7.0 Preliminary Approaches

Development of the 2012 CVFPP included evaluating three significantly different preliminary approaches to flood management in the Central Valley. The preliminary approaches were primarily used to explore different potential physical changes to the existing flood management system and to assist in highlighting the need for policy or other management actions. Evaluating these preliminary approaches highlighted differences in costs, benefits, and overall effectiveness for use in preparing a preferred approach – the SSIA.

This section describes the formulation and evaluation of the three preliminary approaches used to explore the application of physical management actions on regional and systemwide scales. Flood management actions, economic benefits, and policy considerations derived from the three preliminary approaches were used to help formulate the SSIA, which is presented in Section 8.

7.1 Preliminary Approach Formulation Process

Given the geographic scope and range of perspectives on solutions to flood management problems in the Central Valley, thousands of potential alternatives could be formed from the combination of individual management actions. Consequently, a methodology was developed to reduce the number of alternatives to a manageable level while still representing the full range of approaches to resolving the problems and achieving the 2012 CVFPP Goals. This methodology resulted in identification of three fundamentally different approaches, in addition to No Project, for implementing the 2012 CVFPP. These approaches highlight different ways to focus future flood management investments and contribute to the 2012 CVFPP goals in different ways, both in magnitude and geographic scope.

The three preliminary approaches are intended to bracket a potential range of future flood management actions in the Central Valley and address flood problems in fundamentally different ways, not to achieve the 2012 CVFPP goals to the same degree. Information provided through evaluation of these approaches allowed DWR to select better-performing characteristics and avoid poorer performing characteristics from each preliminary approach to assemble the SSIA.

The three preliminary approaches are as follows:

1. **Achieve State Plan of Flood Control Design Flow Capacity –** This approach focuses on improving existing SPFC facilities so that they can convey their design flows with a high degree of reliability based on current engineering criteria. Levee improvements would be made regardless of the areas they protect. This approach provides little opportunity to incorporate benefits beyond flood management.

2. **Protect High Risk Communities –** This approach evaluates improvements to levees to protect life, safety, and property for high risk population centers, including urban and small communities. Levees in rural-agricultural areas would remain in their existing configurations. This approach provides minor opportunity to incorporate benefits beyond flood management.

3. **Enhance Flood System Capacity –** This approach would seek opportunities to achieve multiple benefits through enhanced flood system storage and conveyance capacity, to protect high risk communities, and to fix levees in place in rural-agricultural areas. This approach combines most of the features of the above two approaches and provides more room within flood conveyance channels to lower flood stages throughout most of the system, with additional features and functions for ecosystem restoration and enhancements.

Preliminary approaches are not alternatives from which a single, superior alternative can be selected. Rather, these approaches identify a range of potential physical and operational flood management actions and explore potential tradeoffs in benefits, costs, and other decision-making factors, including corresponding needs of residual risk management actions and necessary policy directives.

7.1.1 Flood Management Elements

Seven major flood management elements were identified that address the key types of improvements that should be made to the flood protection system to meet the 2012 CVFPP goals:

1. **Bypasses –** Includes construction of new bypasses and/or expansion of existing bypasses to reduce peak flows during flood events.

2. **Reservoir Storage and Operations –** Includes forecast-coordinated operations/forecast-based operations (F-CO/F-BO), and flood easements.

3. **Flood Structure Improvements –** Includes major flood structure construction or improvements, and system erosion and bypass sediment removal projects.

4. **Urban Improvements –** Targets a 200-year level of protection (LOP) for urban areas either through individual projects or the DWR Urban Levee Evaluations (ULE) Project.

5. **Small Community Improvements –** Targets a 100-year LOP for small communities.

6. **Rural-Agricultural Improvements –** Includes alternative rural improvements and incorporating the DWR Non-Urban Levee Evaluations (NULE) Project recommendations.

7. **Ecosystem Restoration –** Includes elements such as fish passage improvements, environmental conservation development, river meandering, and other restoration activities.

Table 7-1 shows major elements of the three preliminary approaches. The first two approaches differ significantly regarding improving SPFC facilities. The third approach includes all of the elements of the first two approaches and many additional elements.

Table 7-1. Major Elements of Preliminary Approaches

Flood Management Element	Project Location or Required Components	Achieve SPFC Design Flow Capacity	Protect High Risk Communities	Enhance Flood System Capacity
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, levee improvements, and new levee construction			YES
Reservoir Storage and Operations				
Forecast-Coordination Operations/Forecast-Based Operations	Fifteen reservoirs with Sacramento River Basin and San Joaquin River Basin	YES	YES	YES
Reservoir Storage/Enlarge Flood Pool[1]	• Oroville • New Bullards Bar • New 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 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 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
System Erosion and Bypass Sediment Removal Project	• Cache Creek Settling Basin sediment management • Sacramento system sediment remediation downstream from weirs			YES
Urban Improvements				
Target 200-Year Level of Protection	Selected projects developed by local agencies, State, federal partners		YES	YES
Target SPFC Design Capacity	Urban Levee Evaluation Program results	YES[2]		
Non-SPFC Urban Levee Improvements	Includes approximately 120 miles of Non-SPFC levees that are closely associated with SPFC urban levees whose performance may affect the performance of SPFC levees	YES	YES	YES

Table 7-1. Major Elements of Preliminary Approaches (cont.)

Flood Management Element	Project Location or Required Components	Achieve SPFC Design Flow Capacity	Protect High Risk Communities	Enhance Flood System Capacity
Small Community Improvements				
Target 100-Year Level of Protection	Small communities protected by the SPFC		YES[3]	YES[3]
Target Design Capacity	Non-Urban Levee Evaluation Program results	YES[2]		YES[2]
Rural-Agricultural Improvements				
Site-specific Rural-Agricultural Improvements	Based on levee inspections and other identified critical levee integrity needs			
Target Design Capacity	Non-Urban Levee Evaluation Program results	YES[2]		YES
Ecosystem Restoration				
Fish Passage Improvements	• Sutter Bypass and fish passage east of Butte Basin • Freemont Weir fish passage improvements • Yolo Bypass/Willow Slough Weir fish passage improvements • Deer Creek			YES
Ecosystem Restoration and Enhancement	For areas within new or expanded bypasses, contributing to or incorporated with flood risk reduction projects			YES
River Meandering and Other Ecosystem Restoration Activities	At selected levee setback locations in Sacramento and San Joaquin river basins			YES

Notes:
[1] All approaches include Folsom Dam Raise, as authorized.
[2] Actual level of protection varies by location.
[3] Includes all small communities within the SPFC.
Key:
SPFC = State Plan of Flood Control

7.1.2 Approach Evaluation

To effectively evaluate the preliminary approaches, available technical tools were used to judge how changes to SPFC facilities would affect systemwide performance while also reducing flood damages, protecting public safety, and restoring degraded ecosystems. As part of an approach evaluation, key quantitative indicators were developed. The indicators were used to assess the performance of the preliminary approaches in various areas, including changes to riverine and Delta flood stages, structure and crop flood damages, and potential for loss of life.

Evaluation and comparison of the approaches were designed to highlight various key questions and policy considerations:

- What are the capital costs and time frames for implementation?
- How will the relative threats to communities be assessed and prioritized?
- Is the approach cost effective in avoiding damages to property and reducing risks to life safety?
- Does focusing investments solely on urban areas and small communities fully meet legislative objectives?
- Is reconstructing SPFC facilities to reliably pass design flows an effective means of achieving desired levels of flood protection for different land uses in the system, and what are the systemwide effects of reconstruction in place?
- How can complementary strategies related to floodwater storage and conveyance capacity enhance local benefits of levee reconstructions to provide broader, systemwide benefits? These strategies include storage operation modifications, operations coordination among multiple reservoirs, expansion and enhancement of weirs and bypass systems, and floodplain management.
- What are the implications and trade-offs for land uses and economic development within the Central Valley?
- How will residual risk be addressed after the project is implemented?

7.1.3 Evaluation Tools

To support development of the 2012 CVFPP, existing and available data and tools were primarily used to help understand the performance of the existing flood management system, and assess the effects of proposed improvements. A series of technical analyses was conducted to evaluate hydrologic, hydraulic, geotechnical, economic, ecosystem, and related conditions within the flood management system. Collectively, the analyses reflect a systemwide approach to analyzing flooding and related conditions, assessing flood risks, and formulating broad regional and systemwide approaches to reducing these risks. These analyses were conducted in the Sacramento River Basin, San Joaquin River Basin, and Sacramento-San Joaquin Delta (Delta).

The analytical studies needed to support plan formulation included a series of sequential and parallel evaluations and analyses that are discussed in detail in the 2012 CVFPP Attachment 8: Technical Analysis Summary Report.

The following summarizes the key analytical modeling tools used to support the 2012 CVFPP:

- Synthetic flood hydrology representing existing hydrologic conditions for the Central Valley of California, originally developed for the Comprehensive Study (USACE, 2002).

- Hydrologic Engineering Center 5 (HEC-5) reservoir operations models, originally developed for the Comprehensive Study, to simulate the flood operations of headwater reservoirs and lower basin flood management and multipurpose reservoirs and HEC-Reservoir Simulation (HEC-ResSim) reservoir operations models to simulate releases from Folsom Lake.

- New levee fragility curves developed using geotechnical data from DWR’s ULE and NULE programs.

- Updated Comprehensive Study Unsteady Network (UNET) hydraulic models to simulate river stages, flows, and volumes.

- California Water Resources Simulation Model II (CalSim-II) water resources simulations model to explore the simulated effects of reservoir operational scenarios on water supply reliability.

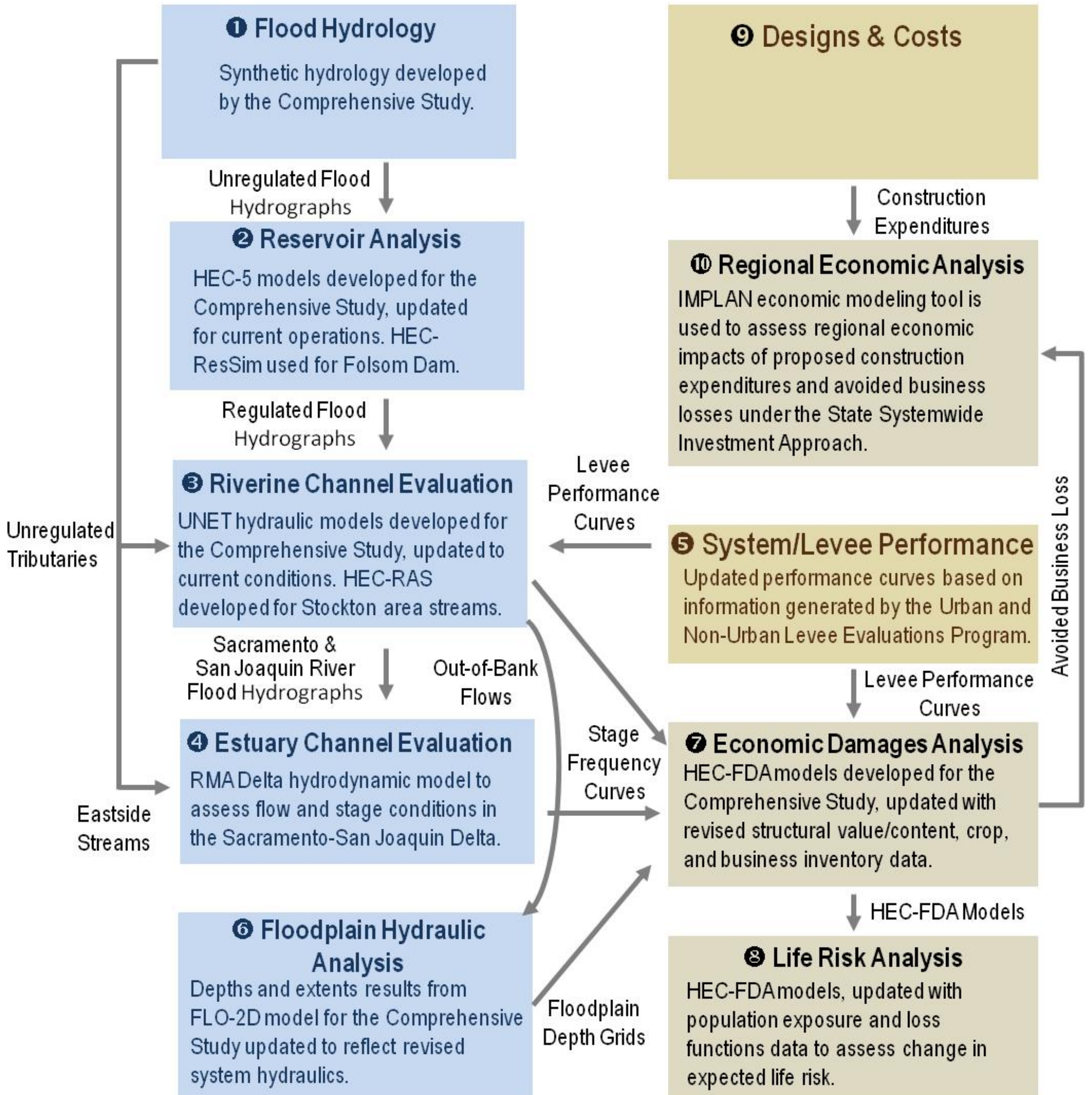
- Resource Management Associates (RMA) Delta hydrodynamic model to determine water surface elevations, and breakout and return flows in the Delta

- Fullerton, Lenzotti and O’Brien – Two-dimensional (FLO-2D) hydraulic models, originally developed for the Comprehensive Study, to model overbank and floodplain hydraulics to delineate floodplain areas and depths.

- HEC River Analysis System (HEC-RAS) hydraulic models for the Calaveras River, Mormon Slough, and Bear Creek in the Stockton area.

- HEC-FDA economic models, originally developed for the Comprehensive Study, to evaluate flood risk, economic damages, and public safety; updated with population exposure and life loss functions data.

Figure 7-1 illustrates the technical analysis and tools supporting the 2012 CVFPP and flow of information between the various analytical tools and data.



Legend:

Comprehensive Study	*Sacramento and San Joaquin River Basins Study Comprehensive Study (USACE, 2002)*
HEC	USACE Hydrologic Engineering Center
HEC-FDA	HEC Flood Damage Analysis model
FLO-2D	Fullerton, Lenzotti, and O'Brien – Two Dimensional model
HEC-RAS	HEC River Analysis System model
HEC-ResSim	HEC Reservoir Operations Simulation model
HEC-5	HEC Reservoir Operations Simulation model (predecessor to HEC-ResSim)
MPLAN	Impact Analysis for Planning
RMA	RMA Finite Element Model of Sacramento-San Joaquin Delta hydrodynamics
UNET	One-Dimensional Unsteady Network Flow model (predecessor to HEC-RAS)
USACE	U.S. Army Corps of Engineers

Figure 7-1. Technical Analysis and Tools Supporting 2012 CVFPP Development

As shown on Figure 7-1, the systemwide analysis begins with hydrology, which provides the basis for unregulated flood flows into reservoirs and streams. This is followed by reservoir models to simulate flood operations at the major flood management reservoirs, and hydraulic models to simulate water stages, flow rates, levee breaches, and out-of-bank flows, in both riverine and estuarine environments. Results from the reservoir and hydraulic simulations are used to conduct economic analyses and ecosystem functions studies. Geotechnical levee performance characterizations and other data provide input to the hydraulic and economic models. Conceptual-level design and cost estimates were developed for the proposed flood management features. Change to regional economic output and employment because of the proposed flood improvements was assessed using cost and economic information.

Findings from evaluation of the preliminary approaches, combined with necessary systemwide policies, informed development of the SSIA as the State’s proposal for balanced, sustainable flood management in the Central Valley. Figure 7-2 illustrates the basic process followed from identification of the planning goals, through identification of management actions, to formulation of preliminary approaches and the SSIA.

