July 2014

West Sacramento Project General Reevaluation Report

US Army Corps of Engineers ®
Sacramento District

WSAFCA
West Sacramento Area Flood Control Agency

Draft Report

Documentation

Cover Photo: Sacramento River, West Sacramento, and Yolo Bypass, March 2011

Photo courtesy of Chris Austin.

WEST SACRAMENTO PROJECT, CALIFORNIA
GENERAL REEVALUATION REPORT

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LIST OF ACRONYMS

ASA(CW) ..... Assistant Secretary of the Army for Civil Works

CDFG ..... California Department of Fish and Game

CEQA ..... California Environmental Quality Act

CERCLA ..... Comprehensive Environmental Response, Compensation, and Liability Act

CFR ..... Code of Federal Regulations

cfs ..... Cubic Feet per Second

CVFPP ..... Central Valley Flood Protection Plan

CVIFMS ..... Central Valley Integrated Flood Management Study

DPR ..... Detailed Project Report

DWR ..... California Department of Water Resources

DWSC ..... Deep Water Ship Channel

EIR ..... Environmental Impact Report

EIS ..... Environmental Impact Statement

EO ..... Executive Order

ER ..... Engineering Regulation

ERR ..... Economic Reevaluation Report

ESA ..... Endangered Species Act

ETL ..... Engineering Technical Letter

FAA ..... Federal Aviation Administration

FEIS ..... Final Environmental Impact Statement

FEMA ..... Federal Emergency Management Agency

Framework ..... Central Valley Flood System Improvement Framework

FRM ..... Flood Risk Management

GAO ..... General Accounting Office

GRR ..... General Reevaluation Report

IDC ..... Interest during Construction

JFP ..... Folsom Dam Joint Federal Project

LCM ..... Life Cycle Management

MOA ..... Memorandum of Agreement

MSL ..... Mean Sea Level

NED ..... National Economic Development

NEPA..... National Environmental Policy Act

NGVD29.....National Geodetic Vertical Datum of 1929

NMFS..... National Marine Fisheries Service

NOI .....Notice of Intent

NRHP .....National Register of Historic Places

OMRR&R ..... Operation and Maintenance, Repair, Replacement and Rehabilitation

PAC.....Post-Authorization Change Report

PED.....Preconstruction Engineering and Design

PL..... Public Law

RD..... Reclamation District

RM.....River Mile

ROD .....Record of Decision

Sac Bank ..... Sacramento River Bank Protection Project

Sac Urban .....Sacramento Urban Levee Improvement Project

SAFCA .....Sacramento Area Flood Control Agency

SCB .....Soil Cement Bentonite

SPF..... Standard Project Flood

SR ..... State Route

SRA .....Shaded Riverine Aquatic

SRFCP ..... Sacramento River Flood Control Project

USBR..... United States Bureau of Reclamation

USFWS.....U.S. Fish and Wildlife Service

VELB .....Valley Elderberry Longhorn Beetle

WRDA.....Water Resources Development Act

WSAFCA ..... West Sacramento Area Flood Control Agency

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WEST SACRAMENTO PROJECT,
POST AUTHORIZATION CHANGE REPORT

1. INTRODUCTION

This post authorization change report is being prepared to document a general reevaluation study of the West Sacramento project. The purpose of the West Sacramento Project is to reduce the flood risk for the City of West Sacramento. The general reevaluation report (GRR) has evaluated system improvements and additional levee improvements and other measures necessary to provide flood risk management for the City of West Sacramento.

2. DESCRIPTION OF AUTHORIZED PROJECT

2.1 Study Location

The study area is located in eastern Yolo County in the north central region of California's Central Valley. The study area approximately corresponds with the city limit for the City of West Sacramento comprising 13,000 acres of mixed-use land and an estimated population of 48,000 residents. The City of West Sacramento is located directly across the Sacramento River from the City of Sacramento, the State's Capitol.

The project area is almost completely bound by floodways and levees [Figure 1]. The study area is bound by the Yolo Bypass to the west, the Sacramento Bypass to the north, and the Sacramento River to the east. Further, the City is bifurcated by the Sacramento River Deep Water Ship Channel (DWSC) and Barge Canal. The associated levee system currently protecting the study area includes nearly 50 miles of levees in Reclamation District (RD) 900, RD 537, Maintenance Area 4, and along the DWSC and Barge Canal. A description of these sub-basins and the levee reaches that comprise each includes the following:

Northern Sub-basin – The northern sub-basin, representing approximately 6,100 acres, is bounded by the Port North area and the DWSC to the south, the Sacramento River North Levee to the north and east, the Sacramento Bypass Levee to the north, and the Yolo Bypass Levee to the west. The right bank of the Sacramento River extends for approximately 5.5 miles of the northern and eastern sides of the basin.

Southern Sub-Basin – The Southern Sub-Basin encompasses approximately 6,900 acres and varies from El. 18.0 feet to El. 8.0 feet. The area is bounded by the Port South Levee and the DWSC to the north, the Sacramento River South Levee to the east, the South Cross Levee to the south, and the DWSC East Levee to the west. The right bank of the Sacramento River extends for approximately 6.2 miles on the east side of the basin.

A majority of the levees within the study area are part of the Sacramento River Flood Control Project. The few exceptions are the Port North area and Port South levees, the DWSC West levee and the South Cross levee. The Port South and DWSC West levees were constructed as part of the Port of Sacramento.

The Port North area includes high ground along the northern portion of the Port of West Sacramento. The South Cross levee is a private levee. Although the DWSC West levee was constructed as part of the navigation project supporting the Port of West Sacramento, this levee provides significant flood benefits to portions of both the northern and southern sub-basins. The Corps currently maintains this navigation levee.

The study area lies within the jurisdiction of the following Congressional Districts:

- 6th District (Doris Matsui)

Additional Congressional Districts that are not located within the study area but near its borders are:

- 3rd District (John Garamendi)
- 4th District (Tom McClintock
- 7th District (Ami Bera)

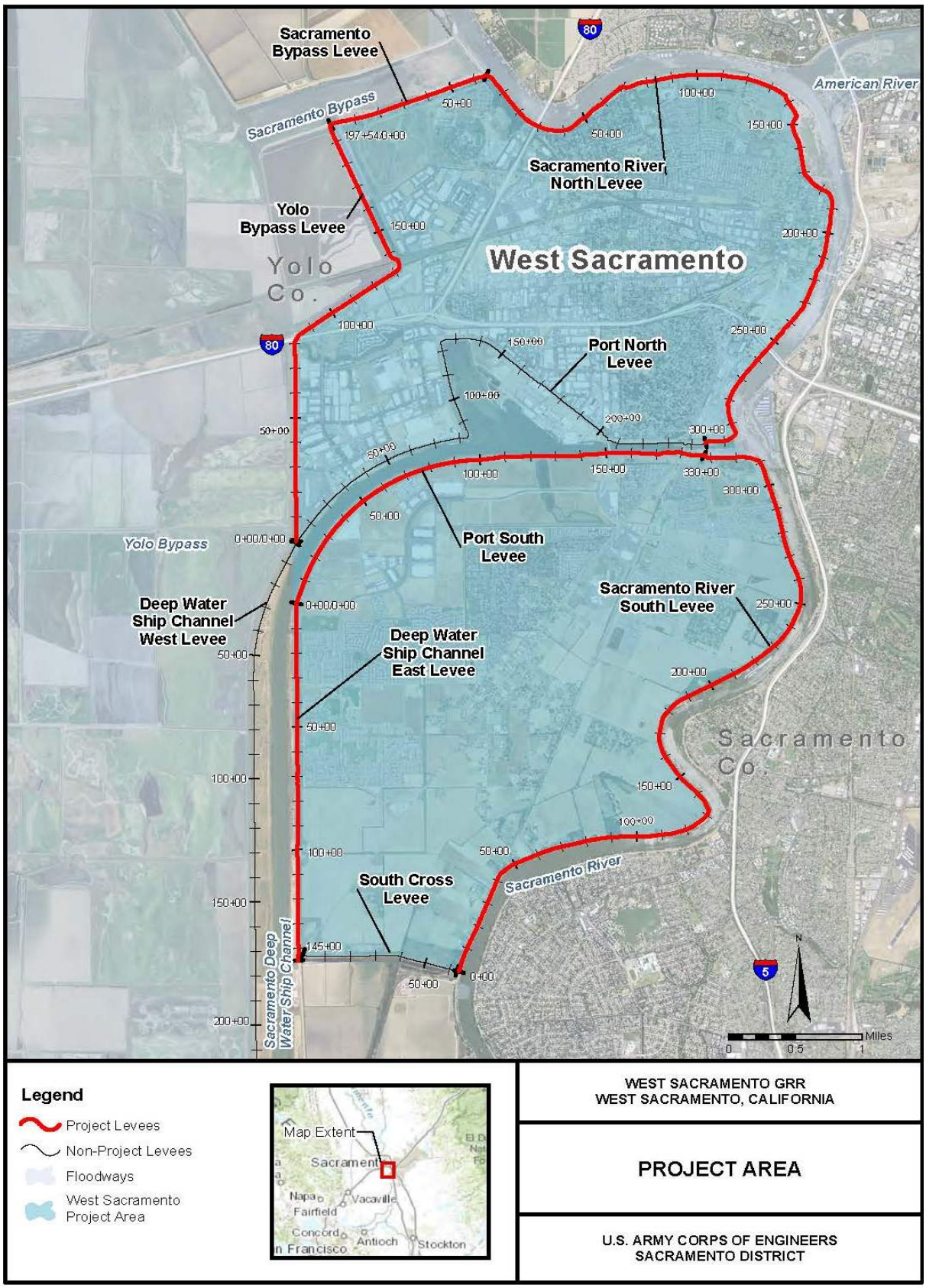

Figure PAC-1: Map of the Project Area.

2.2 Project Sponsors

The non-Federal sponsors for the GRR are the State of California Central Valley Flood Protection Board (CVFPB) and the West Sacramento Area Flood Control Agency (WSAFCA).

2.3 Authorized Project Features

The authorized West Sacramento project is a single purpose flood risk management project with an authorized total cost of $53,040,000 (2010). The project includes the following features:

- Raising and installing a slurry wall along 4.7 miles of the east bank of the Yolo Bypass levee from the Sacramento Bypass south to the Deep Water Ship Channel West Levee.

- Reconstructing and raising the levee along one mile of the south bank of the Sacramento Bypass, including backfill of a drainage ditch and placing riprap along the levee.

2.4 Authorized Local Cooperation Requirements

Authorized Local Cooperation includes requirements to:

- Provide lands, easements, and rights-of-way.
- Modify or relocate utilities, roads, bridges (except railroad bridges), and other facilities, where necessary for the construction of the project.
- Bear all costs of operation, maintenance, repair, rehabilitation and replacement of flood control facilities.

3. AUTHORIZATION

The West Sacramento project was authorized in Section 101(4) of the Water Resource Development Act (WRDA) of 1992, Pub. L. No. 102-580, § 101(4), 106 Stat. 4797, 4801-4802 (1992) (hereinafter WRDA 1992), and revised and supplemented through the Energy and Water Development and Appropriations Act (EWDAA) of 1999, Pub. L. No. 105-245, 112 Stat. 1838, 1840-1841 (1999) (hereinafter EWDAA 1999), and through Section 118 the EWDAA of 2010. EWDAA 2010, Pub. L. No. 111-85, § 118, 123 Stat. 2845, 2852 (2009).

New authority will be required for the changes to the project as a result of the reevaluations contained in this report. Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook, states that “an increase in total project cost, exclusive of price level changes, of more than twenty percent of the total project cost stated in the authorizing legislation” requires authorization by Congress. Project costs are expected to increase by more than 20%.

4. FUNDING SINCE AUTHORIZATION

Since the project's authorization as part of WRDA 1992 portions of the project have been implemented by the Corps of Engineers under a Project Cooperation Agreement (PCA) executed with the California Reclamation Board (now the Central Valley Flood Protection Board) in May 1996. Table PAC.1 lists the West Sacramento work sites and their status.

Table PAC. 1: West Sacramento Project Work Sites and Status.

Item	Feature	Authorization, Overview, and Status
1	Raising and installing a slurry wall along 4.7 miles of the east bank of the Yolo Bypass levee from the Sacramento Bypass south to the Navigation Levee.	Authorization: WRDA 1992. Overview: general seepage remediation and raising levee height on the Yolo Bypass levee. Status: Improvements completed in 2001.
2	Reconstructing and raising the levee along one mile of the south bank of the Sacramento Bypass, including backfill of a drainage ditch and placing riprap along the levee.	Authorization: WRDA 1992. Overview: general seepage, stability, and height remediation on the Sacramento Bypass levee. Status: Improvements completed in 2001.

A funding history, by fiscal year, is shown in Table PAC-2, History of Federal Funding, indicating the category in which funds have been appropriated and the items of work (listed in Table 1) for which the funds have been utilized.

Table PAC. 2: History of Federal Funding.

Fiscal Year	Federal General Investigations	Federal Construction General
1996		$999,000
1997		$209,000
1998		$6,944,000
1999		$618,000
2000		$3,093,000
2001		$3,898,000
2002		$399,000

Fiscal Year	Federal General Investigations	Federal Construction General
2003		$2,837,700
2004		$1,410,000
2005		$1,800,000
2006		$0
2007		$0
2008		$4,373,000
2009		$3,000,000
2010	$448,000	$0
2011		$5,000,000
2012		$0
2013		$0
2014		$0

5. CHANGES IN SCOPE OF AUTHORIZED PROJECT

The scope of the authorized project is not adequate to address the residual flood risk for the West Sacramento area, and the project has reached its authorized cost limit with the items of work that have been constructed thus far. Therefore, the scope of the authorized project will increase. Potential types of scope expansion are measures to address seepage, stability, erosion, and levee height concerns throughout the system of levees that surround West Sacramento. Table PAC-3 shows the constructed features of the authorized project. The additional changes recommended as part of this GRR are presented below.

Table PAC-3: Constructed Features in West Sacramento.

Sacramento Urban Area Levee Reconstruction Project
Construction of berms to improve stability and manage seepage at two relatively small sites along the right bank of the Sacramento River near the Lighthouse Marina and approximately six miles of levee along the right bank of the Sacramento River extending from near the Barge Canal entrance downstream to near the South Cross levee. Construction began in November 1990 and was completed in 1992.

Sacramento Metropolitan Area, 1992 and 1999 Authorization (West Sacramento Project)
Raising and installing a slurry wall along 4.7 miles of the east bank of the Yolo Bypass levee from the Sacramento Bypass south to the Navigation Levee. Reconstructing and raising the levee along one mile of the south bank of the Sacramento Bypass, including backfill of a drainage ditch and placing riprap along the levee. Construction was completed in 2002.

