability aspects of the SSIA compared with current conditions.

Table 3-6. Summary of State Systemwide Investment Approach Sustainability Compared with No Project

	NO PROJECT	STATE SYSTEMWIDE INVESTMENT APPROACH
Overall Sustainability	Low	Medium
Financial	Very high ongoing and long-term annual costs	Very high upfront and lower long-term annual costs.
Environmental	Limited opportunities to improve habitat connectivity, quality, quantity, and biodiversity	Enhanced opportunities to improve habitat connectivity, quality, quantity, and biodiversity.
Social	Varied level of protection throughout the system Significant potential for public safety and economic consequences of flooding	Seeks flood protection comparable with assets being protected. Limits cumulative growth of flood risks to State's people and infrastructure due to system improvements. Reduces reliance on compensatory mitigation for project implementation and regular operations and maintenance due to implementation of systemwide conservation strategy. Rebalances institutional arrangement for operations and maintenance responsibilities.
Climate Change Adaptability	Low system resiliency (ability to adapt)	Conveyance improves flood system resiliency by lowering stages, which improves ability to adapt to climate change.

Key:
State = State of California

3.13.3 Central Valley Flood Protection Plan Goals

Table 3-7 summarizes contributions of the SSIA to the five CVFPP Goals, compared with No Project.

3.13.4 Relative Efficiency

DWR prepared a qualitative comparison to show broad differences in potential performance of the preliminary approaches and the SSIA. Figure 3-6 shows these qualitative comparisons of performance for the SSIA with the three preliminary approaches. These comparisons are the same as shown in Figure 2-6, but with the addition of the SSIA.

Another view of the relative performance of the three preliminary approaches and SSIA is shown in Figure 3-7. The figure shows preliminary cost estimates and estimated performance in terms of the relative contributions of each approach to the primary and supporting goals of the CVFPP.

Table 3-7. Summary of Contributions of State Systemwide Investment Approach to Central Valley Flood Protection Plan Goals Compared with No Project

GOAL OR METRIC	NO PROJECT	STATE SYSTEMWIDE INVESTMENT APPROACH
Contributions to Primary Goal – Improve Flood Risk Management		
– Level of Flood Protection	Varies throughout system • Most urban areas do not have 200-year level of flood protection • Protection to rural-agricultural areas and small communities varies widely	Overall higher protection consistent with assets being protected • Urban areas achieve protection from a 200-year flood, and for small communities achieve protection from a 100-year flood • Overall increased levels of flood protection throughout the system reflecting improved capacity to manage flood peaks
– Life Safety (focused on populations at risk)	Varies throughout system • Public safety threat is high for many communities, particularly those in deep floodplains	Improvement varies • Substantial improvement in urban areas • Improvement in small communities varies
– Economic Damages	$329 million in expected annual damages • Economic damages, particularly in urban areas, are very high	Reduction of 66 percent in expected annual damages • Substantial reduction in damages in urban areas, small communities, and rural areas
Contributions to Supporting Goals		
Improve Operations and Maintenance	Very high current costs • Ongoing and long-term O&M costs are very high relative to other approaches	Decrease in long-term O&M requirements • Decrease in long-term costs due to O&M reforms (clarified roles and responsibilities, consistent standards, and revenue generation improvements) and physical modification to reduce geomorphic stressors
Promote Ecosystem Functions	Limited opportunities for ecosystem benefit • Native habitat may be integrated into SPFC repair projects, primarily through mitigation	Enhanced opportunities for systemwide ecosystem benefit • Floodway expansion provides substantial opportunity to improve ecosystem functions, fish passage, and the quantity, quality, and diversity of natural habitats
Improve Institutional Support	• **Continued dispersion of responsibilities and roles** for flood management in the Central Valley among many agencies with varying functions and priorities	• **Improve flood management functions** through changes and/or clarifications in current State policy directives, legislated authority and responsibilities, and partnerships with federal and local partners
Promote Multi-Benefit Projects	• **Limited opportunities** to integrate other benefits into repairs to SPFC facilities	• **Enhanced opportunities** to integrate water quality, groundwater recharge, recreation, power, and other benefits
Ability to Meet Legislative Objectives (Completeness)		
Ability to Meet Objectives in Flood Legislation	Does not meet • Varied level of protection throughout the system and high potential for public safety and economic damages	Addresses all objectives • Contributes to all objectives with proposed system and regional elements, and supporting implementation policies and programs