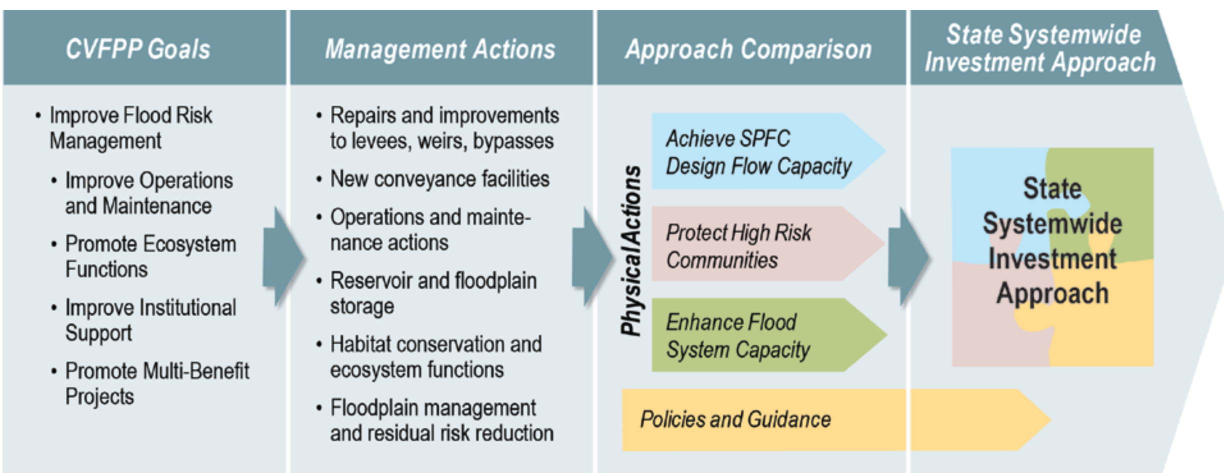


Figure 7-2. Formulation Process for State Systemwide Investment Approach

The following sections describe the baseline No Project and the three preliminary approaches in more detail.

7.2 No Project

No Project is the baseline for comparing the other preliminary approaches, and simulates conditions that would exist without the adoption of the 2012 CVFPP. This baseline will help determine risk reduction and other benefits of the preliminary approaches and provide a baseline cost for continued routine maintenance.

With "No Project," there would be no systemwide action or program of actions to address the CVFPP goals. No Project assumes a continuation of existing systemwide conditions. Existing systemwide conditions include ongoing routine maintenance of the flood management system, floodfighting and post-flood repairs, and other flood management programs. Also included are projects currently authorized, funded, permitted, and/or under construction, such as the following:

- Levee improvements in southern Yuba County implemented by the Three Rivers Levee Improvement Authority (TRLIA) since 2004 (TRLIA, 2011)
- Natomas Levee Improvement Program by Sacramento Area Flood Control Agency (SAFCA) (SAFCA, 2011)
- Folsom Dam Joint Federal Project to improve the ability of Folsom Dam to manage large flood events by allowing more water to be safely released earlier in a storm event, leaving more storage capacity for capturing peak inflow (Reclamation, 2009)
- Levee improvements along the American and Sacramento rivers to safely pass a flow rate of 160,000 cubic feet per second (cfs) under the American River Common Features Project (SAFCA, 2011)
- Marysville levee improvements
- Authorized elements of the Sacramento River Bank Protection Project

This approach does not include any systemwide reconstruction or upgrades. No ecological or habitat restoration projects would be implemented; routine maintenance would continue.

7.3 Preliminary Approach: Achieve State Plan of Flood Control Design Flow Capacity

This approach focuses on reconstructing existing SPFC facilities throughout the system so that the facilities can reliably accommodate established project design flows or design water surface elevations. This approach was formulated to address legislation that required DWR to consider structural actions necessary to reconstruct SPFC facilities to their original design standards (CWC 9614 (g)). It also addresses requests from stakeholders to consider reconstructing the existing flood management system in place, or without major modification to facility locations. This approach does not consider improving SPFC facilities to carry floodflows greater than project design flows, nor enhancements (to levee height, width, or footprint, for example) that exceed current design standards.

7.3.1 Description

The Achieve SPFC Design Flow Capacity Approach includes major remedial actions (facility reconstruction of and modifications to SPFC and appurtenant non-SPFC facilities) to address medium- and high-threat factors identified in the FCSSR (DWR, 2011). Medium- and high-threat factors are those judged to pose the most significant potential threat to SPFC facility integrity. These factors include levee freeboard, levee geometry, structural instability, and seepage, as well as channel capacity to convey design flows. To address these threat factors, this approach includes remediation of approximately 170 miles of urban SPFC levees and 1,400 miles of non-urban SPFC levees. This approach does not include remediation of non-SPFC levees, although it is recognized that non-SPFC levees can affect flooding within the SPFC Planning Area.

Figure 7-3 illustrates the general locations where some type of levee remediation would be needed to convey SPFC design flows, based on the DWR Levee Evaluations Program ULE and NULE overall hazard classifications and categorizations, respectively. Levees shown as purple (higher concern) or orange (medium concern) on the map generally display more performance problems than those shown in green (lower concern), and require remediation to safely convey SPFC design flows. Remedial actions would include the following:

- SPFC levees would be reconstructed or modified to address identified adverse geotechnical conditions and provide a high reliability of accommodating design flows.

- In locations where the current top-of-levee elevation is less than the design water surface profiles with design freeboard, or where the channel capacity is less than the stated design flow capacity, levee height would be raised to achieve design freeboard.

Remedial actions would include different types of stability and seepage berms, cutoff walls, rock slope protection, increasing levee height and/or geometry, and replacement levees needed for the system to convey design flows. Under this approach, the O&M of existing reservoirs, weirs, bypasses, and other structures within the flood management system would continue as under current conditions.

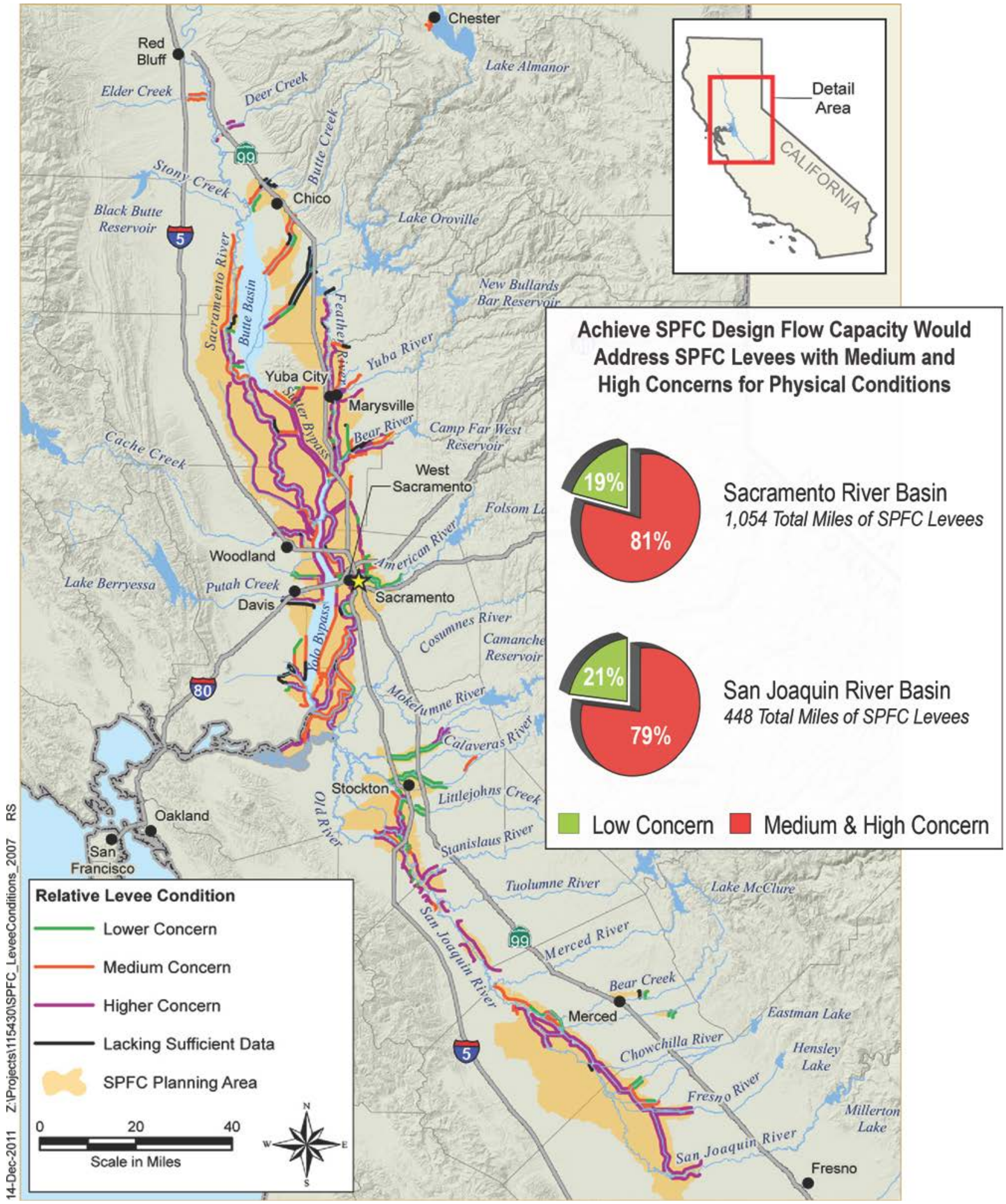


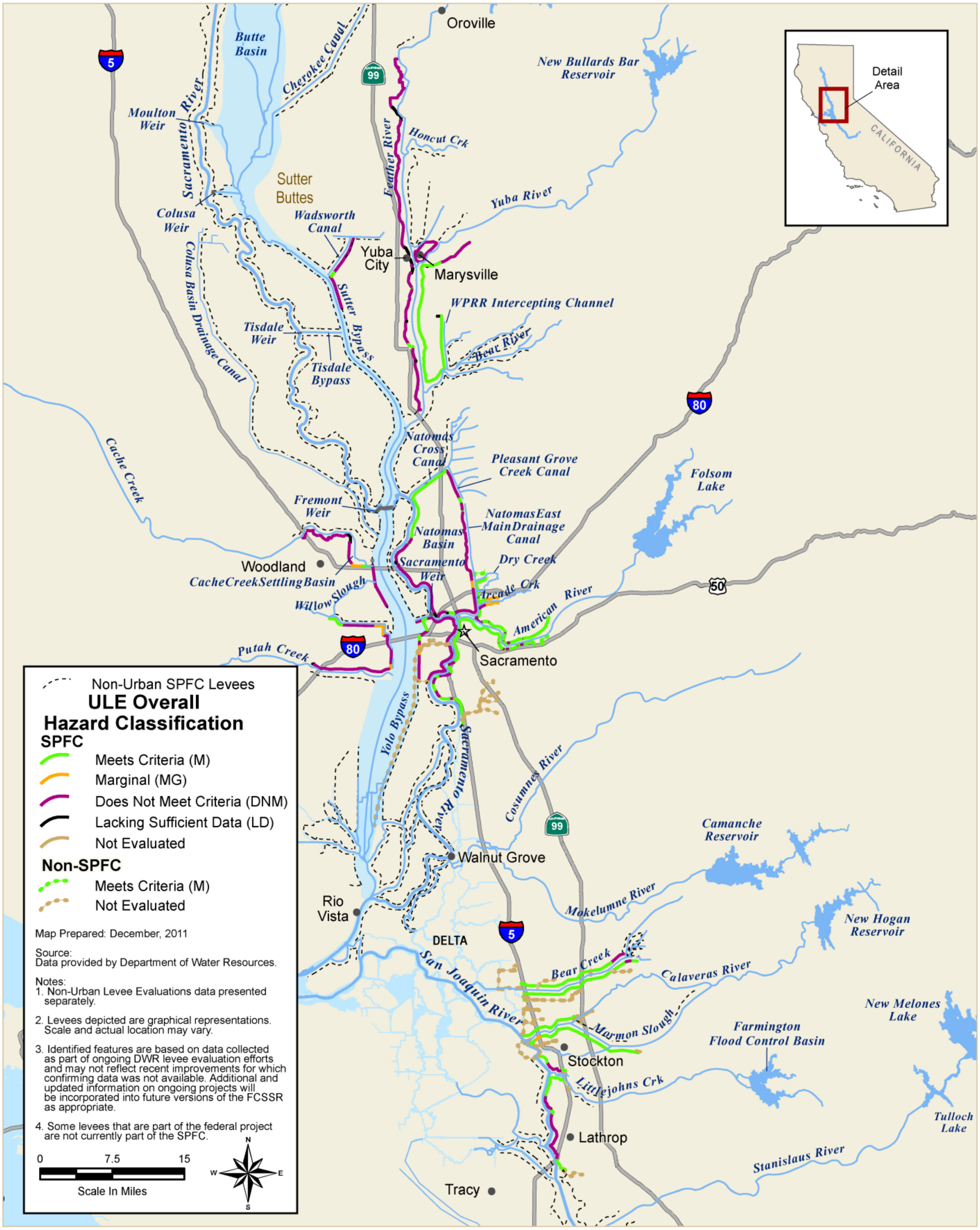
Figure 7-3. Composite Map of Physical Levee Conditions Based on Levee Evaluations Program Results (Urban Levee Evaluations and Non-Urban Levee Evaluations)

7.3.2 Approach Formulation

Under this approach, identified threat factors that adversely affect the ability of the system to safely convey design flows would be addressed via structural methods within the existing facility footprint (in-place reconstruction), where feasible. Overall levee hazard classifications and categorizations for urban and non-urban levees, respectively, are shown in Figures 7-4 through 7-6, based on results from the DWR Levee Evaluations Program. Note that the ULE and NULE results are not comparable because of different methodologies applied for urban and non-urban areas.[1] The ULE and NULE projects are meeting a similar purpose, but urban levees are undergoing a more comprehensive evaluation because of public safety considerations for densely populated areas. No changes in reservoir operations rules or in the way existing weirs and other control structures operate are considered as part of this approach.

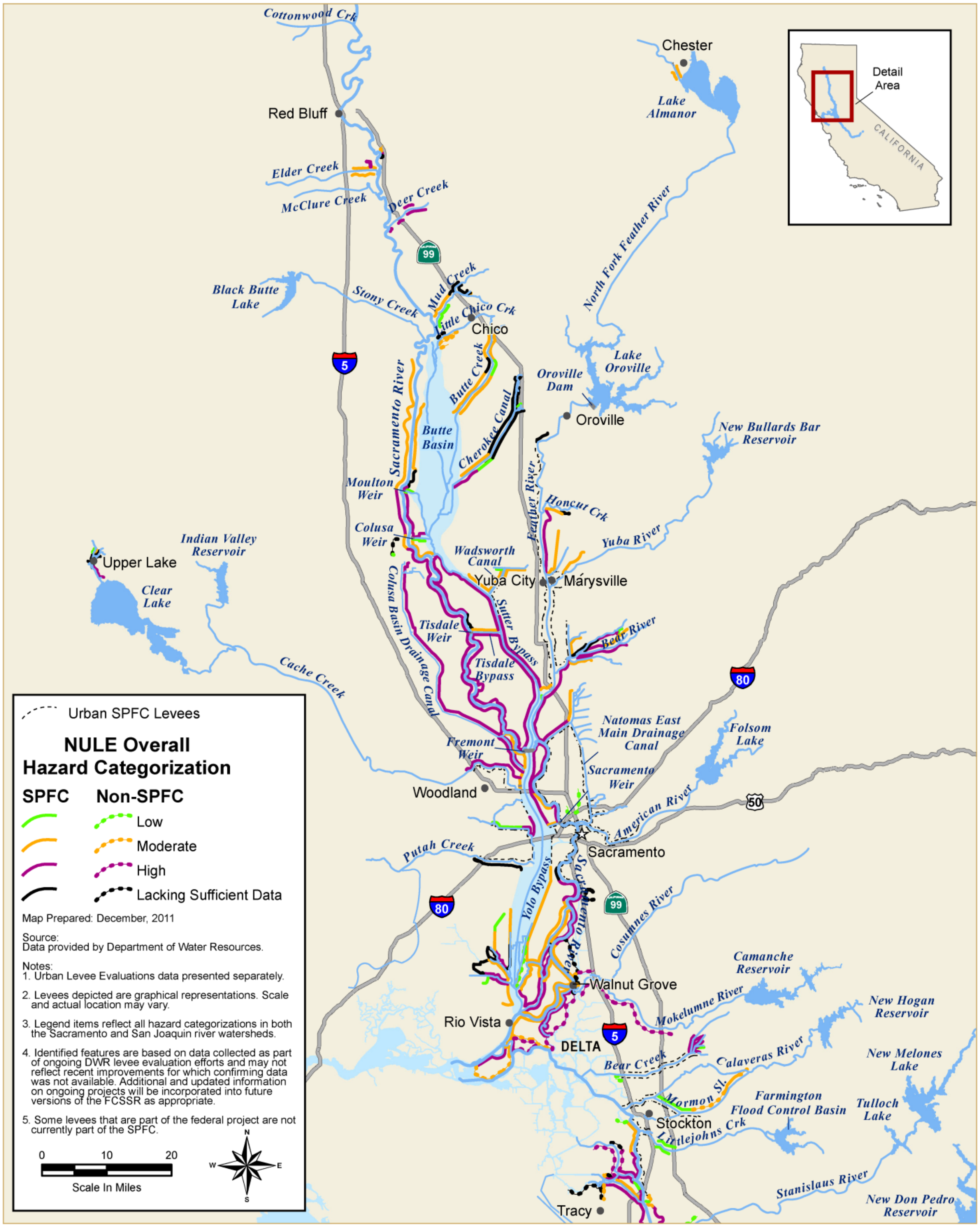
Urban Levees protect densely populated areas

[1] The ULE Project is evaluating urban levees against current design criteria. The NULE Project is evaluating non-urban levees based on systematic, consistent, and repeatable analyses that correlate geotechnical data with levee performance history, and not relative to design criteria.