In addition to the features included in the 1999 authorization, the tentatively selected plan includes the additional features to improve the plan for flood risk management to the entire West Sacramento project area. The principal features of this plan are:

- Slurry cutoff walls to address seepage remediation and stability problems, rock bank protection to address erosion problems, and levee raises to address overtopping issues along the Sacramento River north levee.
- Flood wall and levee raises with embankment fill to address overtopping concerns on the Port North levee.
- Slurry Cutoff walls and slope flattening to address seepage and stability concerns on the Yolo Bypass levee.
- Bank protection to address erosion concerns on the Sacramento Bypass training levee.
- Construct a sheet pile wall with embankment fill to plug gap in levee east of Stone Lock.
- Construct a setback levee with slurry cutoff walls and/or seepage berms to address seepage remediation, rock bank protection to address erosion problems, and levee raise to address overtopping issues along the Sacramento River south levee.
- Slurry cutoff walls or seepage berm to address seepage remediation and stability problems, and levee raise to address overtopping issues along the South Cross levee.
- Slurry cutoff walls address seepage remediation and stability problems, and levee raise to address overtopping issues along the Deep Water Ship Channel east levee and the Port South levee.
- Slurry cutoff walls or seepage berms to address seepage remediation and stability problems, and levee raise to address overtopping issues along the South Cross levee.
- Slurry cutoff walls to address seepage remediation and stability problems, rock bank protection to address erosion problems, and levee raises to address overtopping issues along the Deep Water Ship Channel West levee.

6. CHANGES IN PROJECT PURPOSE

There are no changes in the project purpose. Flood risk management is the single project purpose for both the authorized project and the general reevaluation study.

7. CHANGES IN LOCAL COOPERATION REQUIREMENTS

As indicated above, the non-Federal sponsor for the project are the CVFBP and WSAFCA.

The original project was authorized with cost sharing of 75% Federal and 25%. Conventional cost sharing under the requirements of WRDA 1986 as amended for flood risk management projects is 65% Federal and 35% Local. Any new project components recommended in this report would be cost-shared at 65% Federal and 35% Local. When the new components and old components of the project are combined, the resulting cost will be determined using a cost apportionment procedure to assign the proper cost-sharing to each component.

The State of California and WSAFCA have expressed the desire for implementing the project and sponsoring project construction in accordance with the items of local cooperation that are set forth in the recommendations chapter of the supporting limited reevaluation report. The non-Federal sponsors have certified that they are financially capable of participating in the selected plan.

8. CHANGE IN LOCATION OF PROJECT

There is no change in the project location.

9. DESIGN CHANGES

The draft report describes the recommended design changes. Based upon the types of design changes that are recommended, it is anticipated that these design changes consist of construction of cutoff walls that are significantly deeper than originally designed, enforcement of Engineering Technical Letter (ETL) 1110-2-571(Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures), and providing access for maintenance and flood fighting where it does not presently exist.

10. CHANGES IN TOTAL PROJECT FIRST COSTS

Table PAC-4, Project First Cost, is a four-column comparison of the estimated cost for the project being recommended, the project as authorized by Congress, the authorized project updated to current price levels, and the current project cost estimate.

Table PAC- 4: Project First Cost ($000).

Construction Item	GRR Recommended Plan	Project as Authorized[1]	Project as Last Presented to Congress[2]	Current Project Cost Estimate[3]
Lands and Damages	286,462	1,880	2,388	2,387
Relocations	21,808	15	128	128
Fish & Wildlife Facilities	18,105	2,400	3,201	3,044
Levees & Floodwalls	1,034,413	10,200	35,370	28,394
Pumping Plants	0	0	0	0
Cultural Resources Preservation	8006	131	0	0
Subtotal	1,360,788	14,626	41,087	33,913
Planning Engineering & Design (PED)	152,655	1,665	9,526	10,690
Construction Management	91,318	1,132	2,007	2,034
Total First Cost	1,612767	17,423	52,620	46,677
Associated Costs	0	0		0
Total Costs	1,612,767	17,423	52,060	46,677

[1] Project Cost from Sacramento Metropolitan Area, California Feasibility Report, February 1992
[2] Project Cost based on Project Cost Estimate from June 2009.
[3] Project Cost based on Project Cost Estimate from June 2011

11. CHANGES IN PROJECT BENEFITS

Table PAC-5, Economic Summary, shows a comparison of the benefits given in the project document, the benefits last reported to Congress, and the benefits based on reevaluations that have been done to support the recommended changes to the project. The evaluation of benefits has been

limited to those that would accrue to structures and contents and do not include other benefit categories at this time, such as savings in emergency costs. Table 5 shows a breakdown of first and annual costs and benefits of the recommended plan, along with net economic benefits and benefit-to-cost ratio.

Table PAC-5: Economic Summary ($000).

Item	Project Being Recommended	Authorized Project		
		Authorized Cost/Benefits[1]	Project as Last Presented to Congress[2]	Current Estimate[3]
First Cost	1,612,768	17,400	52,060	46,677
Interest During Construction (IDC)	646,916	1,600	4,787[4]	4,195[4]
Total	2,259,694	19,000	56,847	50,872
Annual Costs				
Interest and Amortization	96,330	1,680	2,955	2,419
OMRR&R	106	20	20[5]	20[5]
Subtotal	96,436	1,700	2,975	2,439
Monetary (FRM)	256,859	9,800	9,800[6]	9,800[6]
Non-monetary	Not applicable	Not applicable	Not applicable	Not applicable
Net Annual FRM Benefits	160,423	8,100	6,825	7,361
FRM Benefit-Cost Ratio	2.7	5.8	3.3	4.0

1.Authorized Cost from 1992 Sacramento Metropolitan Area Feasibility Report
2 Project Cost based on Project Cost Estimate from June 2009
3. Project Cost Estimate from SPK, June 2011
4. IDC was calculated based on a ratio of IDC to first costs from 1992 feasibility study
5. OMRR&R costs taken from 1992 feasibility study
6. Benefits have not been recalculated, benefits from 1992 feasibility study carried forward

12. BENEFIT-COST RATIO

Estimated total annual costs and annual benefits are calculated at an interest rate of 3.75 percent, over a 50-year period of economic evaluation. Table PAC.4 above shows the benefit-to-cost ratio. It also shows a comparison of the benefit-cost ratios for the project being recommended, the project as authorized by Congress, the authorized project updated to current price levels, and the project last presented to Congress.

13. CHANGES IN COST ALLOCATION

There are no changes in cost allocation for the project. All costs are allocated to the flood risk management project purpose for both the Recommended and Authorized projects.

14. CHANGES IN COST APPORTIONMENT

Table PAC.5, Cost Apportionment, shows the Federal and non-Federal costs of the authorized project at current price levels. The authorized project cost share is 75% Federal and 25% non-Federal. For the improvements recommended as a result of this GRR, the cost share is 65% Federal and 35% non-Federal.

Table PAC. 6: Cost Apportionment ($000).

Existing Authorized West Sacramento Project[1]	**Federal**	**Non-Federal**	**Total**
Lands and Damages	180	2,207	2,387
Relocations	0	128	128
Fish and Wildlife Facilities	3,044	0	3,044
Levees and Floodwalls	28,394	0	28,394
Pumping Plants	0	0	0
Subtotal	**31,618**	**2,335**	**33,953**
PED	10,685	5	10,690
Construction Management	2,032	2	2,034
Subtotal	**44,335**	**2,342**	**46,677**
Minimum 25% Share	0	11,669	-
Total Required Cash	-9,327	9,327	-
Cultural Resource Preservation	0	0	0
Total	35,008	11,669	46,677
Cost Sharing (%)	75	25	100
TSP[2]			
Lands and Damages	0	286,462	286,462
Relocations	0	21,808	21,808
Fish and Wildlife Facilities	18,105	0	18,105
Levees and Floodwalls	1,034,413	0	1,034,413
Pumping Plants	0	0	0
Subtotal	**1,052,518**	**308,270**	**1,360,788**
PED	152,655	0	152,655
Construction Management	91,318	0	91,318
Subtotal	**1,296,491**	**308,270**	**1,604,761**
Minimum 35% Share	0	561,666	
Total Required Cash	-253,396	253,396	
Cultural Resource Preservation	8,006		
Total	1,051,101	561,666	1,612,767
Cost Sharing (%)	65	35	100
Total West Sacramento Recommended Plan			
Lands and Damages	180	288,669	288,849
Relocations	0	21,936	21,936
Fish and Wildlife Facilities	21,149	0	21,149
Levees and Floodwalls	1,062,807	0	1,062,807
Pumping Plants	0	0	0
Subtotal	**1,084,136**	**310,605**	**1,394,741**
PED	163,340	5	163,345
Construction Management	93,350	2	93,352
Subtotal	**1,340,826**	**310,612**	**1,651,438**
Minimum Adjusted Share	0	573,335	

Total Required Cash	-262,723	262,723	
Cultural Resource Preservation	8,006	0	8,006
Total	1,086,109	573,335	1,659,444
Cost Sharing (%)	65	35	100

[1] Project Cost Estimate from SPK June 2011
[2]Based on October 2013 price levels, 3.5% interest rate, and a 50-year period of analysis.

15. ENVIRONMENTAL CONSIDERATIONS IN RECOMMENDED CHANGES

The affects to the environment have been considered throughout the planning phase of the project and opportunities have been evaluated to reduce affects to resources within the study area. A vegetation variance will be sought for the Sacramento River reach of the project, which will allow vegetation to remain on the lower half of the waterside levee slope. The waterside vegetation on the Sacramento River is valuable SRA habitat for many State and Federally listed fish species and State-listed Swainson's hawk. Additionally, during the design phase of the project, opportunities will be taken to choose a design that will minimize affects to the American River Parkway where feasible.

Table PAC-7: Summary of Environmental Effects and Mitigation Measures.

Potential Effects	**Mitigation Measure**	**Effects with Mitigation**
Land Use		
Acquisition of properties for flood control easements along the Sacramento River. Conversion of agricultural lands to floodway or easements.	Federal Relocation Act compliance. Farmland Protection Policy Act	Less than significant with mitigation.
Hydrology and Hydraulics		
No effect.	Not applicable.	Not applicable.
Water Quality		
Potential impacts include increased turbidity during bank protection construction, runoff of exposed soils, and cement, slurry, or fuel spills during construction.	Preparation of a Stormwater Pollution Protection Plan, Spill Prevention Control and Countermeasures Plan, and a Bentonite Slurry Spill Contingency Plan. Implementation of BMPs listed in Section 3.5.6 of the EIS.	Less than significant with mitigation.
Vegetation and Wildlife		
Construction of levee improvements and vegetation removal would result in significant loss of vegetation and wildlife habitat on the landside of the Sacramento	When possible, compensation would be planted on planting berms, within rock, or on other lands within West Sacramento- including the setback	Less than significant with mitigation.

Potential Effects	**Mitigation Measure**	**Effects with Mitigation**
River levees.	area. A hydraulic evaluation will be conducted to determine whether mitigation could occur in the Sacramento Bypass. Additional mitigation may be constructed at mitigation banks.	
Fisheries		
Indirect effects to fish habitat from the removal of vegetation from the levee slopes. Direct effects from the placement of rock at bank protection sites, causing an increase in turbidity and a loss of soft bank.	Vegetation variance would allow waterside vegetation to remain on the Sacramento River except where some trees would be removed in order to place bank protection. Bank protection sites would be revegetated following construction. BMPs would be implemented to address turbidity, and are discussed in Section 3.7.7 of the EIS	Less than significant with mitigation.
Special Status Species		
Direct affects to GGS, fish species, and Swainson's Hawks during construction. Indirect effects due to loss of habitat. Vegetation variance for the waterside levee slopes would reduce the effects to endangered fish species.	Replace habitat for species either on-site or in close proximity to lost habitat and purchase credits at mitigation banks if necessary. Implement BMPs discussed in Section 3.7.7 of the EIS during construction to prevent mortality.	Less than significant with mitigation
Cultural Resources		
Adverse effects to historic properties from construction of levee improvements and the setback levee.	Preparation and implementation of a Programmatic Agreement, Historic Properties Management Plan, and Historic Properties Treatment Plans.	Less than significant with mitigation.
Transportation and Circulation		
Increased traffic on public roadways.	Preparation of a Traffic Control and Road Management Plan and other BMPs listed in Section 3.10.7 of the EIS.	Less than significant with mitigation.

Potential Effects	**Mitigation Measure**	**Effects with Mitigation**
Air Quality		
Emissions of criteria pollutants from construction equipment, haul trucks, and barges.	Implementation of SMAQMD's Basic Construction Emission Control Practices and other BMPs, as listed in Section 3.11.7 of the EIS.	Less than significant with mitigation.
Climate Change		
Increased greenhouse gas emissions from construction equipment, haul trucks, and barges.	Implementation of SMAQMD's Basic Construction Emission Control Practices and other BMPs, as listed in Section 3.12.7of the EIS.	Less than significant with mitigation.
Noise		
Increased noise in proximity to sensitive receptors due to construction activities.	Coordination with local residents, compliance with noise ordinances, and other BMPs, as listed in Section 3.13.7of the EIS.	Less than significant with mitigation.
Recreation		
Temporary closure of recreation facilities along the Sacramento River and DWSC during construction, including bike paths, walking trails, and boat launches. Possible closure of the Sacramento Bypass during portions of hunting season.	Notification and coordination with recreation users and bike groups. Flaggers, signage, detours, and fencing to notify and control recreation access and traffic around construction sites.	Less than significant.
Visual Resources		
Vegetation loss and construction activities would disrupt the existing visual conditions along the Sacramento River.	Trees would be planted after construction is completed on planting berms and within bank protection; however there would still be a temporal loss of vegetation. Disturbed areas would be reseeded with native grasses.	Less than significant with mitigation.
Public Utilities and Services		
Temporary disruptions to utility services possible, particularly during relocation of utilities that penetrate the levee.	Notification of potential interruptions would be provided to the appropriate agencies and to landowners.	Less than significant.

Potential Effects	Mitigation Measure	Effects with Mitigation
Hazardous, Toxic, and Radiological Wastes		
No effect from construction activities. HTRW sites encountered would be removed and properly disposed of prior to construction.	Borrow material would be tested prior to use to ensure that no contaminated soils are used for this project.	Less than significant with mitigation.
Socioeconomics, Population, and Environmental Justice		
Disruption to residents alongside construction sites from traffic, noise, and dust. Acquisition of properties for flood control easements.	Federal Relocation Act compliance.	Less than significant.