Key:
O&M = operations and maintenance
SPFC = State Plan of Flood Control
State = State of California

PERFORMANCE CATEGORY	ACHIEVE SPFC DESIGN FLOW CAPACITY	PROTECT HIGH RISK COMMUNITIES	ENHANCE FLOOD SYSTEM CAPACITY	STATE SYSTEMWIDE INVESTMENT APPROACH
Flood Risk Reduction Benefit	Moderate	Moderate-High	High	Moderate-High
Level of Flood Protection	Low-Moderate	Moderate	High	Moderate-High
Life Safety	Low-Moderate	Moderate-High	Moderate-High	Moderate-High
Reduction in Economic Damages	Moderate	Moderate-High	Moderate-High	Moderate-High
Regional Economics	Moderate	Moderate-High	High	Moderate-High
Integration and Sustainability	Low	Low-Moderate	High	Moderate-High
Promote Ecosystem Functions	Low	Low	High	Moderate
Promote Multi-Benefit Projects	Low	Low-Moderate	High	Moderate-High
Sustainable Land Uses	Low	Low-Moderate	High	High
Cost	$$$	$$	$$$	$$
Capital Costs	$$$	$	$$$$	$$
Operations & Maintenance	$$	$$$$	$	$$

BENEFIT KEY

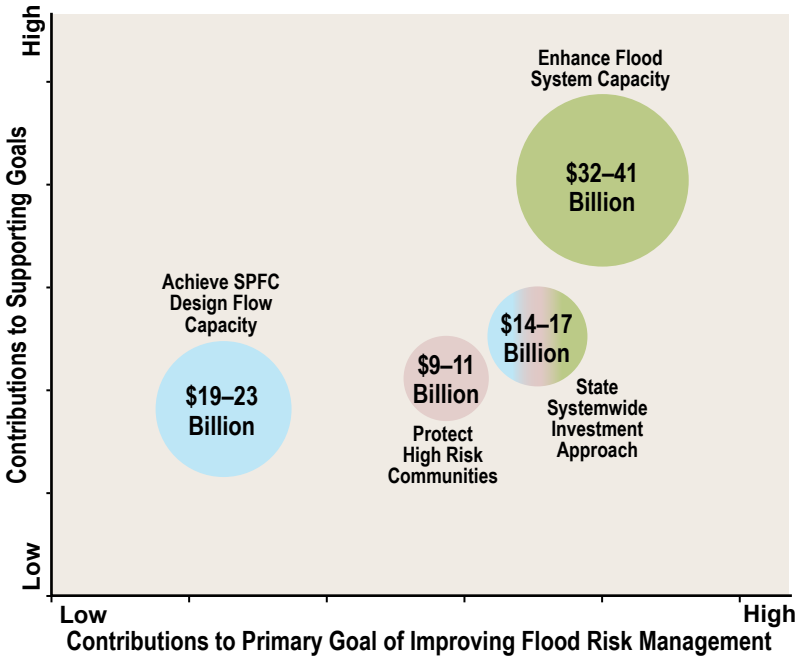
- Low
- Low-Moderate
- Moderate
- Moderate-High
- High

COST KEY

- $ Low-Moderate
- $$ Moderate
- $$$ Moderate-High
- $$$$ High

Key: SPFC = State Plan of Flood Control

Figure 3-6. Performance Comparison for All Approaches



KEY: SPFC = State Plan of Flood Control

Figure 3-7. Relative Comparison of State Systemwide Investment Approach and Preliminary Approach Efficiency

3.14 State Systemwide Investment Approach Benefits

The SSIA, as a multi-benefit and integrated flood management approach, has many direct and indirect benefits to the Central Valley, State, and nation. This section summarizes the benefits of the SSIA.