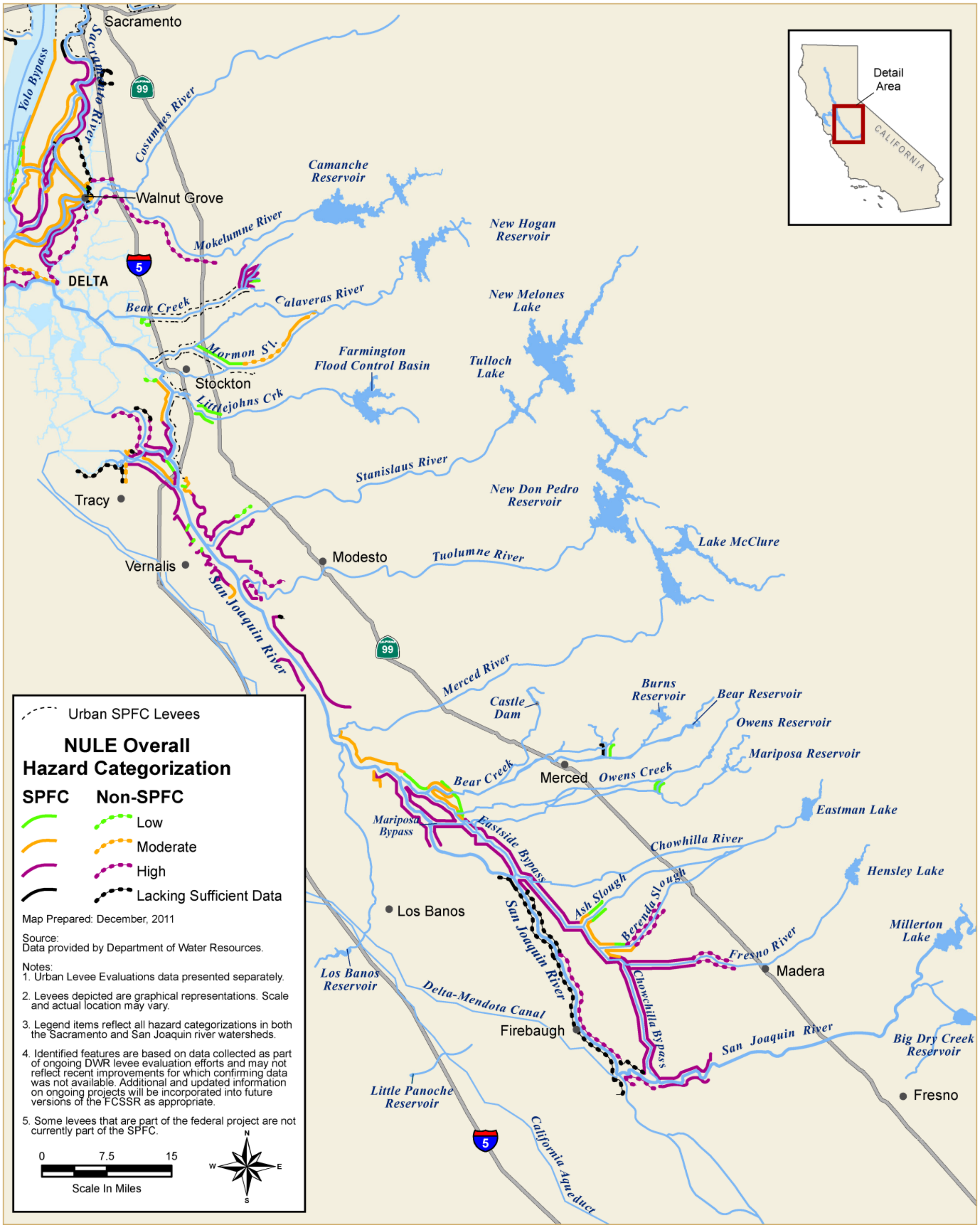
Key: SPFC = State Plan of Flood Control

Figure 7-4. Urban Levee Evaluations Overall Hazard Classification



Key: SPFC = State Plan of Flood Control

Figure 7-5. Non-Urban Levee Evaluations Overall Hazard Categorization for Sacramento River Basin



Key: SPFC = State Plan of Flood Control

Figure 7-6. Non-Urban Levee Evaluations Overall Hazard Categorization for San Joaquin River Basin

To address identified medium- and high-threat factors, the following approaches apply:

- **Levee Crest Elevation (design freeboard)** – In locations where current top-of-levee elevations are higher than, or equal to, design water surface profiles with design freeboard, repairs would be made, where necessary, to address geotechnical and stability factors to accommodate the design profile with high reliability. No increases in levee crest elevation would be considered for these locations. In locations where the current top-of-levee elevations are less than design surface profiles with design freeboard, or where channel capacities are less than stated design capacities, levee raises would be needed to correct for inadequate freeboard. Results of the levee freeboard check conducted by the ULE and NULE projects are described in the FCSSR, Appendix A, Section A-2, and shown in Figures 7-7 through 7-9.

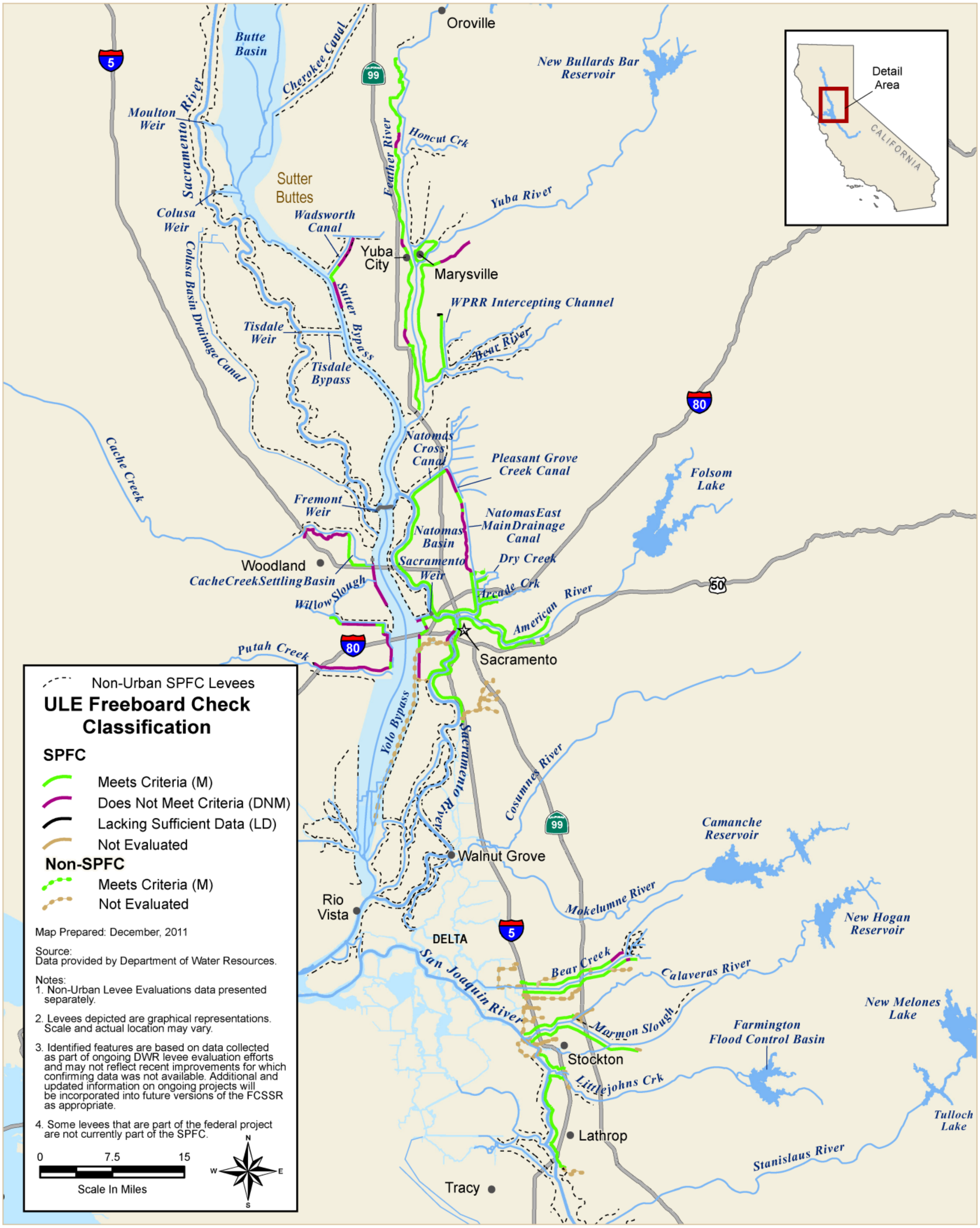
- **Levee Integrity** – The ULE and NULE projects assessed approximately 350 miles of urban and 1,200 miles of non-urban SPFC levees, respectively, and over 500 miles of appurtenant non-SPFC levees. During the preliminary analysis phase and final screening phase of the ULE Project, analyses were conducted to assess the performance of urban levees against identified performance criteria for freeboard, levee geometry, steady-state seepage, and steady-state stability. During Phase 1 of the NULE Project, non-urban levees were assessed for potential for failure from under-seepage, through-seepage, slope stability, and erosion. Results of these assessments for each threat factor are documented in Section 4 of the FCSSR (DWR, 2011a). Based on the ULE hazard classifications and NULE hazard categorizations, levee remediation would be recommended as follows:

  - **Urban Levees** – Levees with hazard classifications of marginal in meeting criteria (MG) or do not meet criteria (DNM) would be recommended to undergo remediation for medium- and high-threat factors. Levees with a hazard classification of lacking sufficient data (LD) would be recommended for further analysis to determine if remediation is required.

  - **Non-Urban Levees** – Levees with hazard categorizations of moderate or high would be recommended to undergo remediation for medium- and high-threat factors. Levees with a hazard categorization of lacking sufficient data would be recommended for further analysis to determine if remediation is required.

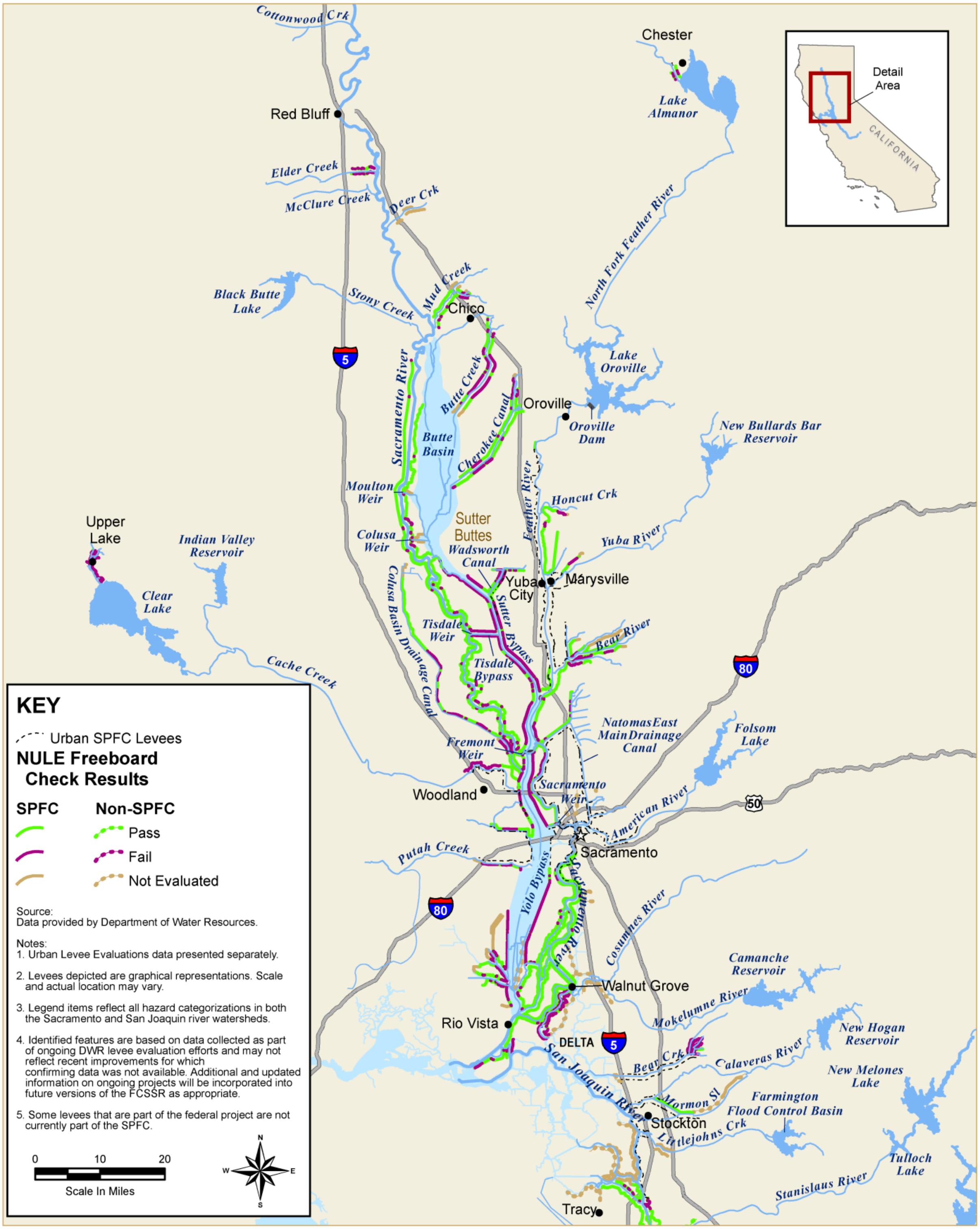
Appurtenant Non-SPFC Levees

Approximately 120 miles of urban, and 400 miles of rural non-SPFC levees were assessed. These levees are generally located immediately adjacent to or opposite SPFC levees such that their function might directly impact that of the SPFC levee system.