6. PUBLIC INVOLVEMENT

To announce the start of the West Sacramento General Reevaluation Study, a notice of intent (NOI) to prepare the West Sacramento General Re-evaluation Report (GRR) Environmental Impact Statement (EIS) was posted in the Federal Register (Vol. 74, No. 133) on July 14, 2009. The recipients were invited to comment on the results of the earlier completed reconnaissance study and to provide input to the feasibility study, including the scoping of the environmental issues that should be address throughout the study. The notice in 2009 announced a group of public workshops, where the public was given the opportunity to comment. A joint National Environmental Policy Act (NEPA)/California Environmental Quality Act (CEQA) public scoping meeting was held to brief interested parties on the West Sacramento General Re-evaluation Report and obtain the views of agency representatives and the public on the scope and content of the EIS/EIR.

The meeting location, date, and times were as follows:

- July 21, West Sacramento City Hall, 1110 West Capitol Avenue, West Sacramento (3-5pm) and (6:30-8pm).

The draft GRR will be circulated for public comment and a series of Public Workshops are planned during the public comment period. Public input will be taken into consideration and the comments received will be included in the EIS/EIR appendices.

17. HISTORY OF PROJECT

As a result of climatic and geographic conditions, regular flooding occurred naturally in the Sacramento Valley. During the winter and spring months, the capacity of the Sacramento River in the valley often exceeded its capacity and overflowed into the surrounding countryside. Indian folklore and newspaper accounts mention at least nine major flood events prior to 1890.The first decade of the 20th century was marked by major flood events in 1904, 1907, and 1909. These flood events had a catastrophic effect on the urban centers of the time bringing transportation, business, and agriculture to a standstill and imparting an estimated $11 million damages. Other notable events in the 20th century include the floods of 1955, 1964, 1969, 1970, and 1982.

The series of storms that struck California in February of 1986 resulted in the flood of record for many areas in northern and central California. Record flows in the American River in combination with high flows along the Sacramento River caused encroachment into the design freeboard of levees protecting the Sacramento Metropolitan Area.

The estimated peak flows associated with the 1986 flood were nearly equal or exceeded the design flows of the Sacramento River, Sacramento Bypass, and the Yolo Bypass in the vicinity of West Sacramento. These record flows in combination with high winds caused severe damage to the levees protecting both the Cities of Sacramento and West Sacramento. Damage caused by erosion and seepage would likely have resulted in the failure of levees at a number of locations if not for extensive emergency operations and repairs.

As a result of the problems experienced during the 1986 flood, the Corps initiated a study of the levees comprising the Sacramento River Flood Control Project that were impacted by the flood. Due to the large scale of the study, the review was split into five phases. The first phase of this study included West Sacramento and was documented through an Initial Appraisal Report titled, Sacramento Urban Area Levee Reconstruction Project, California dated May 1988. This phase included the review of approximately 110 miles of levee and recommended the repair of 34 miles.

The Sacramento Urban Area Levee Reconstruction Project Basis of Design dated, November 1989, recommended the repair of two reaches of levee protecting the City of West Sacramento. The first repair reach included two relatively small sites along the right bank of the Sacramento River near the Lighthouse Marina. The second, and more significant, repair reach included approximately six miles of levee along the right bank of the Sacramento River extending from near the Barge Canal entrance downstream to near the South Cross levee. Construction began in November 1990 for the installation of berms to improve stability and manage seepage along both reaches.

The 1986 flood exposed structural problems and identified the inability of the existing levees to provide critical flood protection to the urban area comprised of the Cities of Sacramento and West Sacramento. As a result, the Corps in cooperation with the State of California initiated the General Reevaluation Report titled, Sacramento Metropolitan Area, California. This report was published in February 1992 and indicated the existing flood control system in the study area provided significantly less than a 100 year level of protection. The study went on to recommend a program of improvements which at the time were estimated to provide the City with a 400 year level of protection assuming implementation of a 200 year flood control only dam on the American River; but, the recommended plan would provide at least a 150 year level of protection if this American River project element was not implemented. The repairs recommended by the Sacramento Metropolitan Area, California, Feasibility Report were

authorized in the Water Resources Development Act of 1992 (Public Law 102-580); however, the 200 year flood control only dam on the American River was never authorized by Congress.

The West Sacramento Area Flood Control Agency (WSAFCA) is a Joint Powers Authority (JPA) created in 1994 through a Joint Exercise of Powers Agreement by the City of West Sacramento, Reclamation District (RD) 900, and RD 537. WSAFCA was established to coordinate the planning and construction of flood protection facilities within the boundaries of the JPA and to help finance the local share of flood control projects. The formation of this agency was primarily in response to authorization of the flood protection repairs recommended in the Sacramento Metropolitan Area General Reevaluation Report. WSAFCA formed an assessment district in 1995 to fund the local cost share of these repairs.

The New Year's Day Flood of 1997 is one of the largest experienced in northern California since the beginning of the measured record in 1906. The flood was notable for its sustained intensity of rainfall, aerial extent, and shear volume of flood water. Over a 3 day period centered on New Year's Day, warm moist winds from the southwest poured more than 30 inches of rain onto watersheds covered with snow and already saturated from one of the wettest Decembers on record.

As a result of the high water, levees along the Sacramento and Yolo Bypasses and within RD-900 along the Sacramento River sustained heavy damage. These damages included erosion along the left bank of the Yolo Bypass; seepage and sloughing along the left bank Sacramento Bypass; and sloughing along the right bank of the Sacramento River within RD-900.

Prior to this flood event, the Corps was in the process of preparing construction plans and specifications for the levee repairs authorized in the WRDA of 1992. The design of these repairs was documented in the report titled, West Sacramento Project, West Sacramento, California, Design Memorandum dated May 1995. However, in the wake of the 1997 flood, the Corps identified underseepage as an area of greater concern in the design and repair of levees. This resulted in a number of design revisions to the levee repairs recommended in the West Sacramento Project Design Memorandum. These design revisions and the associated increase to the total estimated project cost were captured in a supplemental authorization through the Energy and Water Development Appropriation Act of 1999 (Public Law 105-245).

The 1997 event increased understanding of levee performance in the region, including underseepage, and set the stage for the need to reevaluate the authorized project.

1 - STUDY INFORMATION

This chapter provides basic background for the reevaluation of the West Sacramento Project. It also lists the steps in the Corps planning process and relates them to the organization of this report.

1.1 PURPOSE AND SCOPE

This report presents the findings of a general reevaluation study of the authorized West Sacramento Project. The study was conducted to determine whether there is a Federal interest in modifying the authorized project for flood risk reduction in the West Sacramento area, which is located at the confluence of the Sacramento and American Rivers. Flooding in the City of West Sacramento would have devastating economic, social, political, and demographic consequences for the region, and for the State of California as a whole. Existing flood risk management structures are not capable of safely passing large flood flows on the Sacramento River and Yolo Bypass. This project proposes additional measures to reduce the risk of flooding in West Sacramento. These measures are evaluated in the context of current and planned flood risk reduction measures elsewhere in the watersheds of both rivers.

The non-Federal sponsors for the project and general reevaluation study are the State of California Central Valley Flood Protection Board (CVFPB) and the West Sacramento Area Flood Control Agency (WSAFCA).

1.2 STUDY AUTHORITY

This report was prepared as a general reevaluation study of the West Sacramento area. Study authorization of this project was provided in Section 209 of the Flood Control Act of 1962, Pub. L. No. 87-874, § 209, 76 Stat. 1173, 1197 (1962). Construction authority and authority to produce a General Reevaluation Report was provided in Section 101(4) of the Water Resources Development Act (WRDA) of 1992, Pub. L. No. 102-580, § 101(4), 106 Stat. 4797, 4801-4802 (1992) (hereinafter WRDA 1992), and revised and supplemented through the Energy and Water Development and Appropriations Act (EWDAA) of 1999, Pub. L. No. 105-245, 112 Stat. 1838, 1840-1841 (1999) (hereinafter EWDAA 1999). Pertinent sections of these Congressional authorizations are provided below:

1.2.1 Flood Control Act of 1962

The study authority for the West Sacramento area was provided through Section 209 of the Flood Control Act of 1962. Flood Control Act, Pub. L. No. 87-874, § 209, 76 Stat. 1173, 1197 (1962). This statute includes the following statement:

> *The Secretary of the Army is hereby authorized and directed to cause surveys for flood control and allied purposes, including channel and major drainage improvements, and floods aggravated by or due to wind or tidal effects, to be made under the direction of the Chief of Engineers, in drainage areas of the United States and its territorial possessions, which include the following named localities:*
>
> ** * **

> *Sacramento River Basin and streams in northern California draining into the Pacific Ocean for the purposes of developing, where feasible, multi-purpose water resource projects, particularly those which would be eligible under the provisions of Title III of Public Law 85-500.*

1.2.2 Water Resources Development Act of 1992

The Corps later received specific project authority to implement the project recommended in the Sacramento Metropolitan Area, California, Feasibility Report through the WRDA 1992. Section 101(4) of WRDA 1992 includes the following:

> *SACRAMENTO METRO AREA, CALIFORNIA – The project for flood control, Sacramento Metro Area, California: Report of the Chief of Engineers, dated June 29, 1992, at a total cost of $17,000,000, with an estimated Federal cost of $12,800,000 and an estimated non-Federal cost of $4,200,000.*

1.2.3 Energy and Water Development Appropriations Act of 1999

This authorization was revised to address additional levee concerns and associated cost increases through the EWDAA 1999. Specifically, EWDAA 1999 provides the following:

> *Provided further, That the flood control project for West Sacramento, California, authorized by Section 101(4) of Public Law 102-580 is modified to authorize the Secretary of the Army, acting through the Chief of Engineers, to construct the project at a total cost of $32,900,000 with an estimated first Federal cost of $24,700,000 and an estimated first non-Federal cost of $8,200,000.*

1.2.4 Energy and Water Development Appropriations Act of 2010

This authorization was later revised to address levee design concerns and associated cost increases through Section 118 of the EWDAA of 2010. EWDAA 2010, Pub. L. No. 111-85, § 118, 123 Stat. 2845, 2852 (2009). Section 118 of EWDAA 2010 provides the following statement:

> *The flood control project for West Sacramento, California, authorized by section 101(4), Water Resources Development Act, 1992, Public Law 102-580; Energy and Water Development Appropriations Act, 1999, Public Law 105-245, is modified to authorize the Secretary of Army, acting through the Chief of Engineers, to construct the project at a total cost of $53,040,000 with an estimated first Federal cost of $38,355,000 and an estimated non-Federal first cost of $14,685,000.*

1.3 LOCATION AND DESCRIPTION OF THE STUDY AREA

1.3.1 Location

The study area is located in eastern Yolo County in the north central region of California's Central Valley. The study area approximately corresponds with the city limit for the City of West Sacramento comprising 13,000 acres of mixed-use land and an estimated population of 48,000 residents. The City of West Sacramento is located directly across the Sacramento River from the City of Sacramento, the State's capital.

The study area is almost completely bound by floodways and levees [Figure 1-1]. The study area is bound by the Yolo Bypass to the west, the Sacramento Bypass to the north, and the Sacramento River to the east. Further, the City is bifurcated by the Sacramento River Deep Water Ship Channel (DWSC) and Barge Canal. The associated levee system currently protecting the study area includes nearly 50 miles of levees in Reclamation District (RD) 900, RD 537, Maintenance Area 4, and along the DWSC and Barge Canal. A description of these sub-basins and the levee reaches that comprise each includes the following:

Northern Sub-basin – The northern sub-basin, representing approximately 6,100 acres, is bounded by the Port North area and the DWSC to the south, the Sacramento River North Levee to the north and east, the Sacramento Bypass Levee to the north, and the Yolo Bypass Levee to the west. The right bank of the Sacramento River extends for approximately 5.5 miles of the northern and eastern sides of the basin.

- **Sacramento River North Levee** extends for approximately 5.5 miles along the Sacramento River right bank levee from the Sacramento Bypass south to the confluence of the Barge Canal and the Sacramento River.
- **Port North Area** extends for approximately 4.9 miles along the DWSC right bank from the Barge Canal west to the bend in the Navigation Levee.
- **Yolo Bypass Levee** extends for approximately 3.7 miles along the Yolo Bypass levee left bank from the confluence of the Sacramento Bypass and the Yolo Bypass south to the Navigation Levee (DWSC West).
- **Sacramento Bypass Training Levee** extends for approximately 0.5 miles from the Sacramento Bypass levee into the Yolo Bypass.
- **Sacramento Bypass Levee** extends for approximately 1.1 miles along the Sacramento Bypass left bank levee from the Sacramento Weir west to the Yolo Bypass Levee.

Southern Sub-Basin – The Southern Sub-Basin encompasses approximately 6,900 acres and varies from El. 18.0 feet to El. 8.0 feet. The area is bounded by the Port South Levee and the DWSC to the north, the Sacramento River South Levee to the east, the South Cross Levee to the south, and the DWSC East Levee to the west. The right bank of the Sacramento River extends for approximately 6.2 miles on the east side of the basin.

- **Sacramento River South Levee** extends approximately 5.9 miles along the Sacramento River right bank levee from the confluence of the Barge Canal and the Sacramento River south to the South Cross Levee.

- **South Cross Levee** extends along the South Cross levee for approximately 1.2 miles from Jefferson Boulevard to the Sacramento River where it intersects the southern end of Sacramento River South Levee.

- **DWSC East** extends for approximately 2.8 miles along the DWSC left bank levee from the end of Port South Levee south to South Cross Levee.

- **Port South Levee** extends for approximately 4 miles along the DWSC left bank levee from the Barge Canal west past the bend in the DWSC.

- **DWSC West** extends for approximately 21.4 miles along the DWSC right bank levee from the bend in the DWSC at the intersection of Port North Levee and Yolo Bypass Levee south to Miners Slough.

A majority of the levees within the study area are part of the Sacramento River Flood Control Project. The few exceptions are the Port North area and Port South levees, the DWSC West levee, and the South Cross levee. The Port South and DWSC West levees were constructed as part of the Port of Sacramento. The Port North area includes high ground along the northern portion of the Port of West Sacramento. The South Cross levee is a private levee. Although the DWSC West levee was constructed as part of the navigation project supporting the Port of West Sacramento, this levee provides significant flood benefits to portions of both the northern and southern sub-basins. The Corps currently maintains this navigation levee.

Detailed descriptions of the study area characteristics that are related the problems and opportunities in the study area are included in the next chapter. Detailed descriptions of the environmental resources in the study area can be found in the Environmental Impact Statement. Below is a general description of and resources in the study area.