Benefits assessed include reduced economic damages, benefits to local and regional economies, improved public health and safety, ecosystem restoration, open space and recreation, increased flood system resiliency and climate change adaptability, water management, and reduced long-term flood system management costs. Some of these benefits are presented quantitatively and some qualitatively, because some of the benefits could not be calculated at this time. These benefits will be further refined and documented during the feasibility study process scheduled to be initiated upon adoption of the CVFPP by the Board.

3.14.1 Reduced Economic Flood Damages

The USACE Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) model was used to estimate the flood risk reduction benefits of the SSIA. Expected annual flood damages were computed over the array of potential floods, from small to extremely large, compared with the no project condition. The flood damage estimates consider the following:

- Residential, commercial, industrial, and governmental structure and contents damage
- Agricultural/crop losses
- Business production losses

Results of the modeling indicate an overall reduction in total expected annual damages of about 66 percent, with specific reductions in damages and losses as follows:

- Structure and contents flood damages would be reduced by 73 percent
- Crop damages due to flooding would be reduced by 6 percent
- Business production losses would be reduced by 71 percent

3.14.2 Benefits to Local and Regional Economies

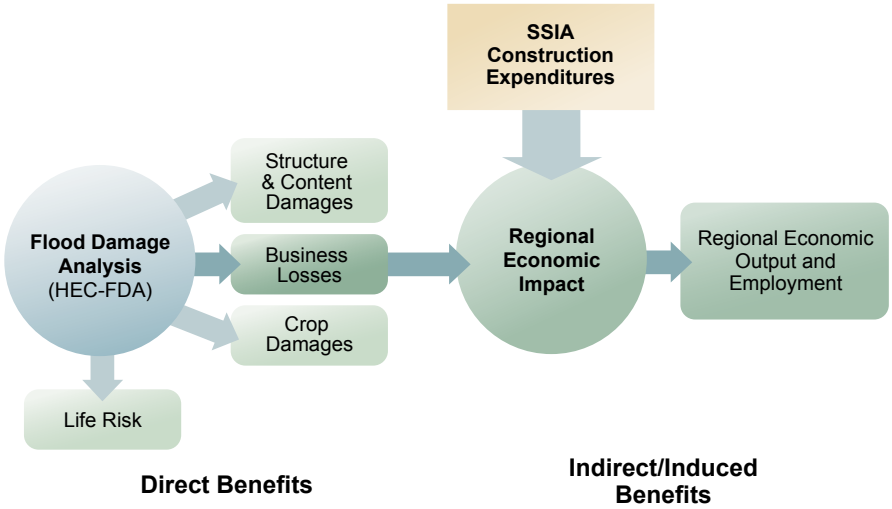
Reduction in flood damages is only one aspect of the potential economic benefits of the SSIA. As illustrated in Figure 3-8, flood risk reduction improvements can also provide both direct and indirect benefits to local, regional, and State economies.

Implementation of the SSIA would contribute to local and regional economic activities, as described below:

- **Increased benefits to regional economies** – Implementing the SSIA would directly and indirectly benefit local and regional economies and support continued economic development in the valley. Implementation of the plan would reduce the potential for lost agricultural, commercial, and industrial production/income, and secondary “ripple” effects, as a result of a flood.

Construction activities related to SSIA implementation could be expected to boost economic output over the coming decades by as much as $900 million, and avoided business losses due to flooding could increase long-term economic output by over $100 million. The potential for flood-induced industry relocation or failure to recover to preflood levels would also be reduced. In addition, construction projects resulting from implementation of the SSIA would be expected to boost regional short-term employment and employment incomes, and increase regional economic output. Construction activities in support of SSIA implementation could be expected to generate as many as 6,500 jobs annually over the coming decades, while reduced business losses from flooding could be expected to boost long-term employment. These employment economic benefits would also enhance the revenues of local governments through increased income and sales taxes.

- **Enhanced agricultural sustainability** – Central Valley agriculture is a critical sector of the State economy that provides and supports reliable, affordable food and fiber production, both domestically and on a global scale. Agricultural and associated processing industries and services also account for a considerable portion of local employment. Flood management improvements would reduce direct crop damages. Improved flood protection would result in an increased ability to obtain favorable crop insurance coverage and rates. Similarly, improved protection would also increase the ability to obtain agricultural loans with favorable terms. As a result, flood management improvement has the potential to contribute to improved agricultural sustainability. Over 90 percent of the citizens in rural-agricultural areas and small communities within the SPFC Planning Area could receive additional flood protection by levee improvement measures, flood proofing, and relocation opportunities presented in the SSIA.