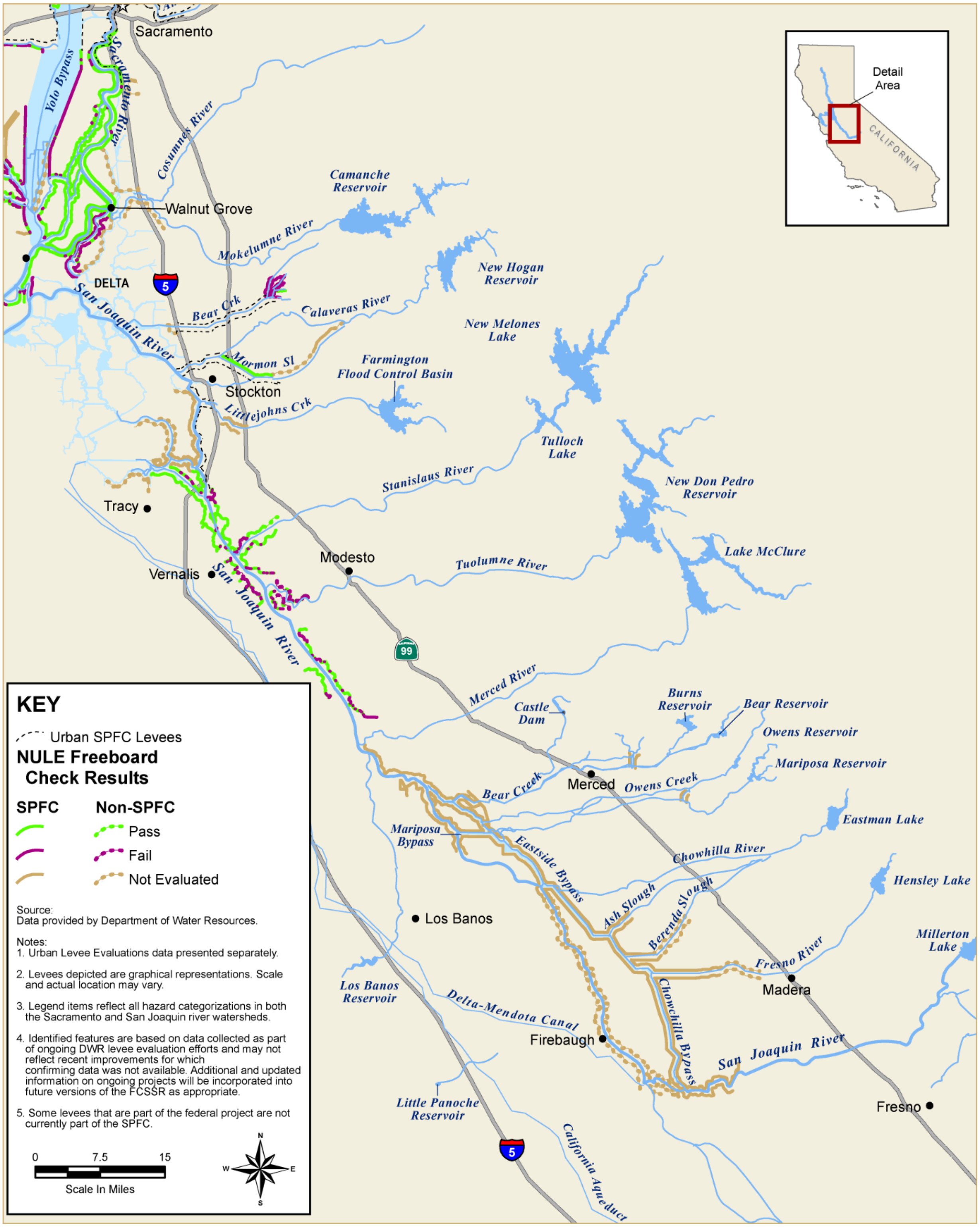
Key: SPFC = State Plan of Flood Control

Figure 7-7. Urban Levee Evaluations Freeboard Check Results



Key: SPFC = State Plan of Flood Control

Figure 7-8. Non-Urban Levee Evaluations Freeboard Check Results for Sacramento River Basin



Key: SPFC = State Plan of Flood Control

Figure 7-9. Non-Urban Levee Evaluations Freeboard Check Results for San Joaquin River Basin

7.3.3 Approach Elements

Types of remedial actions that could be employed to address identified medium- and high-threat factors are listed in Table 7-2. Remedial actions for through-seepage, under-seepage, slope instability, and erosion include constructing different types of stability and/or seepage berms, cutoff walls, rock slope protection, and replacement levees.

Table 7-2. Remedial Actions to Address Identified Medium- and High-Threat Factors

Remedial Action	Levee Threat Factor			
	Through-Seepage	Under-Seepage	Instability	Erosion
Drained stability berm	●		●	
Seepage berm		●		
Combination drained stability and seepage berm	●	●	●	
Conventional soil-bentonite slurry wall (up to 70-foot remediation depth)	●	●		
Deep soil mixing wall (greater than 70-foot remediation depth)	●	●		
Rock slope protection				●
Replacement levee	●		●	

Standardized details were developed for each remedial action to be used as building blocks that could be employed separately or combined with others to provide complete remediation for any set of circumstances. For additional details on this methodology, see Attachment 8J: Designs and Costs. Proposed remedial action quantities for medium- and high-threat factors affecting SPFC urban and non-urban levees are summarized in Tables 7-3 through 7-6.

Table 7-3. Summary of Proposed Remedial Action Quantities to Achieve SPFC Design Flows for SPFC Urban Levees in Sacramento River Basin

Hazard Classification	Total Segment Length (miles)	Structural Remediation (miles)	Erosion Remediation (miles)	Freeboard Remediation (miles)	Other Remediation (miles)
DNM	37.2	23.3	2.7	13.6	0
LD	1.4	0.4	0	1.0	0
MG	2.0	0.6	0	0	0
Total	**40.6**	**24.3**	**2.7**	**14.6**	**0**

Key:
DNM = does not meet criteria
LD = lacking sufficient data
MG = marginal
SPFC = State Plan of Flood Control

Table 7-4. Summary of Proposed Remedial Action Quantities to Achieve SPFC Design Flows for SPFC Urban Levees in San Joaquin River Basin

Hazard Classification	Total Segment Length (miles)	Structural Remediation (miles)	Erosion Remediation (miles)	Freeboard Remediation (miles)	Other Remediation (miles)
DNM	69.0	8.4	0	60.6	0
LD	0	0	0	0	0
MG	0.9	1.0	0	0	0
Total	**69.9**	**9.4**	**0**	**60.6**	**0**

Key:
DNM = does not meet criteria
LD = lacking sufficient data
MG = marginal
SPFC = State Plan of Flood Control

Table 7-5. Summary of Proposed Remedial Action Quantities to Achieve SPFC Design Flows for SPFC Non-Urban Levees in Sacramento River Basin

Hazard Categorization	Total Segment Length (miles)	Structural Remediation (miles)	Erosion Remediation (miles)	Freeboard/ Geometry Remediation (miles)
Moderate	262.2	156.1	72.5	102.6
High	440.9	391.3	201.9	165.8
Lacking Sufficient Data	40.1	23.9	0.0	23.1
Lacking Sufficient Data (Low or Moderate)	13.9	10.1	0.0	10.6
Lacking Sufficient Data (Moderate or High)	18.9	13.9	4.0	8.4
Total	**776**	**595.3**	**278.4**	**310.4**

Key:
SPFC = State Plan of Flood Control

Table 7-6. Summary of Proposed Remedial Action Quantities to Achieve SPFC Design Flows for SPFC Non-Urban Levees in San Joaquin River Basin

Hazard Categorization	Total Segment Length (miles)	Structural Remediation (miles)	Erosion Remediation (miles)	Freeboard/ Geometry Remediation (miles)
Moderate	22.3	9.1	6.4	0.6
High	89.7	62.0	31.8	6.7
Lacking Sufficient Data	0.0	0.0	0.0	0.0
Lacking Sufficient Data (Low or Moderate)	11.8	3.7	9.5	0.2
Lacking Sufficient Data (Moderate or High)	1.1	1.1	0.0	0.0
Total	**124.9**	**76.0**	**47.8**	**7.5**

Key:
SPFC = State Plan of Flood Control

7.3.4 Approach Assessment

Based on an initial assessment, the Achieve SPFC Design Flow Capacity Approach is estimated to cost approximately $19 billion to $23 billion and take 30 to 35 years to implement. This approach would provide an approximate 47 percent reduction in annual flood damages compared to current conditions by correcting identified problems and reconstructing (but not enhancing) SPFC facilities.

This approach would improve the reliability of SPFC facilities compared with existing conditions. Since the original designs did not consider geotechnical and other risk factors addressed by current engineering criteria, reconstruction would significantly improve reliability of the levee system and the LOP provided by the SPFC over that of existing conditions. However, the LOP would be highly variable throughout the system and not linked to the land uses at risk within the floodplain.

Investments in SPFC reconstruction would initially reduce SPFC O&M costs. However, the long-term cost to maintain the system would remain high (similar to current conditions) because reconstruction alone would not address chronic erosion, sedimentation, and other geomorphic conditions inherent to the current system configuration. Consequently, this approach would only partially contribute to the goal of improving O&M.

Details regarding environmental, physical, economic, and life safety assessments of the approach are given below.

Flood Stage Assessment

As mentioned previously, the Achieve SPFC Design Flow Capacity Approach would correct identified problems and reconstruct (but not enhance) SPFC facilities. This approach would improve the reliability of SPFC facilities over existing conditions. Since the original designs did not account for geotechnical problems now known to exist for many levees and their foundations, reconstruction would significantly improve reliability of the levee system and the LOP provided by the SPFC over existing conditions.

This approach would improve the structural integrity of SPFC facilities throughout the system over No Project. However, SPFC facility reconstruction investments would not increase the performance intended by the SPFC over that provided when originally constructed, nor would the investments provide a uniform level of flood protection to any given region or land-use type. Levels of flood protection would continue to vary throughout the system and not all urban areas would achieve the targeted urban level of flood protection as defined in CWC 9602(i).

In some instances, upstream levee reconstruction would result in increased peak flows or stages downstream (see Figures 7-10 and 7-11). Without additional mitigation actions, the level of flood protection in some downstream areas would decrease over current conditions. Consequently, this approach would only partially address the primary CVFPP goal of improving flood risk management.

Physical assessments of the Achieve SPFC Design Flow Capacity Approach were documented in the 2012 CVFPP Supporting Documentation, Technical Documentation. Assessments included hydrologic modeling; reservoir operations modeling; hydraulic riverine, estuarine, and floodplain modeling; and levee performance.

Achieve State Plan of Flood Control Design Flow Capacity Approach

- *Reconstruction of approximately 1,600 miles of levees.*
- *Reconstruction of levees in their current footprint to safely pass design flows would contain more floodflows within channels, thus increasing peak floodflows and stages throughout the system.*
- *Reduction of 47 percent in annual flood damage estimates, including structure values and contents and crops.*
- *Estimated capital costs higher for the Sacramento River Basin because of the greater number of levees in the basin.*

Figure 7-10. Change in Peak Flood Stage for Achieve State Plan of Flood Control Design Flow Capacity Approach Compared to No Project in the Sacramento River Basin (100-year event)

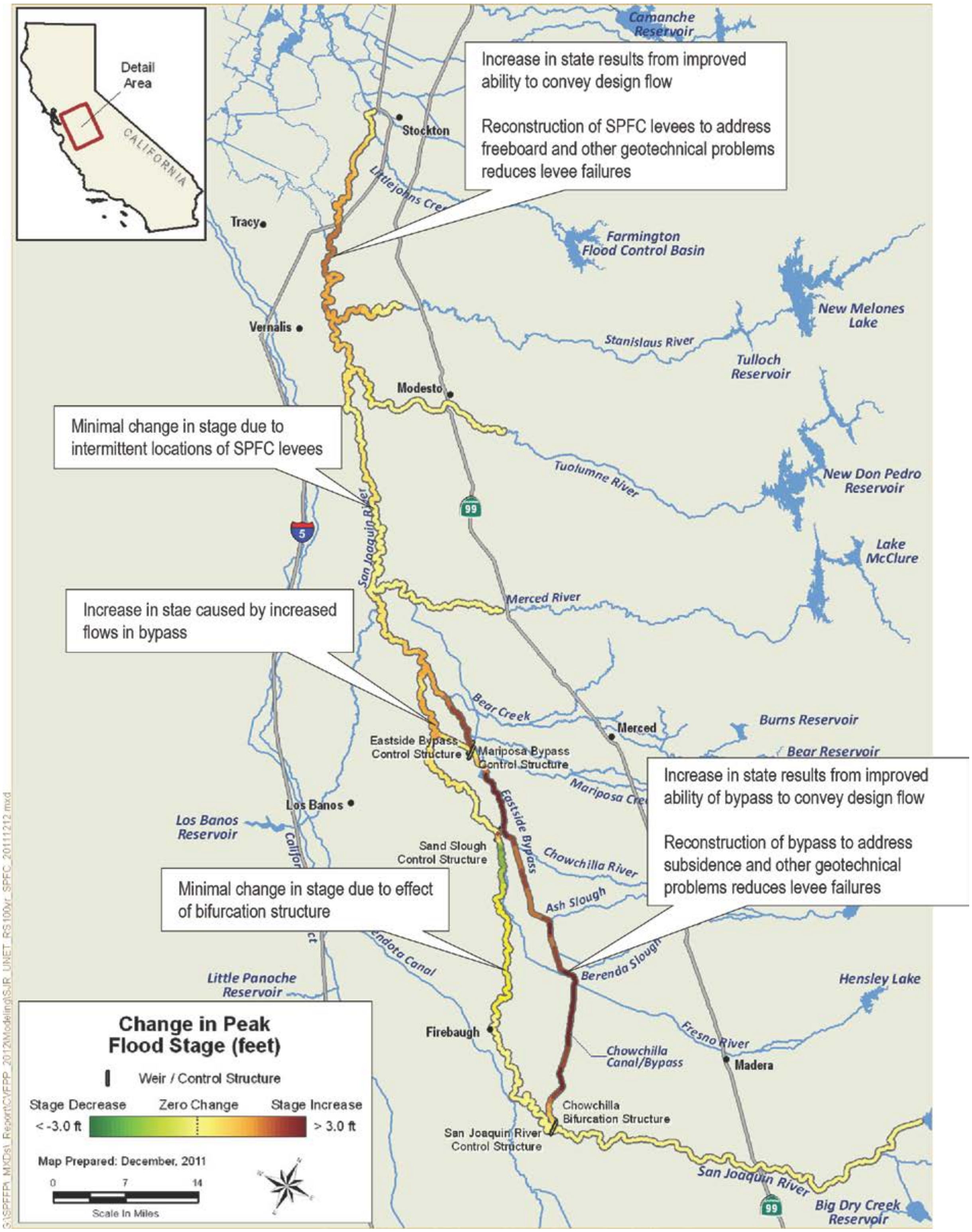


Figure 7-11. Change in Peak Flood Stage for Achieve State Plan of Flood Control Design Flow Capacity Approach Compared to No Project in the San Joaquin River Basin (100-year event)

Environmental Assessment

Because the footprint and operation of SPFC facilities would remain largely unchanged under this approach, opportunities to integrate environmental restoration would be limited (e.g., waterside berms or incorporation of native vegetation into erosion prevention measures along existing levees) and would not result in restoration of ecosystem functions on a systemwide scale. Therefore, existing conflicts between environmental stewardship and levee maintenance practices would continue to hamper the improvement of ecosystem conditions and public safety. There would also be few opportunities to incorporate groundwater recharge or other water-related benefits. Consequently, the approach would have only a minor contribution to the supporting goals of promoting ecosystem functions and multi-benefit projects.

Economics Assessment

Economic assessment for the Achieve SPFC Design Flow Capacity Approach resulted in an initial investment estimate of approximately $19 to $23 billion for correcting identified problems and reconstructing (but not enhancing) SPFC facilities. Investments in SPFC facility reconstruction would initially reduce SPFC O&M costs. However, the long-term cost to maintain the system would remain high (similar to current conditions) because reconstruction alone would not address chronic erosion, sedimentation, and other geomorphic conditions inherent to the current system configuration. Consequently, this approach would only partially contribute to the goal of improving O&M.

Figures 7-12 and 7-14 show the expected annual damages (EAD) for structure and contents, crop, and business losses for the Achieve SPFC Design Flow Capacity Approach compared with No Project for the Sacramento and San Joaquin river basins, respectively. The change in expected damages under the SPFC Design Capacity Approach compared to No Project for the Sacramento and San Joaquin river basins is presented in Figures 7-13 and 7-14, respectively. For both basins, EAD will be reduced significantly compared with No Project.