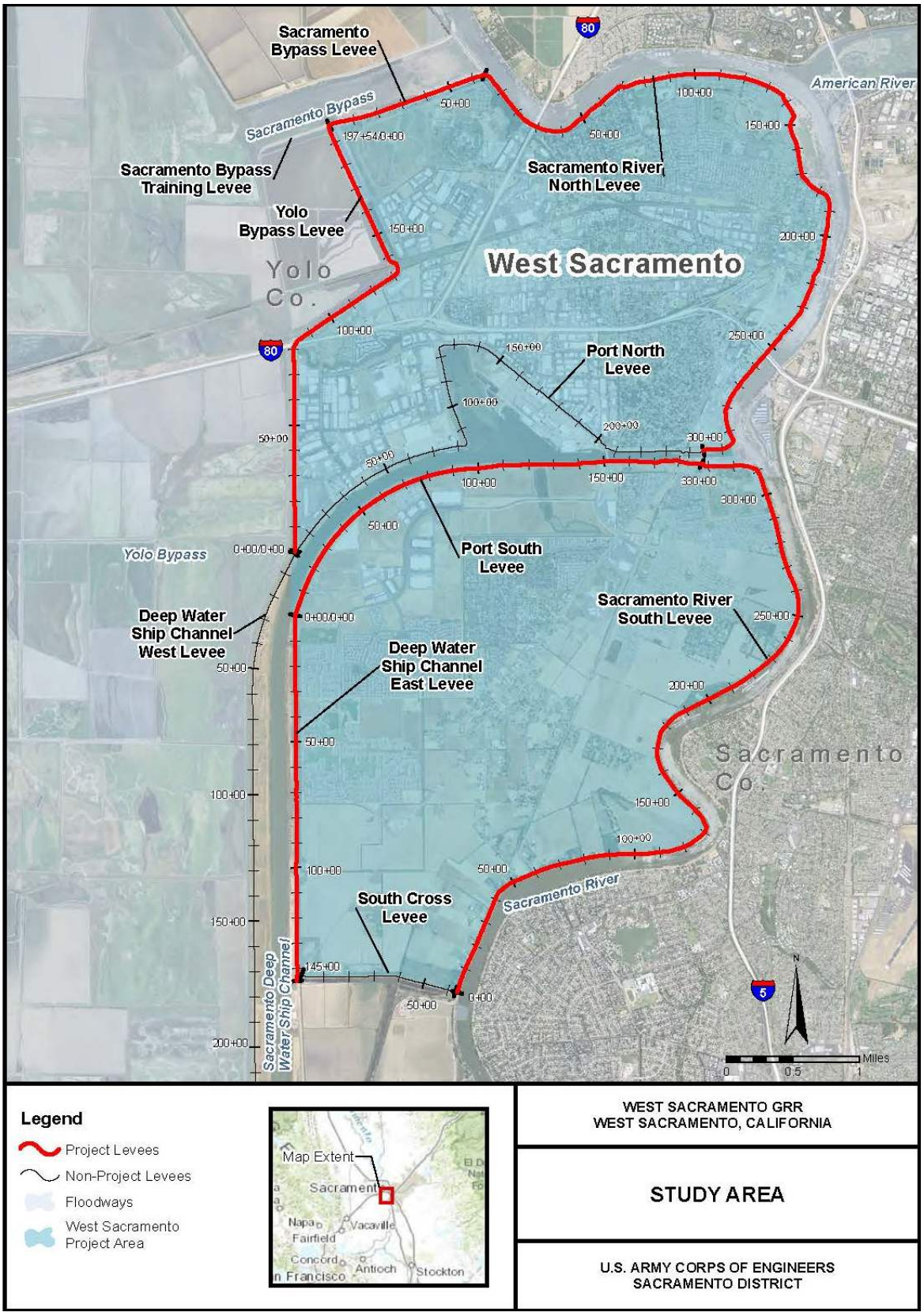

Figure 1-1: West Sacramento Study Area.

1.3.2 Watershed Setting

The study area is located at the southern end of the Sacramento River Basin (Figure 1-2). The Sacramento River is the longest river within the state of California. Starting at the confluence of the South Fork and Middle Fork of the Sacramento River, near Mount Shasta in the Cascade Range mountains, the Sacramento flows south for 447 miles through the northern Central Valley of California. The Sacramento River watershed covers an area of approximately 26,000 square miles. Shasta Dam impounds the upper Sacramento River watershed.

Major tributaries of the Sacramento River include the Feather, Yuba and American Rivers. The American River watershed covers about 2,100 square miles northeast of the City of Sacramento and includes portions of Placer, El Dorado, Alpine, and Sacramento counties. The major flood risk reduction structure on the American River is Folsom Dam, which impounds Folsom Lake. Streams flowing into Folsom Lake include the North, South, and Middle Forks of the American River. Folsom Lake has a capacity of approximately 976,000 acre-feet.

Figure 1-2: Location of the Study Area within the Sacramento River Watershed.

1.3.3 Physical Setting of the Project Area

The study area is geologically part of the Great Valley geomorphic province of California. The valley is filled with materials eroded from the surrounding mountains and deposited by streams and rivers. The project area is underlain by young alluvial deposits. Fine sands and silt rich alluvium are deposited along the flanks of the river bank and finer grained silts and clays are deposited in the floodplains further from the river. The elevation of the study area ranges from approximately 8 to 35 feet North America Vertical Datum 1988 (NAVD88).

The closest active fault is the Dunnigan Hill fault, located approximately 17 miles northwest of West Sacramento. The San Andreas Fault system is 80 miles west of the study area. The closest branches in this fault zone are the Antioch fault, located 42 miles southwest, and the Green Valley and Concord faults, located 45 miles southwest of the study area (California Department of Conservation 1977). The Midland fault, located 22 miles west of West Sacramento, and the Willows fault, located 4 miles east of the city are faults without recognized Quaternary (1.6 million years) displacement (California Department of Conservation 1999).

There are no active faults that run through the project area. There are faults that run along the Sierra Nevada foothills east of Folsom Dam and near Vacaville and Dixon west of the project area. Because much of West Sacramento has a high ground water table and young alluvial deposits, there is a high potential for these soils to liquefy during an earthquake and cause damage to the local levee systems.

The climate of the study area is Mediterranean, characterized by cool, wet winters and hot, dry summers. In the West Sacramento area about 85 percent of the annual rainfall occurs between October and March; about 95 percent falls between October and April. In West Sacramento, average annual rainfall is approximately 18 inches. Mean annual temperature in West Sacramento is 61ºF. December is generally the coldest month with a mean low temperature of 37.7 ºF and an average high temperature of 53.3 ºF. July is the hottest month with an average high temperature of 92.9 ºF and an average low of 58.2 ºF. High temperatures commonly exceed 100 ºF. Rising above 14,000 feet mean sea level MSL, the Sierra Nevada Mountains are the first major barrier crossed by cyclonic storm systems moving east from the Pacific Ocean. Consequently, precipitation in the Sierra Nevada Mountains typically exceeds 30 inches per year[1], with most of this falling as snow. The largest flood events in the Sacramento area result from winter rain-on-snow events caused by atmospheric rivers, week-long heavy precipitation events also known as “Pineapple Expresses” because the moisture originates over the tropical Pacific Ocean.

1.3.4 Land Use and Development

The study area consists of predominantly urban and rural land uses. The predominant urbanized area is located in the North Basin. This area contains commercial, residential and industrial properties. Highways and railroad infrastructure are located in the North Basin. The majority of the critical facilities in the West Sacramento area are located in the North Basin and include the regional USPS mail processing center, the regional Department of Water Resources flood fight facility, the California Highway Patrol Academy (a key facility in state emergencies), and the Port of West Sacramento.

The South Basin includes commercial, residential and rural/agricultural land uses. The South Basin has undergone significant commercial and residential development in the past twenty years.

[1] For example, Tahoe City averages 31.46 inches of precipitation per year (Western Regional Climate Center, COOP data for Tahoe City, online at: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca8758, accessed 26 February 2013).

The major highways in the study area are Interstate 80 and U.S. Highway 50 which traverse from east to west and intersect in the northern portion (North Basin) of the study area. Other major roads include West Capitol Avenue and Jefferson Boulevard. Four bridges cross the Sacramento River between West Sacramento and Sacramento and include the I-80, I Street, Tower, and Pioneer Memorial (Highway 50) Bridges. Because of the easy access to major highways both the US Postal Service and the United Parcel Service maintain distribution centers in West Sacramento.

The Union Pacific Railroad, a major east-west railway, runs through the northern portion of West Sacramento. AMTRAK also serves the Sacramento area and includes the Capital Corridor route that connects Sacramento with the San Francisco Bay area

1.3.5 Ecological Setting

Five habitat types dominate the study area: wetlands, riparian forest, aquatic, shaded riverine aquatic (SRA), and ruderal herbaceous and nonnative grassland. The study area is encompassed by the Pacific Flyway migratory bird route, the westernmost of North America's four flyways. Urbanization over the years has constrained vegetation to limited areas and consequently has inhibited the diversity and range of wildlife in the region. Wildlife is restricted predominantly to the less-developed regions adjacent to the levees along the Sacramento River.

Along the Sacramento River riparian vegetation occurs in narrow, fragmented stretches. SRA habitat has been declining due to levee system maintenance, erosion, and in some cases high flows during storm events that require the emergency placement of rock to prevent failure.

1.4 BACKGROUND AND PROJECT HISTORY

1.4.1 The Sacramento River Flood Control Project

The West Sacramento project is designed to provide flood risk management services for the West Sacramento area and is part of the greater Sacramento River Flood Control Project. Flooding was historically a major problem along the Sacramento River and its tributaries. Efforts to control flooding date to the mid-1800s with the initial construction of levees along the Sacramento, American, Feather, and Yuba rivers. These levees were constructed close to the main channels because from the mid-1800s to about 1910, most hydraulic engineers at the Federal, State and local level thought that this was the most effective way to control flood flows in a river system. Levees close to the main channel allowed reclamation of as much land as possible for agricultural purposes. In addition, it kept flows in the main channel and thus helped flush out hydraulic mining debris that clogged much of the river system and impaired navigation. Similar thinking guided flood control efforts along the Mississippi River during this period.

Record flooding in 1907 and 1909 forced a re-evaluation of this approach. The failure of existing levees to control flooding led the California Legislature to authorize the Sacramento River Flood Control Project (SRFCP), the first comprehensive plan for controlling the floodwaters of the Sacramento River and its tributaries, under the State of California Flood Control Act of 1911. This plan was subsequently approved by Congress in the Flood Control Act of 1917, Pub. L. No. 64-367, § 2, 39 Stat. 948, 949-950 (1917), which authorized Federal participation with the State of California in construction of the flood control system. Because the 1907 and 1909 flood discharges had greatly exceeded existing channel capacity, it was clear that major bypass systems were needed to accommodate excess flood flows. These bypass systems, along with construction of the Natomas levee system, were key components of the plan authorized under the Flood Control Act of 1917.

Federal participation in the SRFCP began shortly after authorization in 1917 and continued for approximately 40 years. The completed flood control system was documented in 1957 in a design memorandum that included design water surface profiles. This design memorandum and these profiles continue to govern the operation and maintenance requirements of the levee system. The system is designed to keep all flows from floods up to a certain magnitude within the river, and then to divert flow into the bypass system once this discharge is exceeded. Throughout the SRFCP, the frequency that flow starts to divert from the Sacramento River to the bypass system varies between a 3-year to 5-year flood event.

Locations where flow is allowed to spill from the Sacramento River into the bypass system include three overflow locations upstream of the project levees, and five weirs within the project levees including Moulton Weir, Colusa Weir, Tisdale Weir, Fremont Weir, and Sacramento Weir. Flow from these weirs (or overflow locations) enters the Butte Basin, the Sutter Bypass, or the Yolo Bypass. Flows from the Feather River and American River are also diverted into the bypass system near where they intersect the Sacramento River, and the bypass system directly receives outflows from many smaller tributaries.

The Fremont Weir is perhaps the most significant overflow location in the system. The Sacramento River crosses from the center of the Sacramento Valley toward the east near the north extent of the Natomas Basin. Because the river crosses the valley, the bypass system had to be constructed such that it crossed the river. The Fremont Weir forces flows up to the 3- to 5-year frequency event (1/3 to 1/5 Annual Chance Exceedance (ACE)) to stay in the river and allows flow to spill to the Yolo Bypass once this frequency is exceeded. Figure 1-3 shows the features of the Sacramento River Flood Control Project.

Folsom Dam and much of the north levee of the American River were authorized by Congress in 1949 under the American River Basin Development Act, Pub. L. No. 81–356, 63 Stat. 852. Folsom Dam was designed with a flood control space that could accommodate the Standard Project Flood (SPF), which did not have a specific frequency, but was estimated to be between the 1/250 ACE and 1/500 ACE event. Construction of Folsom Dam was nearing completion in 1955 when a new flood of record was experienced that caused the objective release for Folsom Dam to occur. Reassessment of the hydrology for Folsom Dam with the 1955 flood event included in the analysis showed that downstream areas, including the City of Sacramento, had considerably less flood protection than previously realized, despite the construction of Folsom dam and of the extensive flood control systems emplaced by the SRFCP. Discussion soon began about the need for additional flood storage upstream of Folsom Dam, which led to a proposal for a flood control dam near the town of Auburn on the North Fork of the American River.

Auburn Dam was authorized by Congress under the Auburn-Folsom South Authorization Act, Pub. L. No. 89-161, 79 Stat. 615, (1965). However, construction on the dam was halted in 1976, when seismic activity near Oroville Dam north of Auburn suggested a system of faults in the western Sierra Nevada Mountains. A U.S. Geological Survey (USGS) investigation identified a fault close to the Auburn Dam site, which led to a reassessment of the dam's design. No decision on the redesign was made and the completed cofferdam and diversion tunnel sat unaltered until 1986, when a new flood of record washed out the cofferdam and very nearly caused catastrophic flooding in Sacramento.

Without Auburn Dam, Folsom Dam remains the only flood water retention structure on the American River. The objective release of Folsom Dam is 115,000 cubic feet per second (cfs) and the emergency release is 152,000 cfs. Since construction of Folsom Dam, the objective flow rate has been met in 1955, 1964, 1986, and 1997, and each time considerable levee repair was required after the event. For the 1964 flood event, flood-fighting efforts were required to prevent levees from failing. In 1986, rapid filling of Folsom Lake led to releases of 134,000 cfs to manage the risk of dam failure. This flow stressed the American River levees and came dangerously close to causing levee failures in the City of

Sacramento. Conditions at the Lake came close to requiring operation of the emergency flood gates at flows in excess of 152,000 cfs, which would likely have flooded Sacramento. Storm abatement prevented this action.

The series of storms that struck California in February of 1986 resulted in the flood of record for many areas in northern and central California. Record flows in the American River in combination with high flows along the Sacramento River caused encroachment into the design freeboard of levees protecting the Sacramento Metropolitan Area.

The estimated peak flows associated with the 1986 flood were nearly equal or exceeded the design flows of the Sacramento River, Sacramento Bypass, and the Yolo Bypass in the vicinity of West Sacramento. These record flows in combination with high winds caused severe damage to the levees protecting both the cities of Sacramento and West Sacramento. Damage caused by erosion and seepage would likely have resulted in the failure of levees at a number of locations if not for extensive emergency operations and repairs.