Key: HEC-FDA = U.S. Army Corps of Engineers Hydrologic Engineering Centers Flood Damage Analysis
SSIA = State Systemwide Investment Approach

Figure 3-8. Components of Economic Analysis

- **Reduced disruption of public services** – In addition to reducing physical damages to structures and infrastructure, flood management improvements would reduce potential disruption of critical public services needed to maintain the health, safety, and welfare of the population. These critical functions include emergency services, transportation, health care, education, and public utilities (water and wastewater, electricity, natural gas, and communications). Interruption of these services and functions would greatly affect socioeconomic conditions in the region and its economic and industrial diversity. The CVFPP has not quantitatively assessed the loss of critical public services, but has estimated the number of critical facilities *exposed* to flood hazards.

3.14.3 Improved Public Health and Safety

A primary objective of the SSIA is to protect the citizens living and working in the floodplains of the Central Valley.

- **Reduced potential for injuries and loss of life** – When fully implemented, the SSIA would significantly reduce the potential for flooding in urban areas and other population centers, thereby reducing the direct threats posed by flooding to public safety, including the potential for injury or loss of life. Implementation of the SSIA would result in an increase in the population receiving at least a 100-year (1% annual chance) level of flood protection from the current 21 percent to over 90 percent. Additional reductions in the potential for loss of life would be achieved as a result of nonstructural flood mitigation, such as improved flood emergency response, operations and maintenance, and floodplain management measures.

  HEC-FDA was used to estimate life risk indicators and inform the decision-making process. However, these values are NOT forecasts of deaths expected to occur from flood events, to be used for emergency planning or other purposes. Instead, these values are informative indices of life risk, providing a metric for assessing the reduction in life risk attributable to the SSIA. Based on the analysis, the SSIA was shown to reduce life risk by about 49 percent compared with current conditions.

  The economic and life safety benefits for the SSIA described above do not include benefits attributable to projects that were recently completed or are currently under construction. Therefore, the overall benefits of the SSIA described herein are considerably underestimated.

- **Reduced release of hazardous materials during floods** – Floods can cause a release of hazardous materials resulting in increased threats to public health and safety. Hazardous materials and contaminants may exist in floodplains, including feed lots, fuel tanks, septic systems, water and wastewater treatment facilities, landfills, illegal dumping, and other sources. Improved flood management under the SSIA would contribute to reducing public exposure to hazardous materials released during floods and improve water quality.

3.14.4 Ecosystem Restoration Benefits

Ecosystem restoration is fully integrated with the flood risk reduction components of the SSIA. Major restoration benefits of the SSIA include the following:

- Floodways would be expanded and extended to improve the flow carrying capacity of the channels, and the lands acquired for the expansion would be used for habitat restoration and environmentally-friendly agricultural activities. Over 10,000 acres of new habitats would be created within the flood management system. In addition, over 25,000 acres of land would be leased for growing grains, corn, and other habitat-compatible crops. Flood management system improvements would provide opportunities for improving ecosystem function and increasing habitat extent, quantity, quality, and connectivity from the Delta to the upper Sacramento River. Expanded floodways would create space for river meandering, sediment erosion and deposition, natural ecosystem disturbance processes, and a healthy diversity of riverine habitat.
- The SSIA would improve fish passage at flood diversions, flashboard dams, and flood management structures. This includes connecting fishery habitat from the Delta to the Yolo and Sutter bypasses and to the Butte Basin. These actions would assist in increasing and improving habitat connectivity and promoting the recovery of anadromous fish populations.
- Changes in flood control facility operations, including directing flows more frequently and for longer durations over weirs and into bypasses, levee setbacks, and other similar measures planned under the SSIA, would enhance riverine processes and improve the overall health of the ecosystem.

Overall, these restoration activities would contribute to improving habitat connectivity along the flood management system, would provide for migration of fish to spawning areas in the watershed, and would enhance riverine processes.