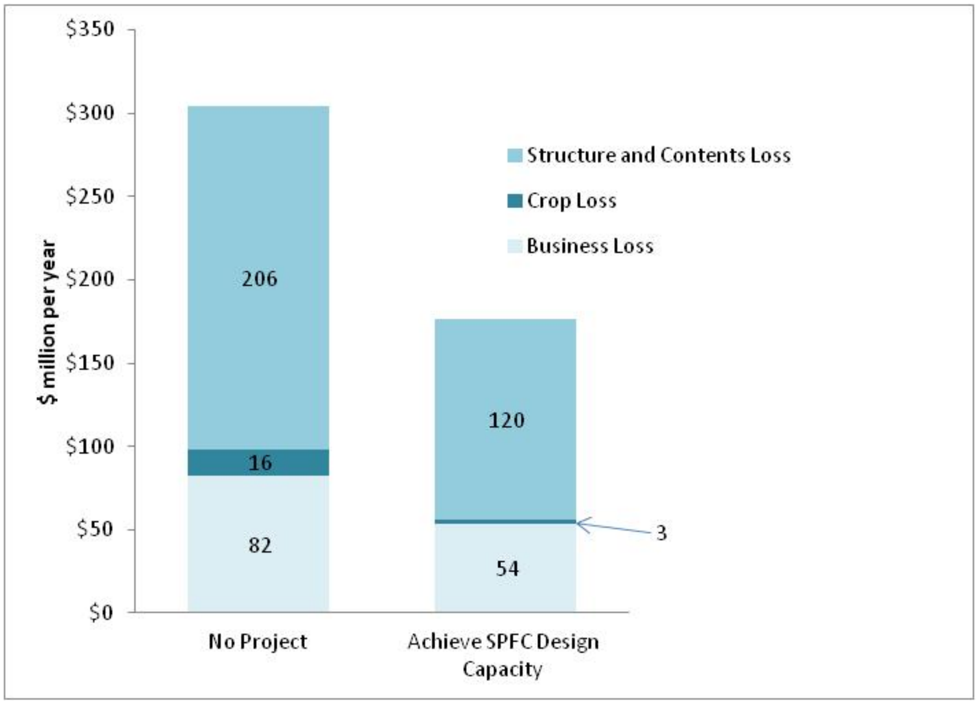


Figure 7-12. Expected Annual Damages from Flooding: Achieve State Plan of Flood Control Design Flow Capacity Approach Compared to No Project for Sacramento Basin

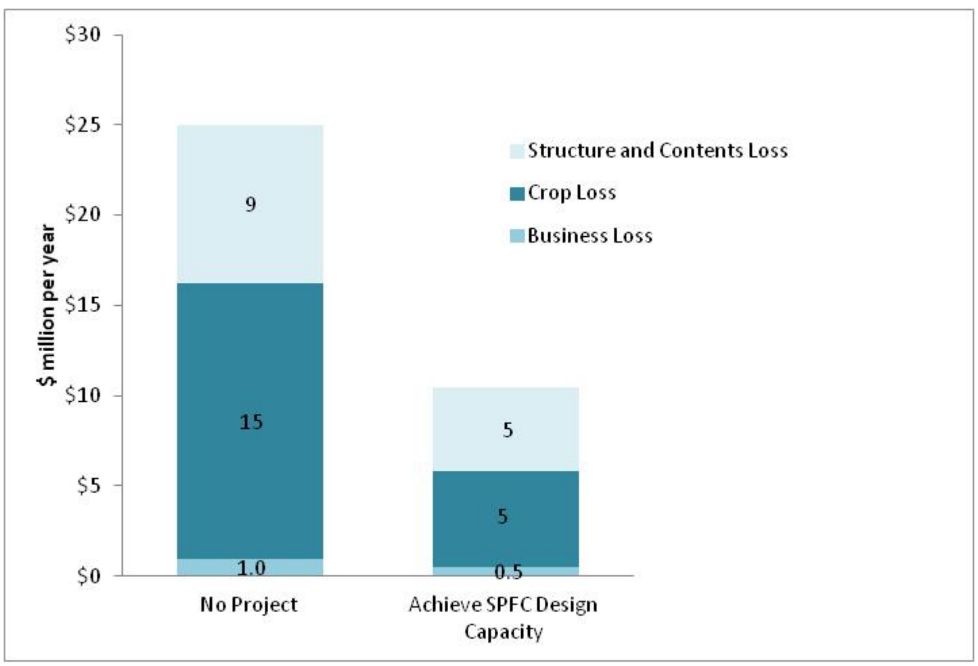


Figure 7-13. Expected Annual Damages from Flooding: Achieve State Plan of Flood Control Design Flow Capacity Approach Compared to No Project for San Joaquin Basin

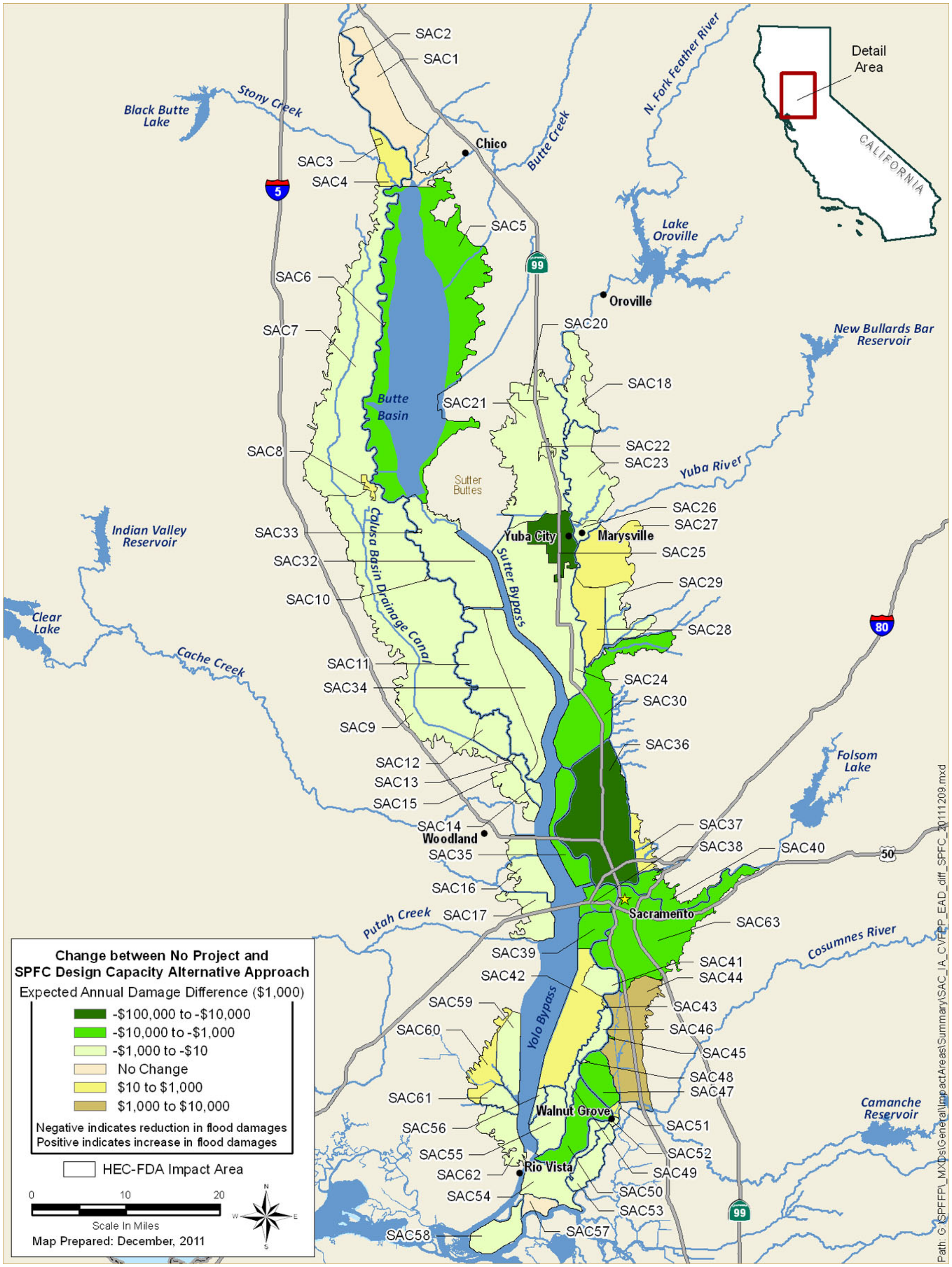


Figure 7-14. Change in Expected Annual Damages for the Sacramento River Basin Under the Achieve State Plan of Flood Control Design Flow Design Capacity Approach Compared to No Project

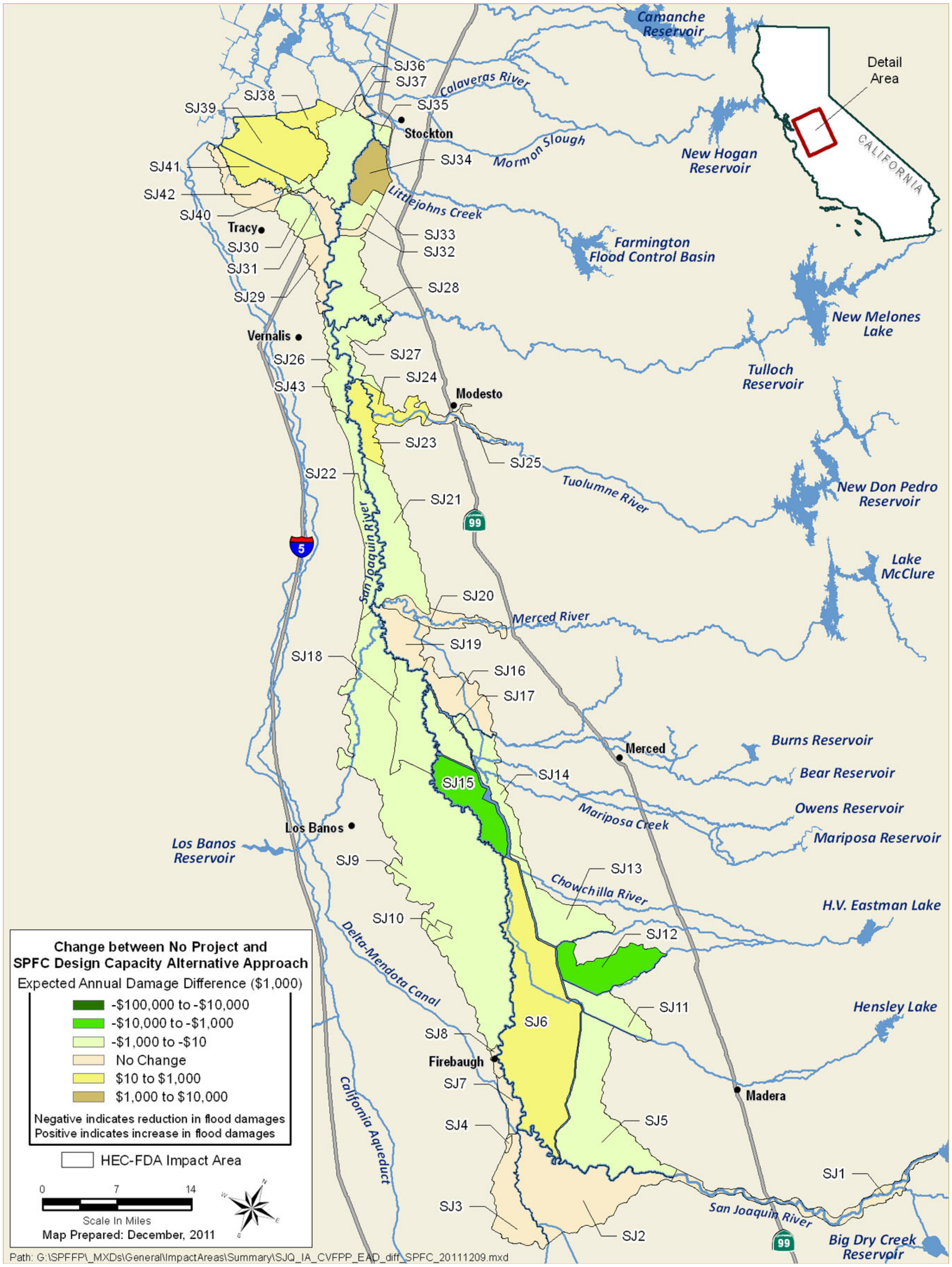


Figure 7-15. Change in Expected Annual Damages for the San Joaquin River Basin Under the Achieve State Plan of Flood Control Design Flow Design Capacity Approach Compared to No Project

Cost Assessment

Cost estimates to repair urban and non-urban levees are developed primarily by ULE and NULE projects. The cost estimates were generated using a Parametric Cost Estimation tool, which developed conceptual-level cost estimates to remediate seepage, stability, and erosion factors. For additional cost details on the estimate approach and assumptions, refer to Attachment 8J: Designs and Costs.

The costs for this approach were categorized into four flood management elements:

1. **System Improvements** – Only costs associated with F-CO/F-BO were included.

2. **Urban Improvements –** Improvements to Urban SPFC Levees through the ULE Program.

3. **Rural Agricultural Improvements** – Improvements to non-urban SPFC levees through the NULE Program.

4. **Residual Risk Management –** This is a minor part of this approach because the repairs to the levees are expected to reduce residual risk.

Table 7-7 summarizes the improvement costs for the Achieve SPFC Design Flow Capacity Approach for the Sacramento and San Joaquin river basins.

Table 7-7. Improvement Costs for Achieve SPFC Design Flow Capacity Approach for Sacramento and San Joaquin Basins ($ Millions)

	Sacramento River Basin			San Joaquin River Basin		
	Low		High	Low		High
System Improvements	$ 43	to	$ 53	$ 48	to	$ 61
Urban Improvements	$ 3,014	to	$ 3,767	$ 813	to	$ 1,017
Rural Improvements	$ 11,095	to	$ 13,869	$ 2,748	to	$ 3,436
Residual Risk Management	$ 485	to	$ 592	$ 247	to	$ 309
Total Costs	$ 14,637	to	$ 18,281	$ 3,856	to	$ 4,823

Because of the greater number of SPFC levees, the estimated capital costs are higher for the Sacramento River Basin than for the San Joaquin River Basin.

7.4 Preliminary Approach: Protect High Risk Communities

This approach focuses primarily on physical improvements to SPFC and non-SPFC facilities to address the highest threats to public safety and property. These threats predominate in densely populated areas, including urban areas and small communities subject to deep or rapid flooding.

7.4.1 Description

This approach includes a variety of physical actions to protect urban areas and small communities from frequent flooding where substantial threats to public safety exist. Flood threat levels were assessed based on population at risk, population density, flood frequency, flood depth, and proximity to main-stem or tributary flood sources. This approach set targets of the following:

- Providing flood protection to urban and urbanizing areas against a 0.5 percent annual exceedence probability (AEP) flood event (1-in-200 chance of flooding occurring in any year), consistent with legislative direction[2].
- Providing flood protection to small communities against a 1 percent AEP flood event.
- The targeted LOP for small communities is considered for planning purposes, and does not represent a State policy or requirement.

This approach addresses the primary goal of improving flood risk management by developing protection from flooding by the main-stem Sacramento and San Joaquin rivers and their major tributaries. Flooding from local sources and interior drainage were not considered in this approach. No facility repairs or modifications would be made to increase the level of existing flood protection in areas where factors would not pose substantial threats to public safety. SPFC facilities would continue to be maintained and repaired as needed (similar to No Project). Secondary goals

[2] All cities and counties within the Sacramento-San Joaquin Valley will be required to make findings related to the urban (200-year) level of flood protection before making certain land use decisions (see California Government Code Sections 65865.5, 65962, and 66474.5). As part of this legislation, DWR is developing policy-level and engineering criteria to help urban level of flood protection to be achieved. Pertinent engineering criteria (such as methods to compute flood depths, and technical standards for levees and floodwalls), are contained in the *Urban Levee Design Criteria* (ULDC) (DWR, 2012) and are incorporated by reference into the policy-level criteria contained in the *Criteria for Demonstrating Urban Level of Flood Protection* (DWR, 2012). Refer to 2012 CVFPP Attachment 3: Documents Incorporated by Reference for more information.

were not addressed in this approach because the approach only provides flood protection as it relates to public safety.

7.4.2 Approach Formulation

Urban communities are defined as communities with populations greater than 10,000 per CGC Section 65007(j). These urban areas are considered high risk communities because of potentially significant public safety consequences that could result from a flood event occurring in densely populated areas. Urban areas would be provided with protection against a 0.5 percent AEP flood event via structural repairs and improvements to levees and other facilities (including levee raises) within their existing footprints, where feasible (in-place reconstruction). Recommended improvements to SPFC urban levees were developed by the ULE Project.

Small communities (communities with populations of less than 10,000) would be provided with protection against a 1 percent AEP flood event via reconstruction of existing SPFC levees or construction of new ring levees. Communities with populations of less than 200 were not considered. Based on flood threat factors (flood frequency, potential flood depth, and proximity to flooding sources), small communities were grouped into four categories to reflect their relative risk of loss of life. The approach for characterizing flood threat levels is illustrated in Figure 7-16. The threat level categories are as follows:

- **High-Threat Level –** Communities that would be subject to high flooding frequency (greater than 1 percent chance per year) and would be subject to deep flooding conditions (potential flood depths of more than 3 feet on average).
- **Moderate- to High-Threat Level –** Communities that would be subject to high flooding frequency (greater than 1 percent chance per year) would be subject to sheet flooding conditions (potential flood depths of less than 3 feet on average), and could be flooded fairly rapidly (located less than 2 miles from a flooding source).
- **Low- to Moderate-Threat Level –** Communities that would be subject to high flooding frequency (greater than 1 percent chance per year), would be subject to sheet flooding conditions (potential flood depths less than 3 feet on average), and would be more than 2 miles from a flooding source.
- **Low-Threat Level –** Communities that would not be subject to high flooding frequency (less than 1 percent chance per year).