1.4.2 West Sacramento Project

As a result of the problems experienced during the 1986 flood, the Corps initiated a study of the levees comprising the Sacramento River Flood Control Project that were impacted by the flood. Due to the large scale of the study, the review was split into five phases. The first phase of this study included West Sacramento and was documented through an Initial Appraisal Report titled, Sacramento Urban Area Levee Reconstruction Project, California dated May 1988. This phase included the review of approximately 110 miles of levee and recommended the repair of 34 miles.

The Sacramento Urban Area Levee Reconstruction Project Basis of Design dated, November 1989, recommended the repair of two reaches of levee protecting the City of West Sacramento. The first repair reach included two relatively small sites along the right bank of the Sacramento River near the Lighthouse Marina (Sacramento River North levee). The second, and more significant, repair reach included approximately six miles of levee along the right bank of the Sacramento River extending from near the Barge Canal entrance downstream to near the South Cross levee. Construction began in November 1990 for the installation of berms to improve stability and manage seepage along both reaches.

The 1986 flood exposed structural problems and identified the inability of the existing levees to provide critical flood protection to the urban area comprised of the Cities of Sacramento and West Sacramento. As a result, the Corps in cooperation with the State of California initiated the Feasibility Report titled, Sacramento Metropolitan Area, California. This report was published in February 1992 and indicated the existing flood control system in the study area provided significantly less than a 1% (1/100) ACE level of protection. The study went on to recommend a program of improvements which at the time were estimated to provide the City with a 0.25% (1/400) ACE level of protection assuming implementation of a 0.5 % (1/200) ACE flood control only dam on the American River; but, the recommended plan would provide at least a 0.67 % (1/150) ACE level of protection if this American River project element was not implemented. The repairs recommended by the Sacramento Metropolitan Area, California, Feasibility Report were authorized in the WRDA of 1992; however, the 0.5 % (1/200) ACE flood control only dam on the American River was never authorized by Congress.

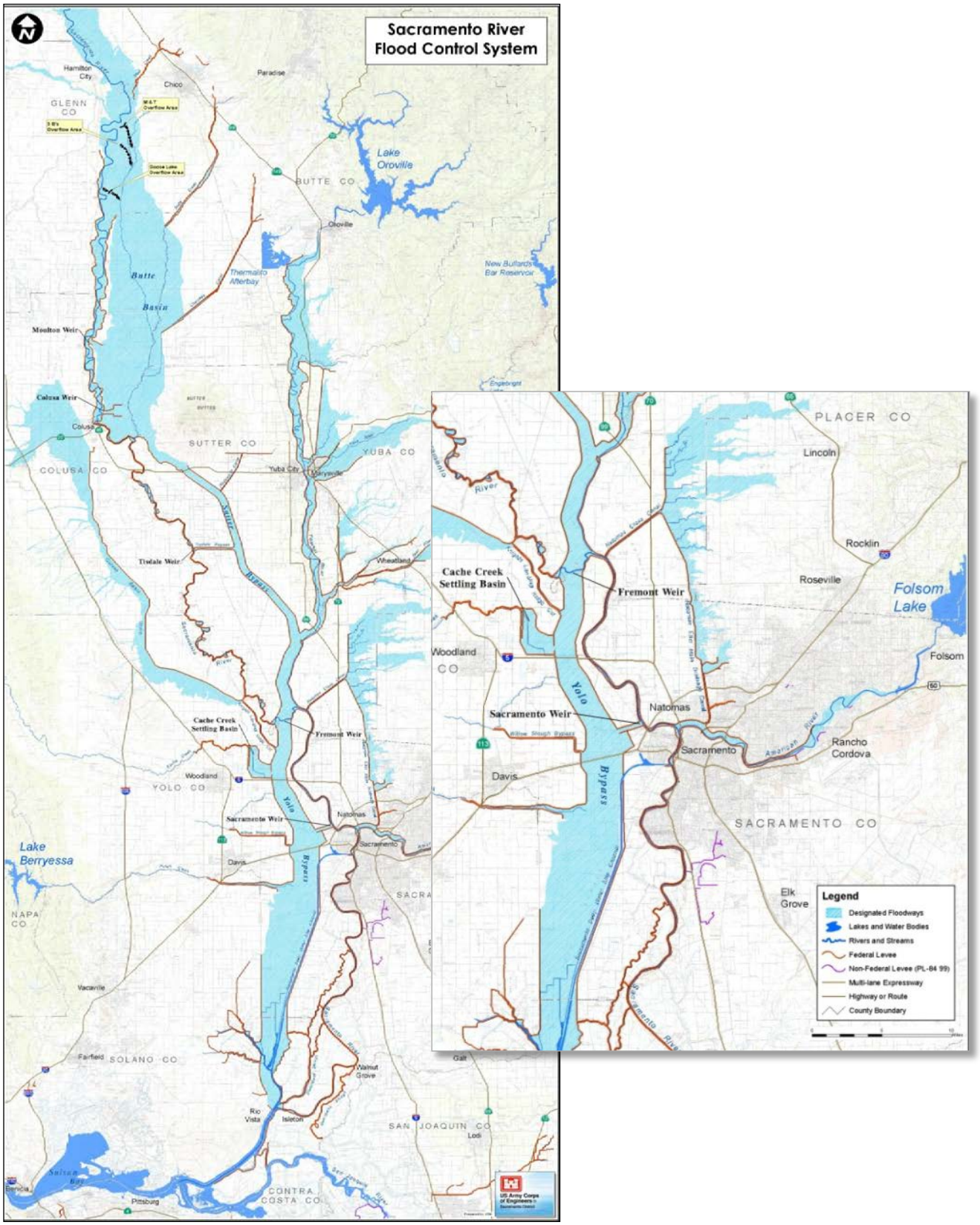

Figure 1-3: Features of the Sacramento River Flood Control Project.

The West Sacramento Area Flood Control Agency (WSAFCA) is a Joint Powers Authority (JPA) created in 1994 through a Joint Exercise of Powers Agreement by the City of West Sacramento, Reclamation District (RD) 900, and RD 537. WSAFCA was established to coordinate the planning and construction of flood protection facilities within the boundaries of the JPA and to help finance the local share of flood control projects. The agency was formed primarily in response to authorization of the flood protection repairs recommended in the Sacramento Metropolitan Area General Reevaluation Report. WSAFCA formed an assessment district in 1995 to fund the local cost share of these repairs.

The New Year's Day Flood of 1997 is one of the largest experienced in northern California since the beginning of the measured record in 1906. The flood was notable for its sustained intensity of rainfall, aerial extent, and shear volume of flood water. Over a 3 day period centered on New Year's Day, warm moist winds from the southwest poured more than 30 inches of rain onto watersheds covered with snow and already saturated from one of the wettest Decembers on record.

As a result of the high water, levees along the Sacramento and Yolo Bypasses and within RD-900 along the Sacramento River sustained heavy damage. These damages included erosion along the left bank of the Yolo Bypass; seepage and sloughing along the left bank of the Sacramento Bypass; and sloughing along the right bank of the Sacramento River within RD-900.

Prior to this flood event, the Corps was in the process of preparing construction plans and specifications for the levee repairs authorized in the WRDA of 1992. The design of these repairs was documented in the report titled, West Sacramento Project, West Sacramento, California, Design Memorandum dated May 1995. However, in the wake of the 1997 flood, the Corps identified underseepage as an area of greater concern in the design and repair of levees. This resulted in a number of design revisions to the levee repairs recommended in the West Sacramento Project Design Memorandum. These design revisions and the associated increase to the total estimated project cost were captured in a supplemental authorization through the EWDAA of 1999. Additional funding to address levee design concerns and associated cost increases was provided in EWDAA of 2010.

1.4.3 Authorized Project Features Summary

Project features, as they have evolved through subsequent authorizations are presented in Table 1-1. Table 1-2 presents an economic summary of the authorized plan and Table 1-3 presents the cost apportionment for the authorized plan. Figure 1-4 shows the features constructed of the authorized plans.

Table 1-1: Authorized Project Features.

Sacramento Urban Area Levee Reconstruction Project
Construction of berms to improve stability and manage seepage at two relatively small sites along the right bank of the Sacramento River near the Lighthouse Marina and approximately six miles of levee along the right bank of the Sacramento River extending from near the Barge Canal entrance downstream to near the South Cross levee. Construction began in November 1990 and was completed in 1992.
Sacramento Metropolitan Area, 1992 and 1999 Authorization (West Sacramento Project)
Raising and installing a slurry wall along 4.7 miles of the east bank of the Yolo Bypass levee from the Sacramento Bypass south to the Navigation Levee. Reconstructing and raising the levee along one mile of the south bank of the Sacramento Bypass, including backfill of a drainage ditch and placing riprap along the levee.

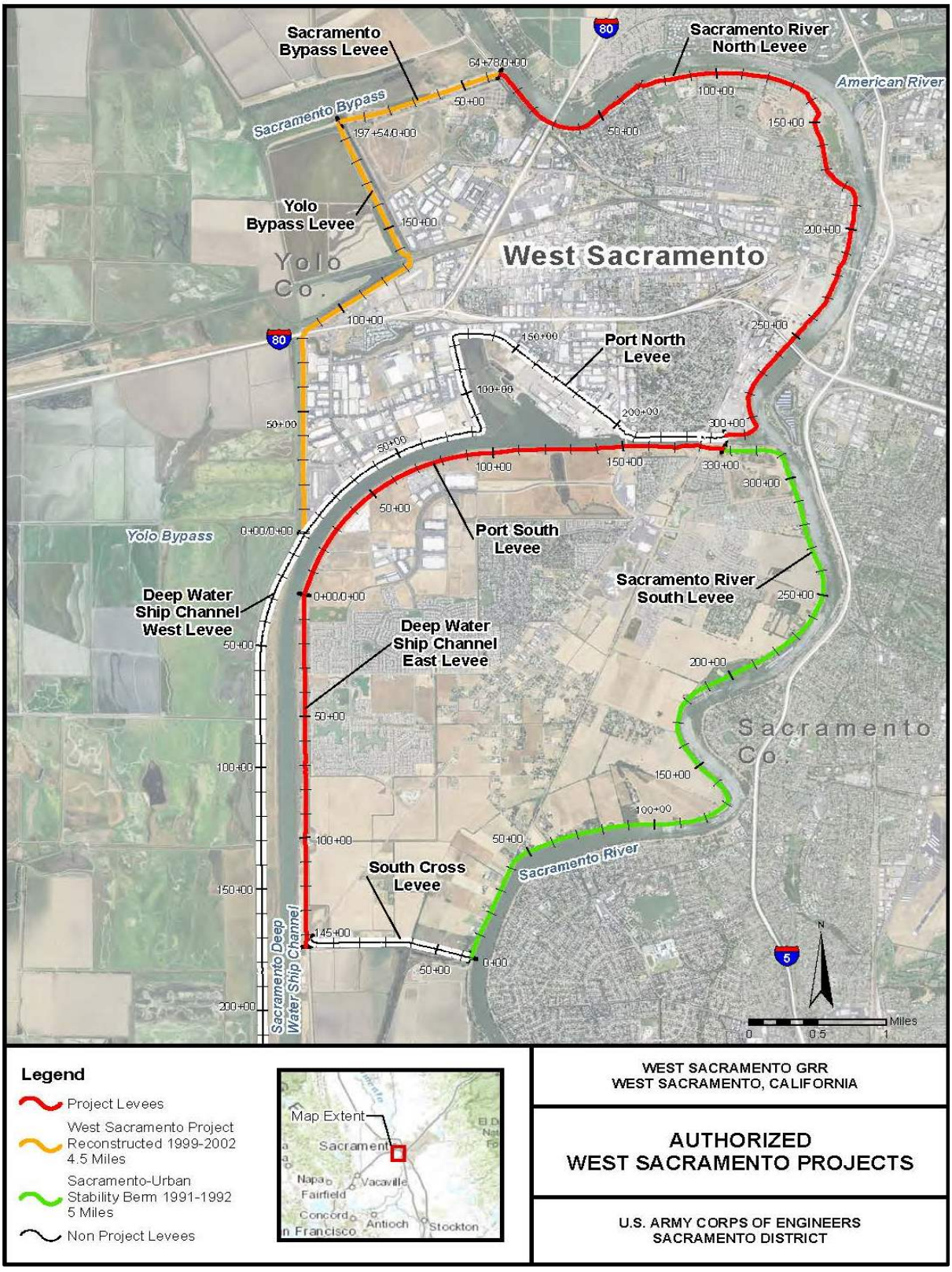

Figure 1-4: Authorized West Sacramento Projects.

Table 1-2: Economic Summary of Authorized Plan

ESTIMATE OF FIRST COSTS ($)*	
ITEM	**TOTAL**
Total First Cost	17,400,000
Interest During Construction	1,600,000
Total Investment Cost	19,000,000
Interest and Amortization	1,680,000
OMRR&R	20,000
Total Annual Costs	1,700,000
AVERAGE ANNUAL BENEFITS	
Total Annual Benefits	9,800,000
NET ANNUAL BENEFITS	8,100,000
BENEFIT TO COST RATIO	5.8

*Economic Summary of the Selected Plan from 1992 Sacramento Metropolitan Area Feasibility Report
Based on October 1991 price level, 8.75% interest rate, 50-year period of analysis

Table 1-3: Authorized Plan Cost Apportionment

ESTIMATE OF FIRST COSTS ($000)*				
ACT	**ITEM**	**FEDERAL**	**NON-FEDERAL**	**TOTAL**
1	Lands and Damages	180	1,700	1,880
2	Relocations	-	15	15
6	Fish and Wildlife Facilities	2,400	-	2,400
11	Levees and Floodwalls	10,200	-	10,200
18	Cultural Resources	131		131
30	PED	1,660	5	1,665
31	Construction Management	1,130	2	1,132
	Subtotal First Cost	15,701	1,722	17,423
	Non-Federal Cash Contribution	-2,601	2,601	
	Total First Cost	**13,100**	**4,323**	**17,423**

Selected plan summary of first cost from 1992 Sacramento Metropolitan Area Feasibility Report
Based on October 1991 price level, 8.75% interest rate, 50-year period of analysis

1.4.4 West Sacramento GRR

Based on the recognition of and our current understanding of underseepage concerns, the West Sacramento GRR is assessing all of the levees that provide flood risk management for the City of West Sacramento. This includes the levees that were improved under the original West Sacramento project authorization. These include the levees along the Sacramento River, Yolo Bypass, Deep Water Ship Channel, Port North and Port South, and the South Cross Levee. The levee on the south bank of the Sacramento Bypass and a portion of the Sacramento River North levee were improved by the local sponsors and are currently not eligible for credit; they are currently considered part of the without project condition.