3.14.5 Open Space and Recreational Opportunities

The State's interest in public health and sustainable economic growth are well supported by the quality of life benefits of nature-based recreation and the economic vitality provided by environmental tourism revenues. The potential for recreational use of the flood control system has long been recognized. In 1929, when the flood control system was under construction, noted landscape architect Frederick Law Olmstead Jr. recommended that a system of recreation lands be preserved within the leveed floodplains along the lower Sacramento River and other waterways.

The SSIA includes floodplain reconnection and floodway expansion, which would improve ecosystem functions, fish passage, and the quantity, quality, and diversity of natural habitats, all of which contribute to increasing opportunities for recreation and ecotourism, as well as augmenting the aesthetic values of those areas. Expansion of habitat areas provides fishing, hunting, and wildlife viewing opportunities. Recreation-related spending associated with increased use by visitors can be an important contributor to local and regional economies.

3.14.6 Increasing Flood System Resiliency and Climate Change Adaptability

Climate change is expected to result in more precipitation in the form of rainfall, more frequent flooding, and higher peak flows. Expansion and extension of the bypass system under the SSIA would reduce peak flood stages throughout the system, increasing the flood carrying capacity of channels and, hence, add flexibility to manage extreme flood events and future climate change effects.

3.14.7 Water Management Benefits

The SSIA, as an integrated flood and water management program, would provide opportunities for improved water management in many ways. While estimates of water management benefits will be quantified for the 2017 CVFPP, DWR expects that the average annual water management benefits of the SSIA may approach a few hundred thousand acre-feet compared to No Project. SSIA elements that could contribute to improved water management include reservoir operations and increases in channel groundwater recharge due to expansion and extension of the bypass system.

- **Reservoir operation** – The F-CO program (see Section 3.5.8) is designed to modify operation of reservoirs in a way that will improve flood management and also provide opportunities for more aggressive refilling of reservoirs during dry years. Such operations could increase water supplies within reservoirs, especially in dry years when the water supply system is most stressed. Water supply benefits from F-BO would vary depending on current reservoir operation manual requirements, watershed hydrology, flexibility in reservoir operation (i.e., adequate release capacity), quality of reservoir inflow forecasts, etc. Therefore, a case-by-case study of flood management reservoirs will be needed to adequately define and quantify the potential benefits of reservoir F-BO.
- **Groundwater recharge** – Groundwater aquifers are naturally recharged through various processes, including percolation of precipitation and infiltration of water from lakes, canals, irrigation and in-channel groundwater recharge. Implementation of the SSIA includes expansion and extension of the bypass system and levee setbacks. These actions would expand flood system lands by an additional 35,000 to 40,000 acres, which would be flooded during high water and contribute to in-channel and floodplain groundwater recharge.

3.14.8 Reduced Long-Term Flood System Management Costs

Although not quantified for the 2012 CVFPP, the SSIA was developed to reduce the overall, long-term costs associated with flood management in the Central Valley. This includes the following:

- Reduced long-term emergency response and recovery needs
- Reduced long-term operations and maintenance costs
- Efficiency through regional approaches to permitting and regulatory needs

3.15 Land Use

SPFC improvements under the SSIA provide for higher levels of flood protection for existing land uses without taking actions that may encourage changes to those uses. Elements of the SSIA have been carefully formulated to reduce flood risk in the area protected by SPFC facilities while avoiding land use changes that promote growth in deep floodplains and increase State flood hazard liabilities. Improved flood protection with the SSIA enhances the likelihood that activities associated with each existing land use will continue to thrive.