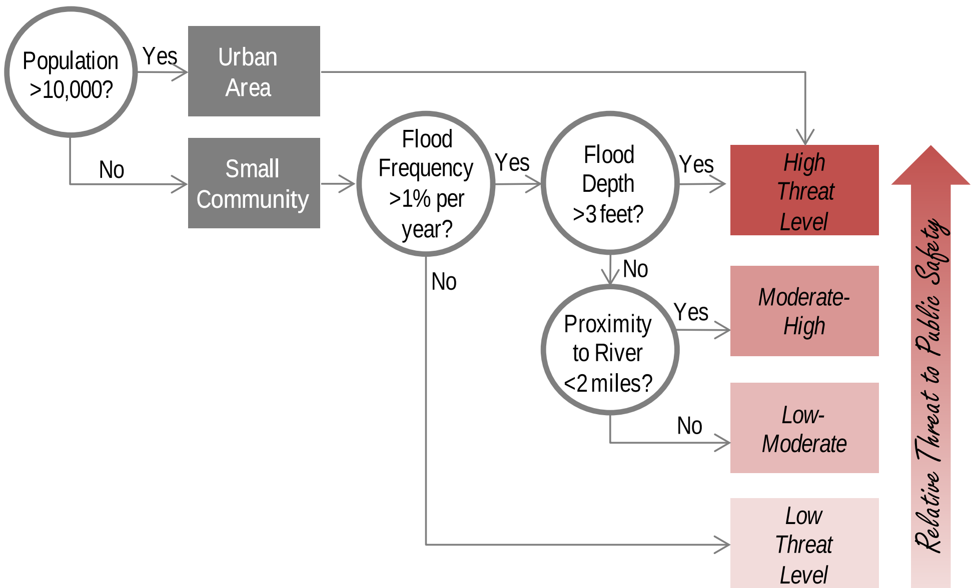
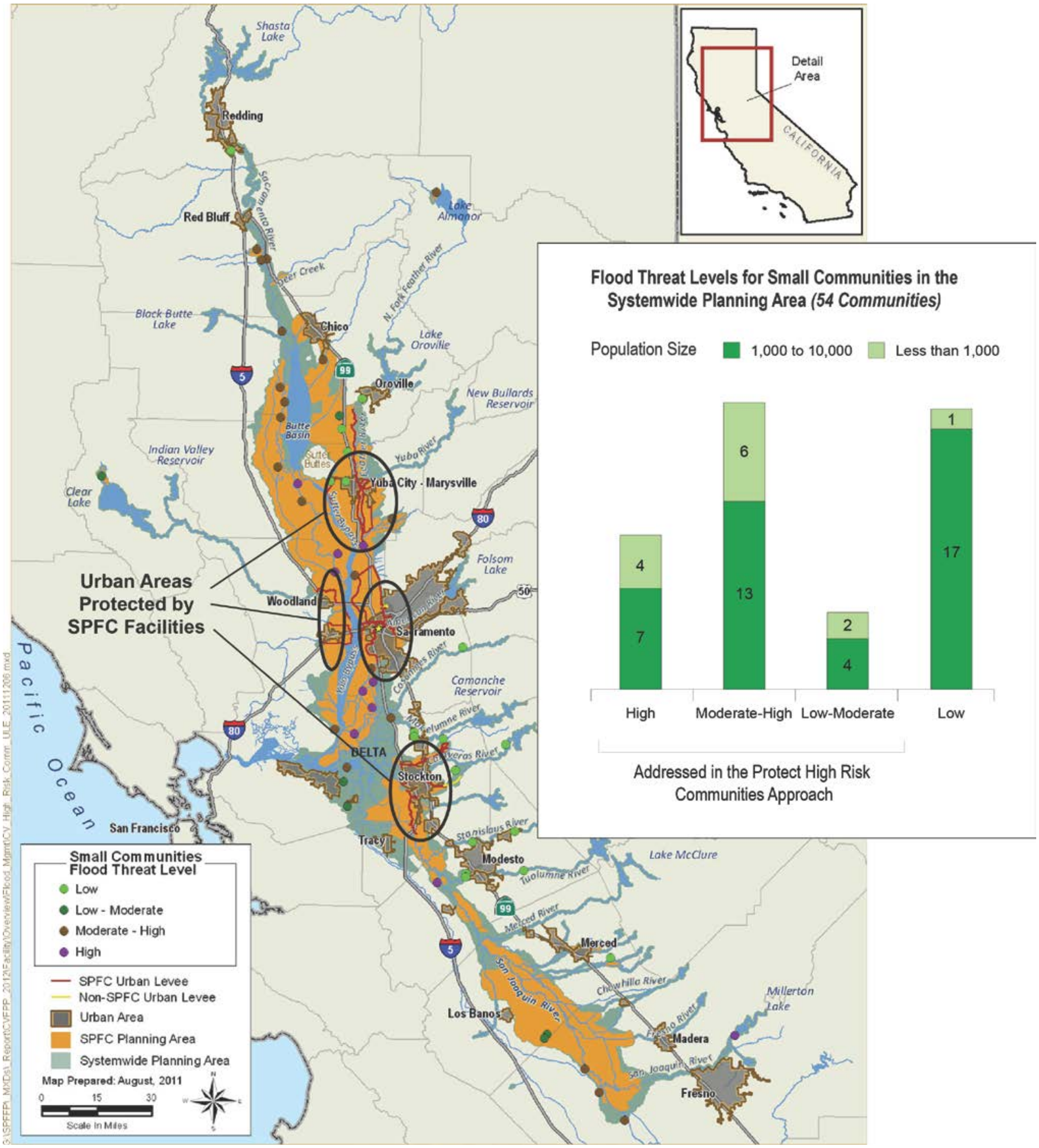


Figure 7-16. Approach for Characterizing Community Flood Risks

Communities with high, moderate-high, and low-moderate flood threat levels would be considered for improvements to their flood protection facilities. Figure 7-17 shows the urban areas and small communities considered in the High Risk Communities Approach.



Key: SPFC = State Plan of Flood Control

Figure 7-17. Urban Areas and Small Communities Included in High Risk Communities Approach

Flood Threat Assessment

Both SPFC and non-SPFC small communities within the Systemwide Planning Area were included in the flood threat assessment. It should be noted that non-SPFC urban communities were not discussed in the 2012 CVFPP. A legislative mandate has been passed, that requires that all urban communities in the Sacramento and San Joaquin River Valleys have protection against a 0.5 percent AEP flood event. Upgrades in protection for non-SPFC urban communities in the Systemwide Planning Area are included in this mandate.

Identifying and characterizing community flood threats involved the following steps:

1. **Identify communities –** The following data sources were used to develop a list of communities within the Systemwide Planning Area:
   - California Department of Finance
   - Census-Designated Places (2000 U.S. Census)
   - California List of Places (U.S. Geological Survey topographic quadrangles)

Population information for communities is from the estimated 2007 population based on 2000 U.S. Census projections and California Department of Finance estimates[3].

2. **Characterize flood threats –** To characterize flood threats to communities, attributes related to flood frequency, potential flood depth, and proximity to the nearest river are used:
   - **Flood frequency –** Each community was evaluated to determine if its annual flood frequency exceeds 1 percent. Information on flood frequencies was obtained using the AEP for economic impact areas presented in the Comprehensive Study, Appendix E, Risk Analysis (USACE, 2002). The economic impact areas cover the majority of the Systemwide Planning Area. If a community spans more than one Economic Impact Area, an area-weighted average was calculated.
   - **Flood depth –** Each community was evaluated regarding whether it was subject to deep flooding conditions, which are considered to be potential average flood depths greater than 3 feet. A flood depth of

[3] 2010 Census data was not made available at the time that this assessment was completed, therefore 2007 Census data was used to establish a baseline population from which projections were made.

3 feet was chosen because it is a flood depth threshold of when flooding could reasonably be life threatening. This information is readily available from the DWR LFPZ maps (DWR, 2008c) and is consistent with California Health and Safety Code Section 50465. Information on flood depth was developed using flood depths from the Comprehensive Study 200-year floodplain (USACE, 2002) and the LFPZs (DWR, 2008c).

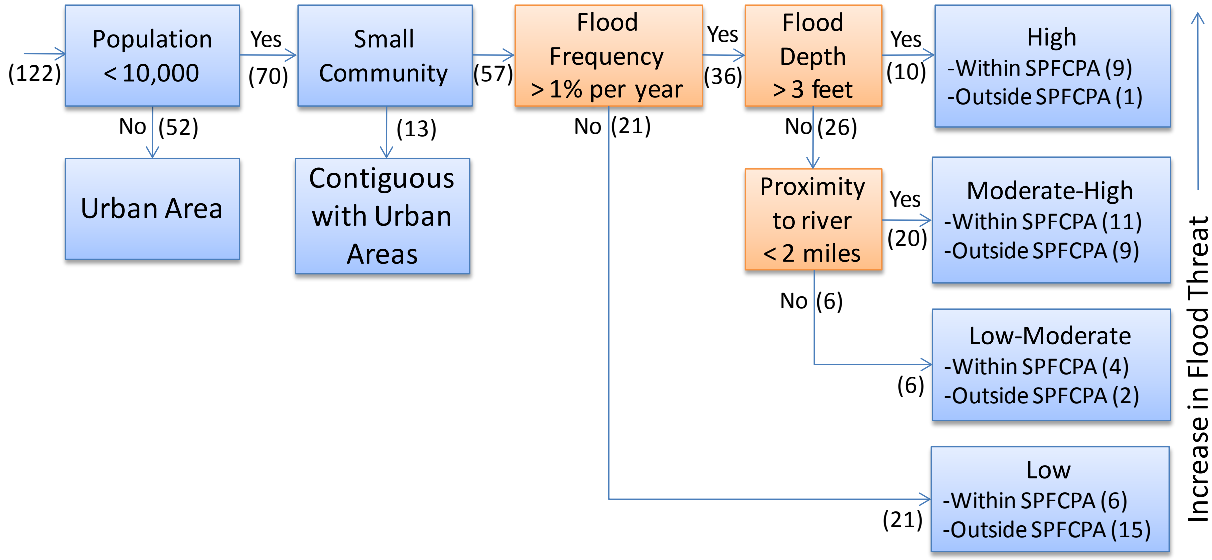
- **Proximity to nearest river –** Each community is evaluated regarding whether it is potentially subject to rapid flooding conditions. Because of the difficulty associated with estimating rapid flooding, for the purpose of this analysis, it was estimated as being within 2 miles of an SPFC levee or other major stream. A proximity of 2 miles was chosen because it is a distance within which flooding could occur quickly. Note that local drainages were not considered.

3. **Assess community flood threat level –** Using the flood threat characterization process (shown in Figure 7-18), community flood threats were assessed. Results are summarized in Figure 7-18 and discussed below:

   - Of 122 unique communities identified within the Systemwide Planning Area, 52 communities were identified as urban (Table 7-8) and 70 were identified as small communities. Of the 70 small communities, 13 were viewed as being contiguous with urban areas, leaving 57 small communities warranting independent consideration in the analysis. Small communities contiguous with urban areas are listed in Table 7-9. Small communities with populations of less than 200 were not considered.

   - All 65 urban communities (52 urban and 13 small communities contiguous with urban communities) were considered to have a high-threat level to public safety from flooding because of their high population density. Small communities contiguous with urban areas were treated as part of the urban metropolitan areas.

   - Of the remaining 57 small communities, 10 were considered to have a high-threat level, 20 were considered to have a moderate-high-threat level, 6 were considered to have a low- to moderate-threat level, and 21 were considered to have a low threat level. Small communities with high, moderate- to high-, and low- to moderate-flood threat levels are listed in Table 7-10.



Legend:
(#) = number represents the number of communities
SPFCPA = State Plan of Flood Control Planning Area

Figure 7-18. Summary of Community Flood Threat Assessment Results

Table 7-8. Urban Areas within the Sacramento and San Joaquin River Basins

Region	Urban Area
Upper Sacramento	• Chico • Red Bluff • Redding
Feather	• Linda • Marysville • Olivehurst • Oroville • Yuba City • South Yuba City
Lower Sacramento	• Arden Arcade • Carmichael • Elk Grove • Fair Oaks • Florin • Folsom • Gold River • La Riviera • Laguna • Laguna West-Lakeside • Parkway-South Sacramento • Rancho Cordova • Rio Linda • Rosemount • Sacramento • West Sacramento • Woodland
Upper San Joaquin	• Atwater • Chowchilla • Livingston • Los Banos • Madera • Merced • Winton
Lower Jan Joaquin	• Antioch • Bay Point • Brentwood • Ceres • Country Club • Discovery Bay • Fresno • Garden Acres • Lathrop • Lodi • Manteca • Modesto • Oakdale • Oakley • Patterson • Pittsburg • Ripon • Stockton • Tracy

Table 7-9. List of Small Communities Contiguous with Urban Areas

	Urban Area				
	Antioch	**Modesto**	**Oroville**	**Sacramento**	**Stockton**
Within SPFC Planning Area		• Bret Harte* • Bystrom* • Shackelford*			• August* • French Camp* • Kennedy* • Lincoln Village* • Morada* • Taft Mosswood*
Outside SPFC Planning Area	• *Sand Hill*		• Palermo	• Gold River • *Hagginwood*	

Notes:
Communities listed from highest to lowest population.
Italicized communities have populations of less than 1,000.
* Communities in the San Joaquin River basin
Key:
SPFC = State Plan of Flood Control

Table 7-10. List of Small Communities by Threat Level

<table>
<tr><th rowspan="2">Planning Area</th><th colspan="4">Flood Threat Level</th></tr>
<tr><th>High</th><th>Moderate – High</th><th>Low – Moderate</th><th>Low</th></tr>
<tr><td>Within SPFC Planning Area</td><td>• Firebaugh*
• Knights Landing
• Grayson*
• Isleton
• Walnut Grove
• Meridian
• Nicolaus
• Courtland
• Robbins
• Hood</td><td>• Colusa
• Durham
• Rio Vista
• Wheatland
• Gerber-Las Flores*
• Glenn
• Clarksburg
• Verona
• Grimes
• Princeton
• Butte City</td><td>• Dos Palos*
• Biggs
• South Dos Palos*
• Upper Lake</td><td>• Live Oak
• Thermalito
• Gridley
• Tierra Buena
• Lockeford*
• Sutter</td></tr>
<tr><td>Outside SPFC Planning Area</td><td>• Friant*</td><td>• Mendota*
• Bethel Island
• Chester
• Los Molinos
• Hamilton City
• Thornton
• Tranquillity*
• Tehama</td><td>• Byron*
• Knightsen</td><td>• Anderson
• West Modesto*
• Rancho Calaveras*
• Rancho Murieta*
• Planada*
• East Oakdale*
• South Woodbridge*
• North Woodbridge*
• Del Rio*
• Riverdale Park*
• Linden*
• Hickman*</td></tr>
</table>

Notes:
* Communities in the San Joaquin River basin
Communities listed from highest to lowest population.
Italicized communities have populations of less than 1,000.
Key:
SPFCPA = State Plan of Flood Control

The goal for urban communities is to have protection against a 0.5 percent AEP flood event. This LOP would be provided through in-place levee reconstruction and improvements to related facilities.

The goal for small communities is to have protection against a 1 percent AEP flood event. This LOP would be provided by improving protection facilities, relocating communities outside the 100-year floodplain, or raising communities above the 100-year flood elevation. Improving protection facilities could include strengthening of levees, raising existing levees, and constructing new levees and/or ring levees. Relocating and raising communities is more expensive, requires public support, and is not being evaluated at this time.

Residual risk is the portion of risk that remains after flood control structures have been built. Risk remains because of the likelihood of the measures' design being surpassed by a flood's intensity and of structural failure of the measures. Methods to reduce residual risk include land-use policies, insurance, building codes, floodproofing, emergency response, and other methods. FloodSAFE and FEMA also have programs that can help manage residual risk. These programs may be evaluated in the future.