1.5 WATERSHED PLANNING

1.5.1 Past and Current Related Studies and Programs

The West Sacramento Project is one of several flood risk management projects authorized within the greater Sacramento River Watershed, and is part of an overall system in place in the Sacramento Valley since the early 1900s known as the Sacramento River Flood Control Project. Currently, there are over a dozen authorized projects being studied or implemented by the Corps within the Sacramento River watershed and tributaries (Figure 1-5). The complexity of the engineering, environmental, and political issues requires a systems and watershed approach for all associated efforts with other local, State, and Federal agencies. The following are brief descriptions of some of the major programs and projects in Northern California and the Sacramento River Watershed that are directly influencing and in need of coordination with the West Sacramento Project efforts.

1.5.1.1 American River Watershed Program

Three authorized projects make up the American River Watershed Program. These projects are the American River Common Features Project, the Folsom Modification Project and Folsom Dam Raise Project. The American River Common Features project primarily includes improvements to the levee system along the American and Sacramento Rivers in Sacramento. The Folsom Modification Project primarily includes features to improve the efficiency and effectiveness of the existing flood control outlet works at Folsom Dam and flood control storage in Folsom Reservoir. The Folsom Dam Raise Project was intended to be constructed following implementation of the Folsom Modification Project. The Folsom Dam Raise Project primarily includes enlarging the flood control storage space in Folsom Reservoir, features to meet USBR's objective of passing the Probable Maximum Flood, and features to help restore the ecosystem downstream from Folsom Dam. The Folsom Modification and Folsom Dam Raise projects, in combination with the authorized Common Features elements downstream from the dam are expected to reduce the flood risk to Sacramento. With the American River Watershed Program, there is an emphasis on considering the individual projects on a more integrated basis. The EWDAA of 2006, Pub. L. No. 109-103, § 128, 119 Stat. 2247, 2259 (2005), directed the Corps and USBR to collaborate on flood damage reduction and dam safety at Folsom Dam.

1.5.1.2 West Sacramento Levee Improvement Program (WSLIP)

WSAFCA, in cooperation with the California Department of Water Resources and the Central Valley Flood Protection Board, have initiated urgently needed improvements to the Federal Project levees protecting West Sacramento. These improvements address identified deficiencies in the levee system based on recent recognition of seepage problems and levee investigations. A catastrophic failure of the levee system around West Sacramento would imperil the health and safety of approximately 48,000 residents, shut down two of California's important freeways (I-80 and U.S. Highway 50), an important rail link from the San Francisco Bay area to the rest of the country, and cause significant residential, commercial, and industrial property damage. WSAFCA and the State are addressing these challenges by moving aggressively forward with the WSLIP by constructing Early Implementation Projects (EIP) at what are considered the most vulnerable locations. One EIP site, the I Street Bridge site was completed in 2008. Construction was completed at two other EIP sites, identified as the California Highway Patrol (CHP) and the Rivers sites, in 2011. The Southport EIP site is currently under design with plans to initiate construction in 2015. The location of these EIP sites is shown on Figure 1-6.

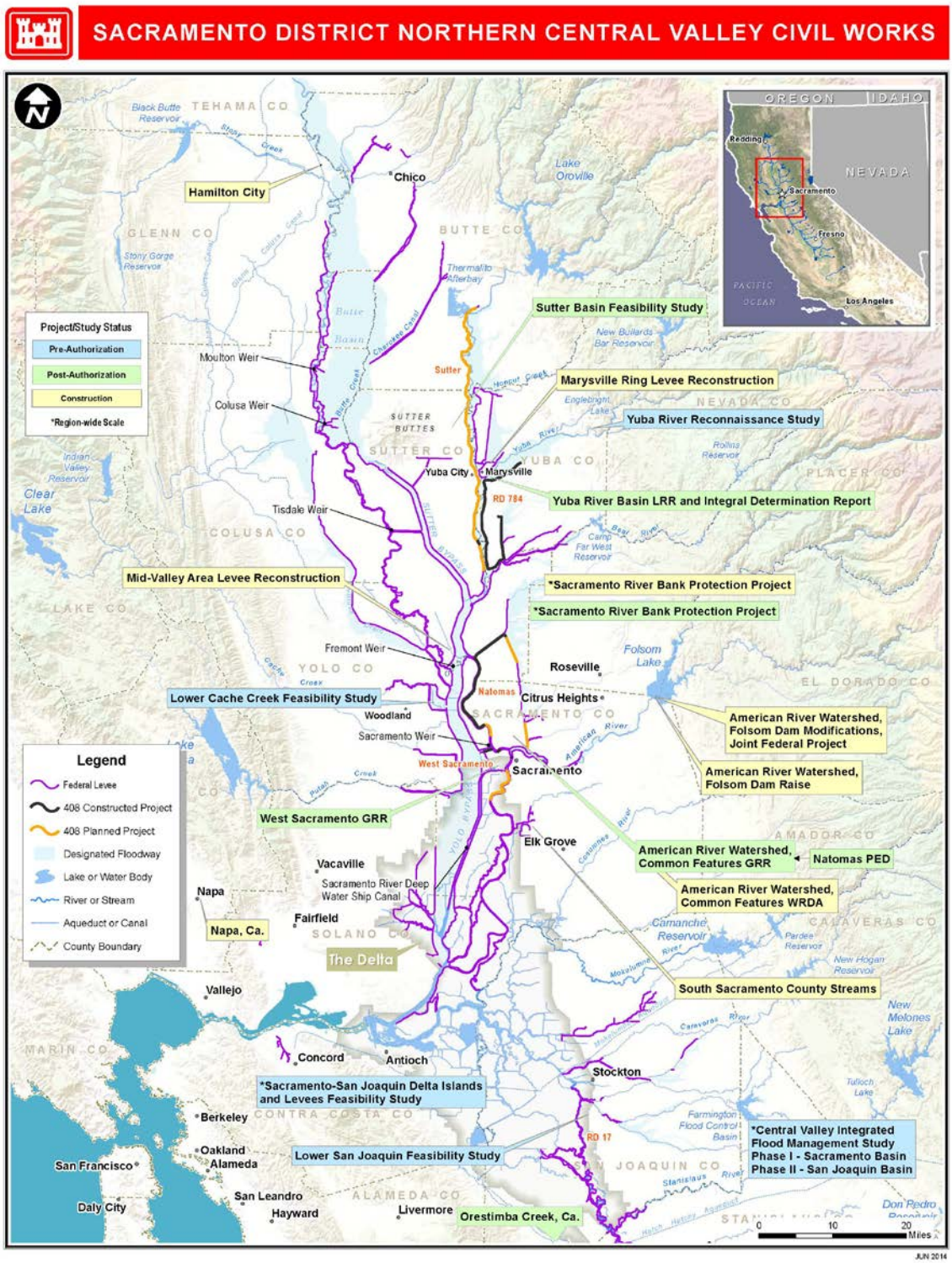

Figure 1-5: Studies and Projects within the Sacramento River Watershed.

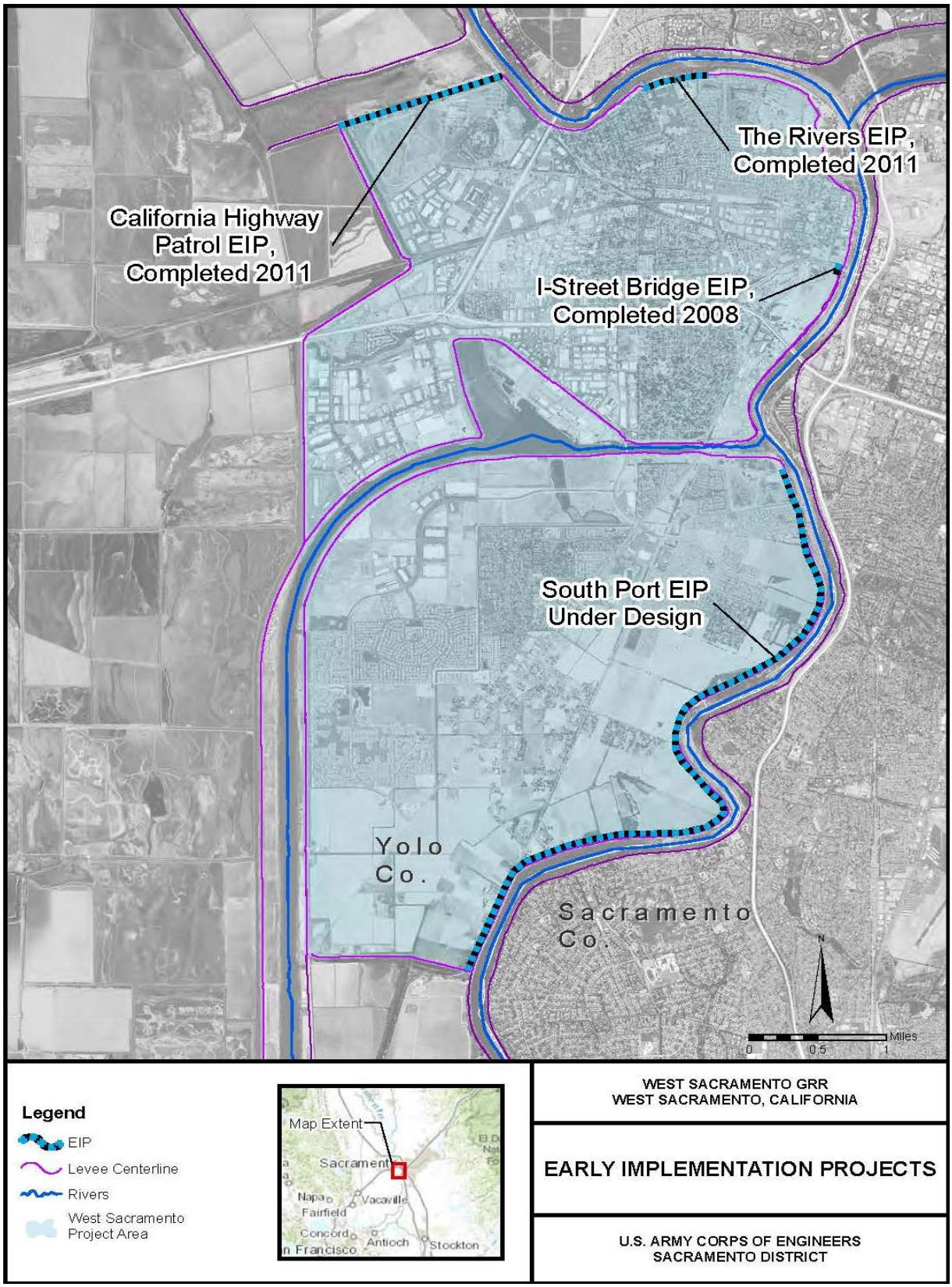

Figure 1-6: West Sacramento Early Implementation Projects.

In addition to approval to modify a federal levee pursuant to 33 U.S.C. § 408 (Section 408), the I Street Bridge site received approval for credit eligibility for levee modifications pursuant to Section 104 of WRDA of 1986, Pub. L. No 99-662, § 104, 100 Stat 4082, 4087-4088 (1986) (Section 104 of WRDA 1986).

The CHP and Rivers EIP sites received approval to modify a federal levee through Section 408. However, due to a change in policy the projects were not approved for credit under Section 104 of WRDA 1986. WSAFCA will seek credit approval through Section 221 of the Flood Control Act of 1970, Pub. L. No. 91-611, § 221, 84 Stat. 1818, 1831 (1970) (Section 221), as amended by Section 2003 of WRDA 2007, Pub. L. No. 110-114, § 2003, 121 Stat. 1041, 1067-1071 (2007).

The Southport EIP site is seeking approval to modify a federal levee through the Section 408 process and will seek approval for credit under Section 221.

1.5.1.3 Sacramento River Deep Water Ship Channel

The Sacramento Deepwater Ship Channel is a 43-mile long channel formed by widening and deepening the existing channel from the Suisun Bay to Rio Vista and by excavating a new channel from that point to Lake Washington in West Sacramento. The channel project also includes a triangular harbor and turning basin in Lake Washington and a 1.5 mile shallow-draft barge canal with an 86-foot-wide and 600-foot long navigation lock between the harbor and the Sacramento River.

The channel project was completed in 1963, with the Sacramento-Yolo Port District as the local sponsor. A feasibility report that evaluated the need for a deeper draft channel was completed in 1980. The report recommended enlarging the Suisun Bay and Sacramento River Deep Water Ship Channels from New York Slough to the Port of Sacramento from the existing 30 foot deep channel to 35 feet. Dredging was completed from river mile 41.5 to 35 in April 1991. The presence of utilities in the channel led to the project being stopped. A Limited Reevaluation Report (LRR) was started by the Corps in 2002 to verify the economic and environmental feasibility of continuing the authorized and partially completed deepening project. The draft LRR is currently on hold and the completion date has not been established.

The barge canal and lock, which has a 4-foot lift at normal pool elevation, provides for the transfer of barges between two different water surface elevations. A 135-foot span, single leaf combination highway and railroad bridge crosses the canal at the harbor end of the lock. The bridge and lock were in "caretaker" status under the jurisdiction of the Corps until its transfer to the City of West Sacramento Redevelopment Agency in 2006. The lock is permanently closed except in emergency or special situations; future operation is uncertain. The lock acts as a barrier between the Sacramento River and the DWSC and will be evaluated as part of this General Reevaluation Report.

1.5.1.4 Sacramento River Flood Control Project

In 1917, the Federal government authorized the Sacramento River Flood Control Project, which adopted the system of locally built levees as Federal levees, and constructed additional levees, bypasses, overflow weirs, and pumping facilities. Currently, the Sacramento River Flood Control Project extends from the river's mouth near Collinsville in the Sacramento-San Joaquin Delta to near Chico Landing in the northern Sacramento Valley. Approximately 980 miles of levee were constructed as part of the project, providing flood protection to roughly 800,000 acres of highly productive agricultural lands, the cities of Sacramento, West Sacramento, Yuba City, and Marysville, as well as numerous other small communities. Although the Sacramento River Flood Control Project levees were often constructed of poor materials such as river dredge soils that would not meet today's engineering standards, the levees are still relied upon to provide flood protection during major storms to over 1 million people in

approximately 30 communities with an estimated $69 billion in urban and agricultural development (CVFPP 2012).

1.5.1.5 FloodSAFE

FloodSAFE California is a strategic initiative of the State of California to improve flood protection and public safety. The FloodSAFE program is designed to accomplish five broad goals: reduce the chance of flooding; reduce the consequences of flooding; sustain economic growth; protect and enhance ecosystems; and, promote sustainability. The California Department of Water Resources (DWR) is leading FloodSAFE. Success of the FloodSAFE program depends on active participation from many key partners, such as Governor's Office of Emergency Services, CVFPB, California Department of Fish and Wildlife (CDFW), the Corps, FEMA, the U.S. Fish and Wildlife Service (USFWS), the National Oceanic Atmospheric Administration, tribal entities, and many local sponsors and other stakeholders. One of the products of the FloodSAFE program is the Statewide Flood Risk Report.