Following is a summary of land use conditions under the SSIA:

- **Urban Land Use** – Urban and urbanizing areas within the SPFC Planning Area would achieve a minimum of 200-year (0.5% annual chance) flood protection, as specified by legislation. Legislation requires each city and county within the Sacramento-San Joaquin Valley to amend its general plan to include data, analysis, goals, and policies for protection of lives and property, and related feasible implementation measures. DWR will make data, analysis, and information gathered for the CVFPP available to local agencies for inclusion in their amended general plans. In addition, these local entities are required to amend their zoning ordinances to be consistent with their general plans. As a result, urban development would continue based on sound planning; however, the SSIA does not promote urban development in floodplains beyond existing urban/urbanizing areas.
- **Small Community Land Use** – The SSIA supports the continued viability of small communities within the SPFC Planning Area to preserve cultural and historical continuity and important social, economic, and public services to rural-agricultural populations, agricultural enterprises, and commercial operations. Under the SSIA, several small communities within the SPFC Planning Area would achieve 100-year (1% annual chance) flood protection through structural means such as ring levees, where feasible. This would preserve small community development opportunities within specific boundaries without encouraging broader urban development. However, some small communities adjacent to existing urban areas may achieve a 100-year level of flood protection or higher as a result of improvements for the adjacent urban areas. For other small communities where structural improvements are not feasible, the SSIA proposes nonstructural means such as flood proofing and elevating structures to support continued small communities land use, providing feasible flood protection in a way that is not growth-inducing.

EFFECTS OF STATE SYSTEMWIDE INVESTMENT APPROACH IMPLEMENTATION ON LAND USE

Preliminary analyses indicate that with implementation of the SSIA it is expected that:

- 100 percent of existing urban areas protected by SPFC facilities attain 200-year level of flood protection
- About 20 of the small communities in the SPFC Planning Area (from a total of 27) will attain 100-year level of flood protection, at a minimum. The rest of the small communities are expected to get flood protection through nonstructural means, including raising, flood proofing, and relocation of structures
- About 90 percent of residents in small communities within the SPFC Planning Area will receive at least 100-year flood protection
- In rural areas, the level of flood protection will increase slightly; in the Sacramento River Basin, rural areas receiving a 25-year or higher level of protection would increase by about 6 percent, while the San Joaquin River Basin will increase slightly
- About 10,000 acres of agricultural lands would be converted to environmental habitat restoration within the expansion of the bypass systems

- **Rural-Agricultural Area Land Use** – The SSIA includes improvements for rural-agricultural flood protection, but excludes participation in flood projects to achieve 100-year (1% annual chance) flood protection that would be growth-inducing and, thus, increase potential flood risks. The SSIA includes many elements to preserve rural-agricultural viability, such as purchase of conservation easements to preserve agriculture and prevent urban development, when consistent with local land use planning and in cooperation with willing landowners. Because expansion of floodways would be primarily in rural-agricultural areas, some loss of agricultural land would occur. However, based on preliminary planning, 75 percent of additional land needed for bypass expansion would continue to be farmed. The remaining 25 percent that would be subject to more frequent flooding would be converted to ecosystem uses.

  The State will work with FEMA's National Flood Insurance Program to promote the continued sustainable rural-agricultural economy and to examine opportunities to provide affordable flood insurance for low risk agricultural and farming structures in the floodplain.

- **Ecosystem/Open Space Land Use** – Opportunities for ecosystem and open space land use would increase within the footprint of the flood management system facilities, especially through expansion of bypasses and select areas where setback levees for multiple benefits prove feasible. This net increase in habitat area should contribute to flood risk reduction and ecosystem restoration and enhancement, while providing for open space and recreational opportunities in rural areas.

  Setback levees along some reaches of the main rivers may increase habitat area. These setbacks are likely to be most feasible in reaches where there are known levee conditions that would be difficult to correct with fix-in-place methods, operations and maintenance problems exist, channel hydraulic performance would be significantly improved, regional flood risk reduction benefits would be realized, and/or there is an opportunity for uniquely valuable ecosystem restoration.

LIMITING GROWTH IN CENTRAL VALLEY FLOODPLAINS

SSIA improvements are designed to discourage growth in rural floodplains with the intention of reducing flood risks. The State does not promote flood management improvements that would induce growth in rural areas.

Urban flood risk reductions under the SSIA will be limited to areas protected by facilities of the State Plan of Flood Control.

Agricultural conservation measures proposed by the SSIA are also designed to limit conversion of agricultural land to urban uses, and to preserve the robust agricultural economy of the Central Valley.

Feather River Setback Levee was Constructed for Multiple Benefits Including Improved Flow Conditions

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The California Natural Resources Agency
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