7.4.3 Approach Elements

As discussed above, urban communities will be provided with protection against a 0.5 percent AEP flood event through in-place levee reconstruction. Approaches to providing protection against a 1 percent AEP flood event vary from one small community to the next, and range from in-place levee reconstruction to construction of ring levees. Table 7-11 summarizes the proposed actions for high risk small communities. Considering limitations in data availability, only 27 small communities were assessed for the CVFPP. They are primarily a subset of the high risk small communities in Table 7-11, but also include a sampling of lower risk communities which would require residual risk related measures, rather than levee improvements or construction.

Table 7-11. Summary of Structural Evaluations for Small Communities

Small Community	Available Data?	Within SPFC Planning Area?	Recommendation	Description
Knights Landing – Option 1	Yes	Yes	Fix in Place	Repair entire levee segments 162, 172, and 217 as described in GAR, with the addition of a levee raise to the entire length of segment 162.
Knights Landing – Option 2	Yes	Yes	Ring Levee	Construct ring levee by tying a new levee to existing levee segments 162 and 217. A portion of 162 would be raised to meet freeboard criteria.
Isleton	Yes	Yes	Ring Levee	Construct ring levee by tying a new levee to existing levee segments 40 and 378. A portion of segment 378 would be raised to meet freeboard criteria.
Courtland	Yes	Yes	Fix in Place	No flood inundation is shown for Courtland. Repair entire levee segments 126 and 131, as described in NULE GAR.
Hood	Yes	Yes	Ring Levee	Construct ring levee by repairing a portion of levee segment 106, as described in NULE GAR, replacing existing levee segments to the south and east, and constructing new levee to the north.
Nicolaus	Yes	Yes	Fix in Place	No flood inundation is shown for Nicolaus. Repair levee segments adjacent to community, as described in NULE GAR.
Walnut Grove	Yes	Yes	Ring Levee	Construct multiple three-ring levees by repairing levee segments in surrounding area, as described in NULE GAR, and replacing existing nonproject levees with new levees.
Robbins	Yes	Yes	Ring Levee	Construct ring levee around town.
Grayson	Yes	Yes	Training Levee/Fix In Place	Repair adjacent levee segment (207) along left bank of San Joaquin River per GAR recommendations, and construct training levee north of Grayson.
Friant	Partial	No	New Levee/Tieback	Construct new levee along left bank of San Joaquin River and tieback levee along western edge of Friant.
Meridian	Yes	Yes	Ring Levee/Fix In Place	Repair adjacent levee segment (115) along left bank of Sacramento River per NULE GAR recommendations, and construct ring levee around rest of town.
Clarksburg	Yes	Yes	Ring Levee	Construct ring levee by repairing a portion of levee segments 303 and 244, as described in GAR, replacing a portion of an existing levee segment to the north and constructing a new levee to the west.
Durham	Yes	Yes	Fix in Place	This area should be considered apart of Chico. At the minimum, repair levee segments 263 and 381, as described in GAR.
Hamilton City	Partial	No	Ring Levee	No levee data are available from NULE GAR. A ring levee would be constructed with new levee.
Mendota	Partial	No	Ring Levee	No levee data are available from NULE GAR. A ring levee would be constructed with new levee on the east, west, and south, and by replacing a portion of existing nonproject levee to the north.

Table 7-11. Summary of Structural Evaluations for Small Communities (contd.)

Small Community	Available Data?	Within SPFC Planning Area?	Recommendation	Description
Glenn	Partial	Yes	Ring Levee	No levee data are available from NULE GAR. A ring levee would be constructed with new levee on the north, west, and south, and by replacing a portion of existing nonproject levee to the east.
Bethel Island	No	No	Not Assessed	Community has been identified by FEMA as being in the 100-year floodplain. However, no flood inundation is shown for Bethel Island. No levee data are available from NULE GAR.
Princeton	No	Yes	Not Assessed	Community has been identified by FEMA as being in the 100-year floodplain. However, no flood inundation is shown for Princeton. No levee data are available from NULE GAR.
Verona	No	Yes	Not Assessed	Community has been identified by FEMA as being in the 100-year floodplain. However, no flood inundation is shown for Verona. No levee data are available from NULE GAR.
Thornton	No	No	Not Assessed	Community has been identified by FEMA as being in the 100-year floodplain. However, no flood inundation is shown for Thornton. No levee data are available from NULE GAR.
Butte City	Yes	Yes	Ring Levee/Fix In Place	Repair adjacent levee segment (68) along left bank of Sacramento River per GAR recommendations, and construct ring levee around the rest of the town.
Colusa	Yes	Yes	Training Levee/Fix In Place	Repair adjacent levee segments (100 and 287) along right bank of Sacramento River per GAR recommendations, and construct training levee to the north and west of Colusa.
Firebaugh	Yes	Yes	Training Levees/ Ring Levees/Fix In Place	Repair adjacent levee segments (5030) along left bank of San Joaquin River per GAR recommendations, and construct training levees to the north and south of Firebaugh, west of the San Joaquin River, and construct two small ring levees east of the San Joaquin River to protect housing subdivision and water treatment facility.
Chester	TBD	No	Not Assessed	Community has been identified by FEMA as being in the 100-year floodplain. However, no data found in GAR and no inundation observed from 100-year floodplain figures.
Los Molinos	No	No	Not Assessed	Community has been identified by FEMA as being in the 100-year floodplain. However, no data found in GAR and no inundation observed from 100-year floodplain figures.
Gerber-Las Flores	Partial	Yes	Fix In Place	Community has been identified by FEMA as being in the 100-year floodplain. However, no inundation observed from 100-year floodplain figures, but GAR contains data for Elder Creek levees.

Table 7-11. Summary of Structural Evaluations for Small Communities (contd.)

Small Community	Available Data?	Within SPFC Planning Area?	Recommendation	Description
Grimes	Yes	Yes	Training Levee/Fix In Place	Repair adjacent levee segment (288) along right bank of Sacramento River per GAR recommendations, and construct training levee south of Grimes.
Rio Vista	No	Yes	Not Assessed	Community has been identified by FEMA as being in the 100-year floodplain. However, no data found in GAR and no inundation observed from 100-year floodplain figures.
Wheatland	Partial	Yes	Fix in Place	Repair levee segments (138, 240, and 154) along the banks of Bear River and Dry Creek. GIS figures do not show 100-year floodplain inundation, and town is built such that is difficult to protect with no knowledge of where floodflows originate.
Tehama	Partial	No	Not Assessed	Community has been identified by FEMA as being in the 100-year floodplain, and Tehama is built such that it can easily be encircled with ring levee. However, GIS figures do not show 100-year floodplain inundation, and GAR only contains data for one levee segment upstream.
Tranquility	Partial	No	Not Assessed	Community has been identified by FEMA as being in the 100-year floodplain, and Tranquility is laid out such that is easy to encircle with ring levee. However, GIS figures do not show 100-year floodplain inundation, and no data in NULE GAR.
Biggs	Partial	Yes	No Corrective Action Needed	Community has been identified by FEMA as being in the 100-year floodplain. However, no flood inundation is shown for Byron. Levee data are available from NULE GAR; however, it was categorized as low threat so no costs were identified.
Dos Palos/ South Dos Palos	Partial	Yes	Fix in Place	Repair entire levee segments 5028 and 5029, as described in NULE GAR.
Byron	No	No	Not Assessed	Community has been identified by FEMA as being in the 100-year floodplain. However, no flood inundation is shown for Byron. No levee data are available from NULE GAR.
Upper Lake	Partial	Yes	Fix In Place	Community has been identified by FEMA as being in the 100-year floodplain. However, 100-year floodplain maps do not show inundation. Surrounding levees already ring community. Fix existing levees per GAR recommendations, and possibly add a wing/training levee to prevent floodwaters backing up from the south.
Knightsen	No	No	Not Assessed	Community has been identified by FEMA as being in the 100-year floodplain. However, no data found in GAR and no inundation observed from 100-year floodplain figures.

Key:
FEMA = Federal Emergency Management Agency
GAR = Geotechnical Assessment Report
GIS = geographic information system
NULE = Non-Urban Levee Evaluations
SPFCPA = State Plan of Flood Control Planning Area
TBD = To be determined

No changes in reservoir operations rules or how existing weirs and other control structures function were considered as part of this approach. Only structural changes would be made to reach the desired levels of protection for urban areas and small communities. Conservation and environmental restoration elements are not addressed in this approach because the approach only provides flood protection as it relates to public safety.

7.4.4 Approach Assessment

Based on an initial assessment, this approach is estimated to cost about $9 billion to $11 billion and take 15 to 20 years to implement. The approach would provide approximately an approximately 63 percent reduction in mean annual flood damages compared to current conditions. Additionally, levee improvements that are limited to urban areas and small communities would result in minimal change to how the system functions, and to peak floodflows and stages.

Flood Stage Assessment

Although limited, this approach would include the opportunity to improve O&M of SPFC facilities in the vicinity of a number of urban areas and small communities. This would include provisions for local erosion monitoring and problem corrections. However, the long-term cost to maintain the system would remain high (similar to current conditions) because this approach would not address chronic erosion, sedimentation, and other geomorphic conditions associated with the large extent of rural SPFC facilities. Consequently, this approach would only partially contribute to the goal of improving O&M.

Additionally, levee improvements that are limited to urban areas and small communities would result in minimal change to how the system functions, and to peak floodflows and stages (Figures 7-19 and 7-20). Peak floodflows under this approach would not be reduced over No Project flows and in the Sacramento River Basin; a minor increase in peak flows would be seen in some downstream locations because the improved urban levees would keep more water in the floodways, resulting in increased stage in the levee system.

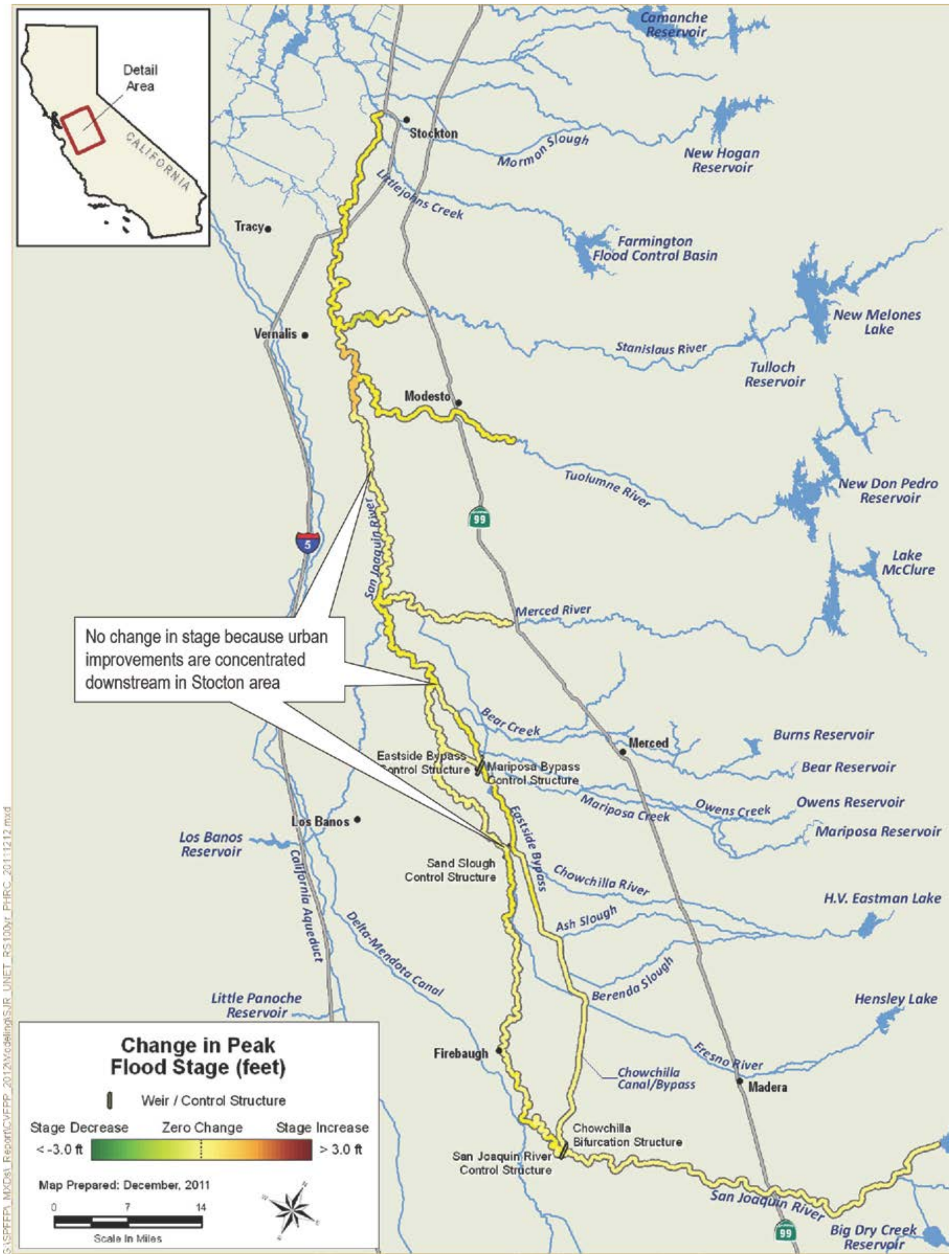


Figure 7-19. Change in Peak Flood Stage for Protect High Risk Communities Approach Compared to No Project in Sacramento River Basin (100-year event)

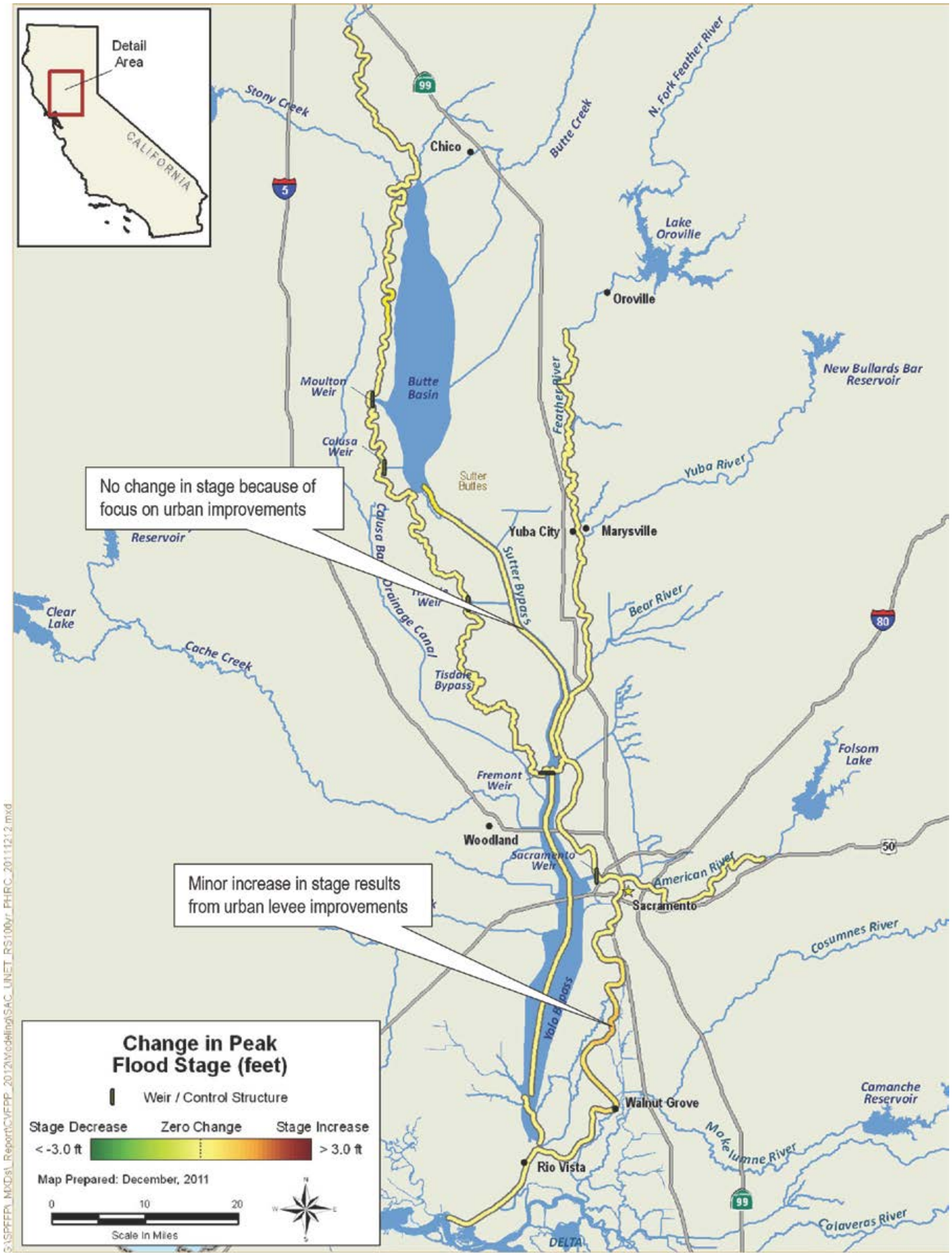


Figure 7-20. Change in Peak Flood Stage for Protect High Risk Communities Approach Compared to No Project in San Joaquin River Basin (100-year event)

Environmental Assessment

This approach would generate some opportunities to integrate environmental features into urban area and small community protection actions, including the construction of waterside berms or incorporation of native vegetation or habitat. However, because these opportunities would largely be site-specific, and because the footprint and operation of the SPFC facility would remain largely unchanged, this approach would not result in the restoration of ecosystem functions on a systemwide scale. There would also be few opportunities to incorporate groundwater recharge or other water-related benefits. Consequently, this approach would have only a minor contribution to the supporting goals of promoting ecosystem functions and multi-benefit projects.