1.5.1.6 Central Valley Flood Protection Plan (CVFPP) and Central Valley Integrated Flood Management Study (CVIFMS)

The Central Valley Flood Protection Act of 2008 (CVFPA), passed by the California legislature as Senate Bill (SB) 5, directs local flood risk management efforts. The CVFPA, along with other companion legislation, required the Central Valley Flood Protection Board to adopt the Central Valley Flood Protection Plan (CVFPP) by July 2012.

The CVFPP is developing system wide plans to address flood risk management (FRM) issues in the Central Valley of California, which includes the Sacramento and San Joaquin River Basins. Because of the importance of close collaboration and coordination with the State of California on the FRM measures the Corps is conducting a parallel planning process, the Central Valley Integrated Flood Management Study (CVIFMS). CVIFMS is a next phase of the Sacramento and San Joaquin River Basins, California Comprehensive Study. The CVIFMS is strategized to be the Federal compliment to the current CVFPP process that is a multi-objective watershed study focused on integrated water resource management for flood risk management, ecosystem restoration, and other water resource purposes. The CVFPP and CVIFMS are long-range management programs to reduce the flood risk within the Sacramento and San Joaquin River basins, while restoring and protecting the riparian and floodplain ecosystems. They will provide a framework for a management plan that can be effectively implemented and supported by local, state, and Federal agencies.

The Final CVFPP was released in June 2012. The CVFPP identifies the state's vision for modernizing the State Plan of Flood Control (SPFC) facilities to address current challenges and future trends. The goals of the CVFPP are as follows:

<u>CVFPP Primary Goal</u>

- Improve Flood Risk Management – Reduce the chance of flooding, and damages once flooding occurs, and improve public safety, preparedness, and emergency response through the following:
    - *Identifying, recommending and implementing structural projects and actions that benefit lands currently receiving benefits from facilities of the SPFC.*
    - *Formulate standards, criteria and guidelines to facilitate implementation of structural and non-structural actions for protecting urban areas and other lands of the Sacramento and San Joaquin river basins and the Delta.*

CVFPP Supporting Goals

- Improve Operations and Maintenance – reduce system-wide maintenance and repair requirements by modifying the flood management systems in ways that are compatible with natural processes and adjust, coordinate and streamline regulatory and institutional standards, funding, and practices for operations and maintenance, including significant repair.
- Promote Ecosystem Functions – Integrate the recovery and restoration of key physical processes, self sustaining ecological functions, native habitats, and species into flood management system improvements.
- Improve Institutional Support – Develop stable institutional structures, coordination protocols, and financial frameworks that enable effective and adaptive integrated flood management (designs, operations, and maintenance, permitting, preparedness, response, recovery and land use and development planning).
- Promote Multi-Benefit Projects – Describe flood management projects and actions that also contribute to broader integrated water management objectives identified through other programs.

The physical features are organized into regional and system elements, including: urban, small community and rural agricultural improvements projects to achieve local and regional benefits, and system improvements that provide cross-regional benefits and improve the function and performance of the SPFC. System elements include weir and bypass system expansion, flood system structures, and operational changes of reservoirs, weirs and bypasses.

The CVFPP proposes improvements to urban (population 10,000 or more) levees to achieve protection from a 200-year (0.5% annual chance) flood at a minimum. The CVFPP states that since many of the existing levees in urban areas are often located immediately adjacent to houses and businesses, few opportunities exist for setting back levees or making improvements that enlarge levee footprints. Therefore, reconstruction of existing urban levees is generally the method for increasing flood risk management. The State is already supporting many urban levee improvement projects, including West Sacramento, through the Early Implementation Program.

Key benefits of implementing the recommendations included in the CVFPP, compared with current conditions, are the following:

- 67% reduction in expected annual damages.
- Construction to increase economic output by $900 million and generate over 6,500 jobs annually.
- Avoided business losses to increase long term economic output by over $100 million.
- 49% reduction in life risk.
- 10,000 acres of new habitat and 25,000 acres of habitat-compatible crops.
- Sustainable rural-agricultural lifestyle.
- Resiliency and adaptation to future changes.

After release of the Final CVFPP in June 2012, the State initiated two basin-wide feasibility studies (Sacramento and San Joaquin Basins). These State feasibility studies will examine the measures and alternatives considered in the 2012 CVFPP to determine their feasibility and will identify a Locally Preferred Plan for consideration by USACE. The CVIFMS would integrate information and findings of the

two State basin wide feasibility studies. Since the majority of the Central Valley flood risk management facilities and most of the State Plan of Flood Control (SPFC) facilities are part of the State-Federal flood management system, any modifications or additions to this system requires Federal participation and approval through USACE. Major improvements or modifications to the SPFC will require a feasibility study to be used by Federal decision makers and Congress to authorize new projects or project modifications, and appropriate funds.

CVIFMS will evaluate flood risk management improvements in the Central Valley from a Federal perspective, and provide a framework for authorization and implementation of flood risk management projects in the Central Valley. Following completion of CVIFMS it is anticipated that several regional Feasibility Studies will be completed. When completed the feasibility studies will be used to determine Federal interest in implementing elements of the CVFPP and identify non-Federal responsibilities for improvement to the system.

Improvements to the conveyance system, such as widening the Sacramento Weir and Bypass, would provide greater system flexibility and resiliency in accommodating future hydrologic changes in the project area, including those due to climate change.

1.5.1.7 Delta CALFED Program

The 1,300 square miles of the Sacramento-San Joaquin River Delta are the hub of California's water delivery system that redistributes runoff from over 40 percent of California's landmass to farms and to more than two-thirds of the state's population. By the 1990s, water quality issues in the Delta made it no longer reliable as a water supply source and led to its failure as an ecosystem to sustain many species of concern. CALFED, a multi-agency team representing agricultural, environmental, urban, fishery, water supply and business interests, is committed to adopting mutually acceptable water quality standards and to developing long-term strategies addressing fish and wildlife, water supply reliability, levee stability, and water quality needs in the Delta. CALFED determined that the Delta levee system is critical to all CALFED objectives and named the Corps as the Federal lead of the program.

The purpose of CALFED's three-phase program is to develop a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta system. Phase 1 was completed in September 1996, identifying three preliminary categories of solutions for Delta water conveyance. Phase II was completed with the publication of the Final Programmatic Environmental Impact Report/ Environmental Impact Statement (EIR/EIS) and signing of the Record of Decision (ROD) on August 28, 2000. The ROD was adopted as a joint Federal-State document and defined the programmatic plan. The CALFED Program is now in Phase III, implementation of the preferred alternative.

1.5.1.8 Sacramento River Bank Protection Project

The erosive forces from flood events on the Sacramento River have weakened the 100 year-old levees of the Sacramento River Flood Control Project. In response to requests from the State of California, Congress authorized the Sacramento River Bank Protection Project in two phases to maintain the integrity of these levees and other flood control facilities. Phase I of the Sacramento River Bank Protection Project, Section 203 of the Flood Control Act of 1960, Public Law 106-53, started in 1960 and was completed in 1975 with the installation of 480,000 lineal feet of rock revetment bank protection. Phase II was authorized by Congress in 1975, WRDA 1974, Pub. L. No. 93-251, § 202, 88 Stat.49, and provided for an additional 405,000 lineal feet of bank protection. To date, approximately 390,000 lineal feet of Phase II have been completed with continued construction planned. Expanded authority to

provide for an additional 80,000 lineal feet of bank protection before the completion of Phase II has been provided under WRDA 2007, Pub. L. No. 110-114, § 3031, 121 Stat. 1041 ,1113.

Additional funding to maintain the Sacramento River Flood Control Project system is required beyond that already authorized. The Sacramento River Protection Project Annual Inspection Report for 2009 identified 154 locations in need of repair, some of which are deemed "critical" and potentially subject to failure during a flood event. Monitoring to provide early warning for emergency response and emergency flood fighting are stopgap measures while funding for repairs is being sought.

1.5.1.9 WSAFCA Assessment Fee

In July of 2007 West Sacramento voters passed the Proposition 218 ballot measure to form a new assessment district by the West Sacramento Area Flood Control Agency. The assessment will finance the local share of flood risk management projects, such as the WSLIP and West Sacramento projects, and ongoing operations and maintenance. The City Council for West Sacramento reaffirmed its General Plan policy of achieving a minimum of 200 year (0.5% annual chance) protection for the City by adopting Ordinance 07-11 in May 2007. The Council also established an in lieu fee on future development to provide additional resources for levee improvements.

1.5.1.10 Public Law 84-99 Eligibility Retention and Flood System Improvement Framework

In the aftermath of Hurricane Katrina, the Corps began to place heightened emphasis in the removal of woody vegetation from flood control works under 33 C.F.R. § 208.10(b)(1) and its replacement by sod (see also Engineering Technical Letter (ETL) 1110-2-583, Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures, dated 30 April 2014). In Central California, the situation is unique in that dry conditions make it nearly impossible to maintain a sod cover on most levees. Because of this, many levees have brush and trees that were preserved in an effort to provide erosion protection for the levees. Additionally, the vegetation on the levees provide important habitat. (Note – WRRDA 2014 (Pub.L. 113-121) contains language that will affect the guidelines presented in ETL 1110-2-583; implementation guidance is expected within one year).

The State of California developed an interim, short-term framework to address vegetation issues in the context of its ongoing activities to reduce flood risk in the Central Valley. The short-term strategy consists of removal of and trimming of vegetation to facilitate inspection and flood fighting, according to revised inspection criteria recently developed by DWR. The criteria used during this short term are considered interim, and will transition to the Corps standard, to be implemented as part of the Central Valley Flood Protection Plan after 2012. The State anticipates a "life-cycle management" approach to the vegetation remaining in this interim period after the short-term plan is implemented. This "life-cycle management" will consist of:

- Monitoring the health and condition of trees and woody vegetation;
- Removal of trees as they deteriorate, either through age, disease, or damage, before they can fall and cause harm to the levees; and,
- Adequate repair and replacement of levee materials lost when trees are removed.

In 2012, the CVFPP was completed. That document lays out strategies for implementing more comprehensive system-wide improvements over time.

1.5.2 Summary

The implementation of the projects at Folsom Dam, the changing levee vegetation framework, and other studies in the area all must be considered in establishing the future without-project condition. Additionally, the ongoing efforts toward development of a comprehensive plan of flood risk management in the Central Valley make it all the more important that the West Sacramento Project not adversely affect the development of the comprehensive CVFPP. It is assumed that the West Sacramento and American River Common Features Projects would be an early implementation project of the overall State plan.

1.6 PLANNING PROCESS AND REPORT ORGANIZATION

The planning process consists of six major steps: (1) specification of water and related land resources problems and opportunities; (2) inventory, forecast and analysis of water and related land resources conditions within the study area; (3) formulation of alternative plans; (4) evaluation of the effects of the alternative plans; (5) comparison of the alternative plans; and, (6) selection of the recommended plan based upon the comparison of the alternative plans.

The chapters of this report relate to the six steps of the planning process as follows:

- Chapter 2, Problem Identification, covers the first step in the planning process (specification of water and related land resources problems and opportunities). It also covers the second step of the planning process (inventory and forecast). It establishes planning objectives for the reevaluation of the project.
- Chapter 3, Alternatives, is the heart of the report. It covers the third step in the planning process (formulation of alternatives) as well as the fourth step in the planning process (evaluation), the fifth step in the planning process (comparison), and the sixth step of the planning process (selection).
- Chapter 4, The Selected Plan, describes the selected plan resulting from the evaluation of alternatives.
- Chapter 5, Changes to the West Sacramento Project, integrates the reevaluated West Sacramento Project with the other previously recommended, authorized, and constructed portions of the project to describe the proposed changes to the authorized West Sacramento Project.
- Chapter 6, Public Involvement, Review, and Consultation, covers the public and agency participation in the study to date.
- Chapter 7, Recommendations, provides the recommendation for project reauthorization.

2 - PROBLEM IDENTIFICATION

This chapter presents the results of the first step of the planning process, the specification of water and related land resources problems and opportunities in the study area. The chapter concludes with the establishment of planning objectives and planning constraints, which are the basis for the formulation of alternative plans.

2.1 NATIONAL OBJECTIVE

The Federal Objective, as set forth in the WRDA of 2007, specifies that Federal water resources investments shall reflect national priorities, encourage economic development, and protect the environment by:

(1) seeking to maximize sustainable economic development;

(2) seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used; and

(3) protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems.

In consideration of the many competing demands for limited Federal resources, it is intended that Federal investments in water resources as a whole should strive to maximize public benefits, with appropriate consideration of costs. Public benefits encompass environmental, economic, and social goals, include monetary and non-monetary effects and allow for the consideration of both quantified and unquantified measures. In summary, the Federal Objective specifies the fundamental goal of Federal investments in water resources.

The Federal objective is not specific enough for the development of a water resource project. The formulation of alternative plans requires the identification of study specific planning objectives.

Benefits from plans for reducing flood hazards accrue primarily through the reduction in actual or potential damages to affected land uses. There are three primary benefit categories, reflecting three different responses to a flood hazard reduction plan. Inundation reduction benefits are the increases in net income generated by the affected land uses when the same land use pattern and intensity of use is assumed for with- and without-project conditions. Intensification benefits are increases in net income generated by intensified floodplain activities when the floodplain use is the same with and without the project but an activity (or activities) is more intense with the project. The third category of benefits is location benefits. If an activity is added to the floodplain because of a plan, the location benefit is the difference between aggregate net incomes (including economic rent) in the economically affected area with and without the project. In general, the NED Plan will be formulated to protect existing development and vacant property that is interspersed with existing development.

2.2 PUBLIC CONCERNS

A number of public concerns have been identified during the course of this study and the West Sacramento Levee Improvement Program. Input was received through coordination with the sponsors, coordination with other agencies, and through public workshops. A discussion of public involvement is

included in the Draft Report in Chapter 6, Public Involvement, Review and Consultation. The public concerns that are related to the establishment of planning objectives and planning constraints are:

- The program may adversely affect a large area of sensitive habitat. The program should document how impacts to sensitive habitat are first avoided, second being minimized, and third being mitigated.
- Vegetation Removal: The Corps' Engineering Technical Letter regarding vegetation on levees, ETL 1110-2-571, causes much public concern. Much of the riparian habitat present in the Sacramento Valley was lost due to construction of the Sacramento River Flood Control Project and associated land reclamation. Therefore, the remaining habitat along the rivers is critical. Vegetation that is on and near levees along the project is part of this habitat. There is concern that additional vegetation removal will reduce the remaining habitat present in the Sacramento valley.
- Real Estate and Encroachments: Since completion of the Sacramento River Flood Control Project, in certain reaches, development has occurred right up to and in some cases onto the levee. The Sacramento River North reach is one area where this has occurred. There is concern that for the construction of levee improvements to be in compliance with Corps' Levee Design criteria, much of this real estate development and encroachments that has occurred up to and on the levees will have to be removed.
- Erosion Protection Armoring: Erosion protection is included in the array of measures. Erosion protection usually involves placing rock revetment to counter the forces of flow and velocity to protect against a possible levee failure. There is concern about placing rock revetment in river environments because of the impacts to aquatic and riparian habitat.