Economics Assessment

Based on an initial assessment, the Protect High Risk Communities Approach is estimated to cost between approximately $9 billion to $11 billion and take 15 to 20 years to implement. This approach would provide an approximate 63 percent reduction in annual flood damages compared to current conditions.

The potential for loss of life and economic damages in urban areas, which would achieve an urban level of flood protection, would be reduced substantially. Improved flood protection for small communities would also reduce the potential for loss of life and economic damages, while preserving the important resources these communities provide to surrounding rural-agricultural areas.

However, levels of protection elsewhere in the valley, particularly rural areas, would generally not improve. Consequently, this approach only partially addresses the primary goal of improving flood risk management. Figures 7-21 and 7-22 show the EAD for structure and contents, crop, and business losses for the Protect High Risk Communities Approach, compared with No Project for the Sacramento and San Joaquin river basins, respectively. Figures 7-23 and 7-24 present the change in expected damages under the Protect High Risk Communities Approach compared to No Project for the Sacramento and San Joaquin river basins respectively. For both basins, expected annual damages to structures and businesses would be reduced considerably from those incurred under No Project; however, changes to damages to crops would be minor because rural levees would not be improved under this approach.

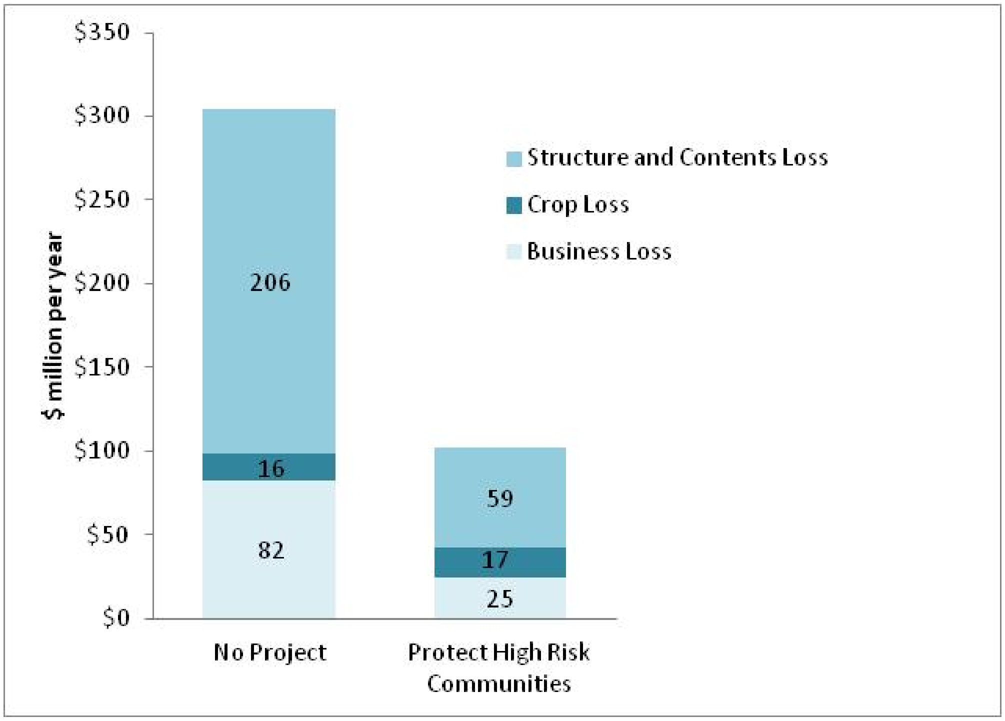


Figure 7-21. Expected Annual Damages from Flooding: Protect High Risk Communities Approach Compared to No Project for Sacramento River Basin

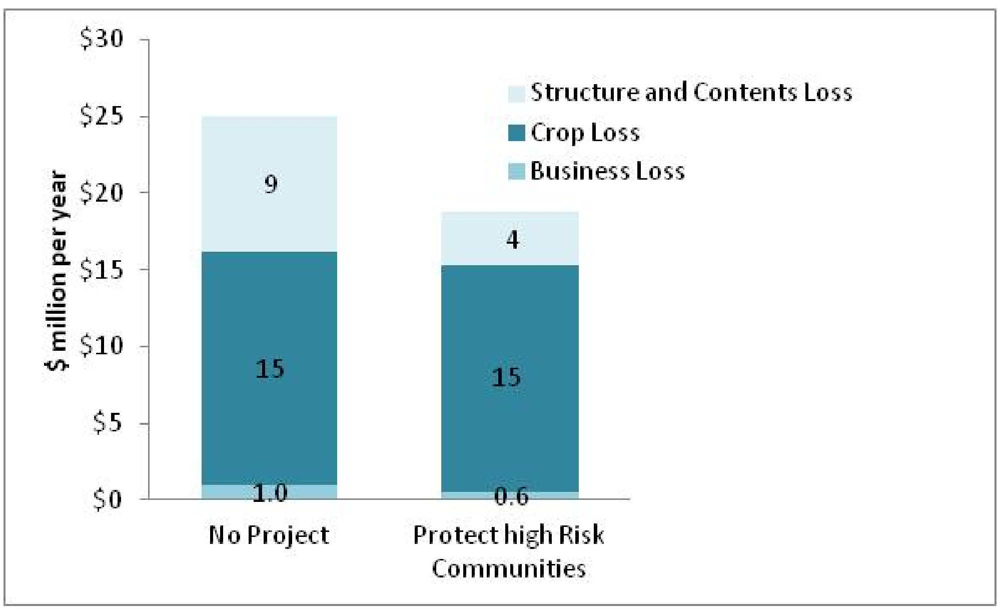


Figure 7-22. Expected Annual Damages from Flooding: Protect High Risk Communities Approach Compared to No Project for San Joaquin River Basin

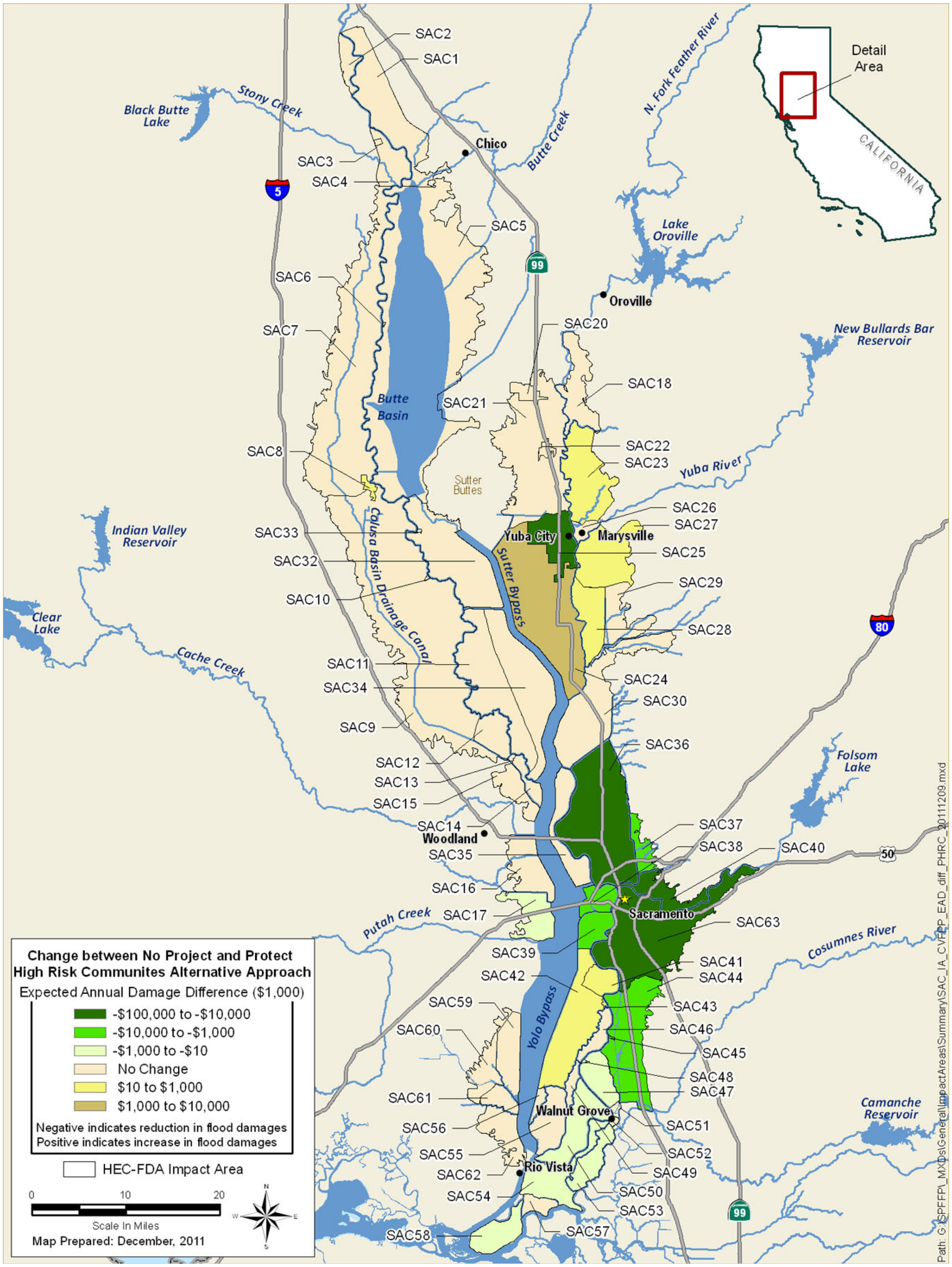


Figure 7-23. Change in Expected Annual Damages for the Sacramento River Basin Under the Protect High Risk Communities Approach Compared to No Project

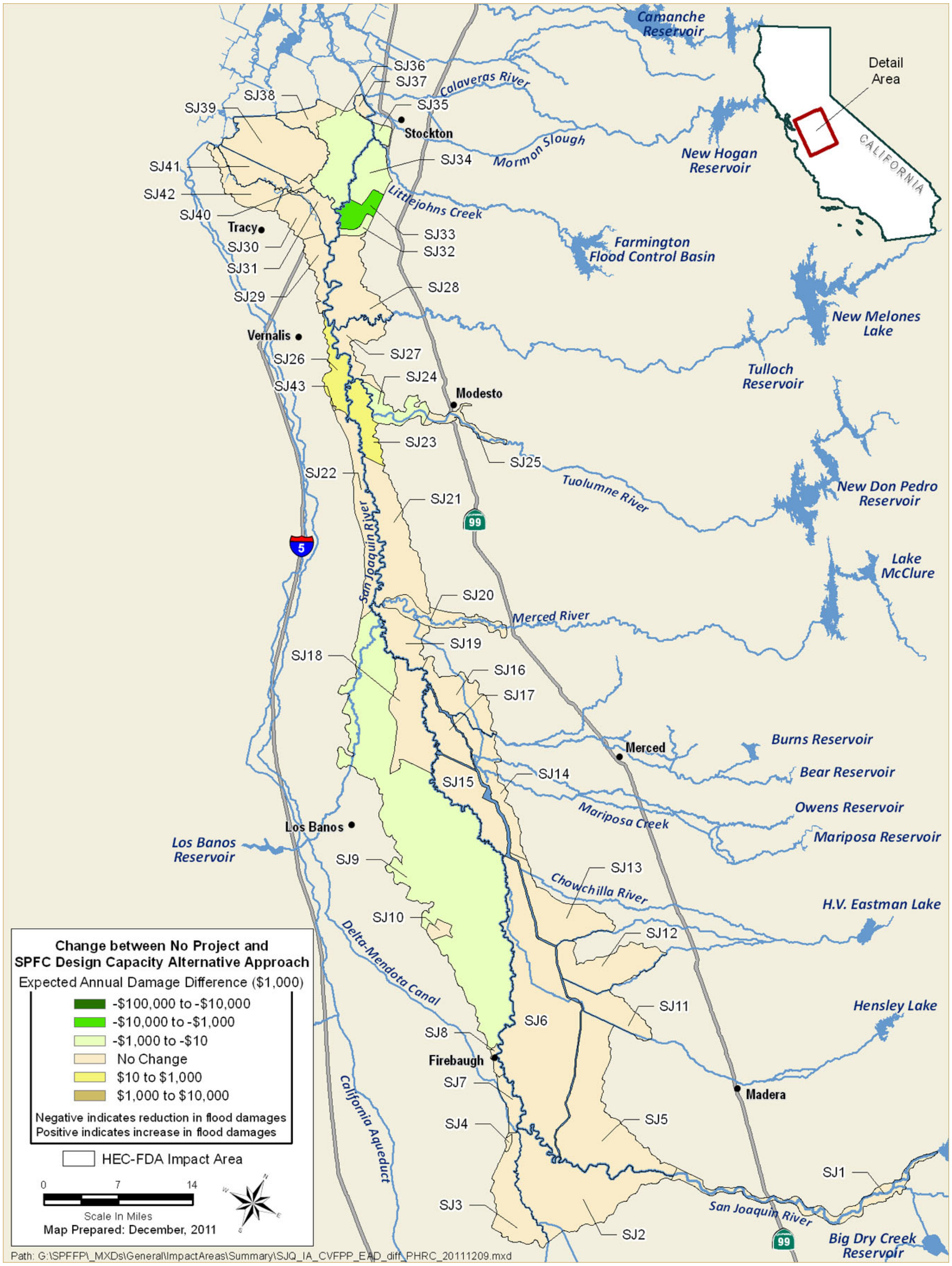


Figure 7-24. Change in Expected Annual Damages for the San Joaquin River Basin Under the Protect High Risk Communities Approach Compared to No Project

Cost Assessment

Attachment 8J: Designs and Costs provides cost estimates for the Protect High Risk Communities Approach. The costs for this approach were categorized into four flood management elements:

1. **System Improvements –** Only costs associated with F-CO/F-BO were included.

2. **Urban Improvements –** Includes 200-year LOP urban SPFC levee projects.

3. **Rural Agricultural Improvements –** Includes up to 120 miles of levee improvements to non-urban SPFC levees through the NULE Program, and new levees for small communities located within the SPFC.

4. **Residual Risk Management –** Includes features such as flood information sharing and collection and establishment of a rural post-flood recovery program because of the minimal investment in rural levee repairs could allow for more levee failures.

Table 7-12 summarizes the improvement costs for the Protect High Risk Communities Approach for the Sacramento and San Joaquin river basins.

Table 7-12. Improvement Costs for Protect High Risk Communities Approach for Sacramento and San Joaquin Basins ($ Millions)

	Sacramento River Basin			San Joaquin River Basin		
	Low		High	Low		High
System Improvements	$ 43	to	$ 53	$ 48	to	$ 61
Urban Improvements	$ 5,136	to	$ 6,099	$1,224	to	$ 1,440
Rural Improvements	$ 1,097	to	$ 1,316	$ 156	to	$ 188
Residual Risk Management	$ 878	to	$ 1,062	$ 479	to	$ 575
Total Costs	$ 7,154	to	$ 8,530	$ 1,907	to	$ 2,264

The estimated capital costs for improving SPFC facilities to achieve an urban LOP and for protection of small communities are significantly higher for the Sacramento River Basin because of the greater magnitude of population at risk.