2.3 PROBLEMS

The Sacramento Metropolitan area, including West Sacramento, is one of the most at risk areas for flooding in the United States. There is a high probability that flows in either the Sacramento River or the Yolo Bypass will stress the network of levees protecting the study area to the point that levees could fail. The consequences of such a levee failure would be catastrophic since the inundated area is highly urbanized and the flooding could be up to 20 feet deep. This section describes the problems addressed by the GRR to reduce flood risk in the West Sacramento area. The following sections include a description of the flood risk in terms of the probability of flooding and the resulting consequences.

2.3.1 Problem: There is a high probability of flooding in the West Sacramento Area

The West Sacramento area has a high probability of flooding due to its location at the confluence of the American and Sacramento Rivers, adjacent to the Yolo Bypass and within the floodplain of the Sacramento River. Both of these rivers have large watersheds with very high potential runoff which has overwhelmed the existing flood management system in the past. The city of West Sacramento is essentially surrounded by a system of levees that provide flood risk management for the city. The existing levee system was designed and built many years ago, before modern construction methods were employed. These levees were constructed close to the river to increase velocities which would flush out hydraulic mining debris. This debris is essentially gone now but the high velocities associated with flood flows are eroding the levees which comprise the flood risk management for the study area. All of these factors which contribute to the high probability of flooding are discussed in more detail in the following sections.

Past Flood Events

Newspaper accounts and anecdotal evidence mention at least nine major floods in the Sacramento River valley prior to 1900, which prompted the construction of spoil bank levees across the flood plain. The modern flood control system originated with the SRFCP levees authorized in 1917, the Central Valley Project (including Shasta Dam), the construction of Folsom Dam completed in 1956, and the completion of Oroville Dam in 1967. Since the operation of Folsom Dam on the American River became effective, large floods have occurred in 1955, 1964, 1969, 1970, 1982, 1986, 1997, and 2006. The 1986 flood is the flood of record.

February 1986 Flood

In February 1986, a series of storms led to severe flooding in central and northern California. In many areas, precipitation from this 10-day storm delivered more than half of the normal annual precipitation for the area. The Sacramento River flood control system was overloaded and reservoirs in the system were filled beyond their design capacity. Record flow releases from the reservoirs produced river flows that exceeded the design capacity of downstream levees: water came within inches of overtopping levees protecting Sacramento. The timely cessation of the storm event prevented overtopping of the American River levees. At the runoff peak, an estimated 650,000 cfs flowed past the Sacramento metropolitan area in either the Sacramento River or Yolo Bypass and out to the Sacramento Delta.

Emergency levee work and flood fighting prevented catastrophic flooding. However, the extended high water caused boils, slips, sloughing, seepage, flood flow erosion and wave erosion that required emergency work to minimize or prevent further damage during the flood. Several levees upstream from West Sacramento failed during this flood. At the conclusion of the storm, the Governor declared emergencies in 39 counties, with damages totaling more than $500 million.

January 1997 Flood

In mid- to late-December 1996, heavy snow fell in the Sierra Nevada Mountains. This was followed by heavy precipitation on the western slope of the mountains. The rain began to fall on December 26, and from December 31 to January 3, an atmospheric river (locally known as a “Pineapple Express”) brought approximately 30 inches of rain on the western slopes of the Sierra Nevada Mountains, dumping more than half a year’s worth of rain on Northern California in 10 days. In addition to the local rainfall, 50°F temperatures and rain in the Sierra Nevada Mountains melted the snowpack below 6,000 feet. The combination of record snowfall and record rain resulted in high stream flows around Sacramento. The Sacramento River peaked within half a foot of the 1986 record level. Folsom Dam was barely able to keep releases within the objective release of 115,000 cfs. Upstream from West Sacramento, levees on the Feather River at Olivehurst and on the Sutter Bypass failed during the flood event.

General Description of the Floodflows

Flood flows from the north are split between the Sacramento River and the Yolo Bypass. Under the current design of the Sacramento River Flood Control Project, diversions to the Yolo Bypass at the Fremont Weir account for 70% of the Sacramento River flow at Verona. The Sacramento River downstream of the Fremont Weir has a channel capacity of 110,000 cfs and this will not change with the implementation of authorized improvements to the West Sacramento Project. The channel could see flows as much as 138,000 cfs, depending on the operation of the Fremont Weir.

Evaluation and determination of the extent of flood damages due to levee overtopping and/or levee failure were performed with numerical floodplain models using FLO-2D. Table 2.1 shows the area inundated for the 0.5% (1/200) ACE event. The without project evaluations all assume that authorized

projects in the watershed are in place. Figure 2.1 shows the 50% (1/2) ACE through the 0.2% (0.2/100) ACE floodplains for the study area associated with a breach at Index Point 1. The 0.5% (1/200) ACE floodplains are shown because the State of California Senate Bill 5 requires urban areas to have 0.5% (1/200) ACE level of protection as described in the Urban Levee Design Criteria (DWR, 2012). The 0.5% (1/200) ACE event was also chosen based on the intent of the modifications to Folsom Dam as part of the Joint Federal Project (JFP) to control releases up to a 0.5% (1/200) ACE event.

Table 2.1 0.5% (1/200) ACE Flood Plain Area.

Economic Impact Area	Total Acres	Total Square Miles
North Basin	5,468	8.545
South Basin	6,822	10.66
TOTAL	12,290	19.205

Flood Management System Capacity

Evaluation of storms and floods of record indicate that critical flood-producing conditions in the Sacramento River Basin will exist only during the winter season when there is a wet snowpack and a prolonged series of storms occurs over the basin. Usually, storm precipitation amounts are distributed in the same general pattern as normal annual precipitation amounts. Major departures from this pattern do occur, however. Generally, a storm series will last from 2 to 5 days; however, some series have been longer (the 1986 storm lasted 10 days). During such periods, groundwater levels rise, infiltration capacities decline, and the natural and artificial storage within the basin is progressively filled.

Flood flows in the American River basin are rather frequent and of two general types: winter rain-on-snow floods and spring snowmelt floods. Historically, only flood flows resulting from intense winter rainfall over the foothills and mountains have caused serious flooding. Outside the winter season, storms are less severe, cover smaller portions of the basin at a time, and are so widely separated in time that existing basin flood control facilities are easily capable of controlling the runoff.

Prior to the construction of levees, the Sacramento River annually would overflow its banks flooding the primarily riparian and wetland habitats of the valley. After levee construction began under the SRFCP, flows were confined to the river in most areas. Before the bypass system was constructed, levee failures occurred frequently, flooding the areas intended to be reclaimed. After completion of the SRFCP system, which included the bypass system, levee failures still occurred, but only on the more severe flood events.

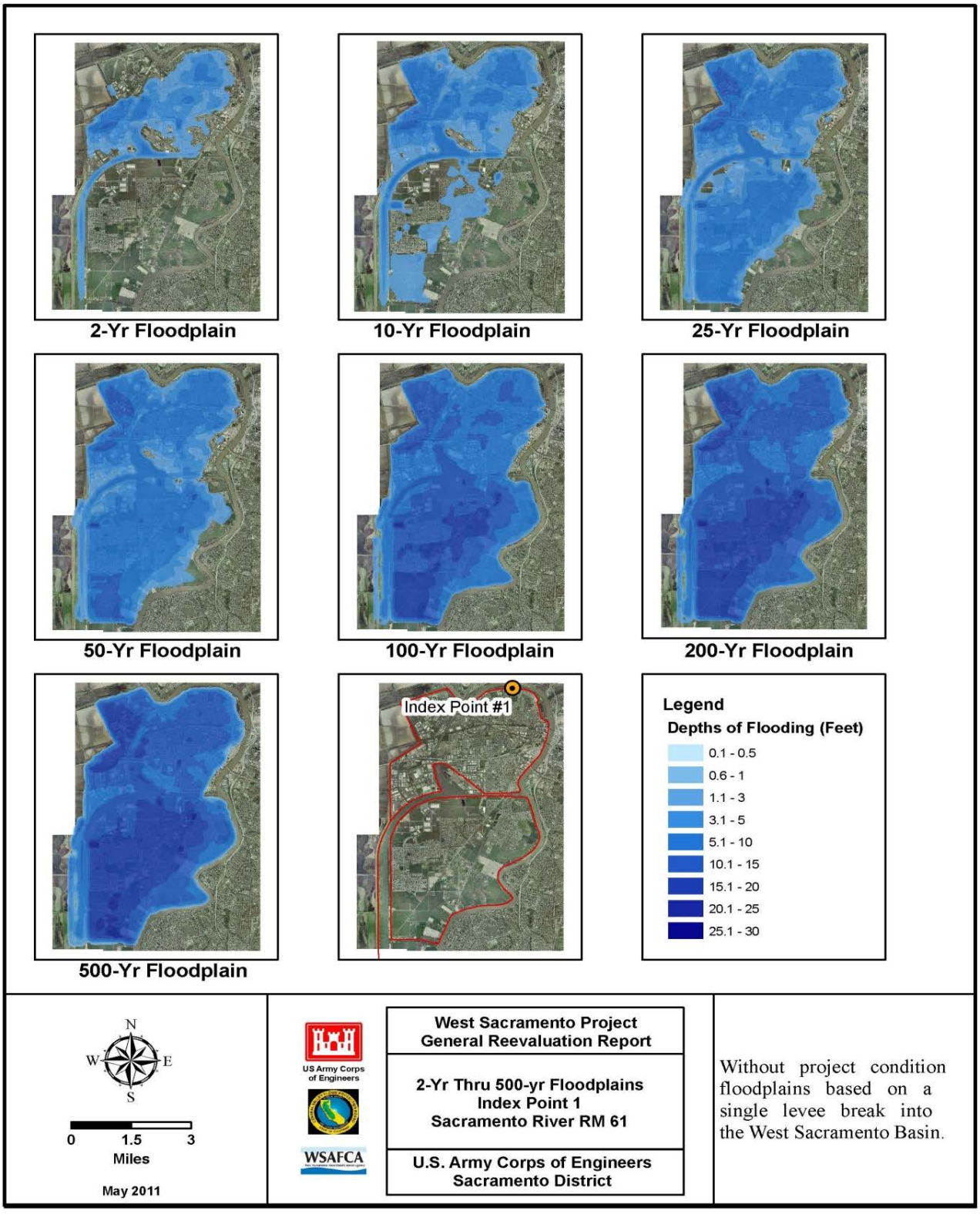

Figure 2.1: West Sacramento Area 2-year through 500-year flood plains.

The SRFCP was designed to pass the known flood of record, which at the time of Congressional authorization was the 1911 flood. During construction of the system, a new flood of record occurred in 1927, which was incorporated into the overall system design. After completion of the Federal system in the 1950s, a new flood of record occurred in 1986, followed by the slightly smaller flood of January 1997. The floods of 1986 and 1997 delivered much more water to the leveed reaches than they were designed to carry, resulting in levee failures. On the American River, the four biggest floods have all occurred after completion of Folsom Dam and the SRFCP. In general, throughout the Sacramento Valley, climatology since completion of the Federal system has been much wetter with more precipitation than the period that the original design of the system was based upon and more flow delivered to the levee system than it was intended to safely carry. This has resulted in large levee failures, with ensuing significant loss of property and some loss of life.

Table 2.2 shows the design capacities for various locations in the river system and computed flows for a 0.5 % (1/200) ACE event over the American and Sacramento Basins.

Since the SRFCS was completed in the 1950s, few improvements have been completed: most of the work completed is maintenance such as bank protection, and seepage and stability fixes to correct localized problem within reaches. Over this same period, many areas have seen substantial urban development. This urbanization has dramatically increased the consequences of levee failure in these areas. Since levee improvements have not kept pace with the rate of urban development, overall flood risk has drastically increased since completion of the SRFCS system in the 1950s.

Table 2.2: Design Flows and Flood Flows in the Project Area.

Location	SRFCP Estimated Design Capacity (ft^3/sec)	0.5% (1/200) ACE event flows (ft^3/sec)*	
		Sacramento Basin Storm Centering	American River Storm Centering
Sacramento River (upstream of Sacramento Bypass)	107,000	121,000	118,000
Sacramento River (downstream of American River Confluence)	110,000	135,000	132,000
Sacramento Bypass	112,000	149,000	148,000
American River (including flow from Natomas East Main Drainage Canal)	152,000	162,000	163,000

* Assumes a release of 160,000 ft^3/sec from Folsom Dam. At the time of this writing, 160,000 ft^3/sec is the objective flood release from Folsom Dam with the JFP improvements in place.

Effects of Folsom Dam Operational Improvements on Downstream Levees

The existing configuration of Folsom Dam is such that the invert of the lower level outlets is at elevation 289 feet, the spillway sill is at elevation 418 feet, and the bottom of the 400,000 acre feet permanent flood control pool is at elevation 427 feet. Because of this configuration, only 30,000 cfs can be released until the stage in the reservoir reaches the spillway. The objective release for Folsom Dam is 115,000 cfs. However, this amount of flow cannot be released until the stage is sufficiently high enough above the spillway to force it through the spillway. With this configuration and with the levees downstream of Folsom Dam only being able to safely convey 115,000 cfs, there is a significant risk of flooding for the City of Sacramento.

With the Folsom Dam JFP, an auxiliary spillway is being constructed with a spillway sill at elevation 368 feet. With this new spillway, a release of 115,000 cfs can be made at a much lower reservoir stage than with the existing spillway only, also allowing for this release to be made for a longer duration. Additionally, with this new spillway and allowing for releases to increase to 160,000 cfs, the 0.5% (1/200) ACE event design storm can be safely conveyed past the dam.

However, the levees downstream of the dam are currently unable to pass flows of 160,000 cfs. The intent of the American River Common Features Project is to construct the necessary levee improvements in order to safely convey a peak release of 160,000 cfs from Folsom Dam through the City of Sacramento. In addition, the project will construct necessary improvements in levees protecting the city in order to provide at least the same level of flood risk reduction as the improvements being constructed at Folsom Dam and to safely convey the higher flows from the dam.

The City of West Sacramento lies across the Sacramento River from the City of Sacramento. West Sacramento is also susceptible to levee failures from flood events on the American River and the Sacramento River. For purposes of the West Sacramento project, the levee improvements included under the Common Features project are carried into West Sacramento so that up to a 0.5% (1/200) ACE event from storms happening on the American River and/or the Sacramento River are safely conveyed past the City of West Sacramento. North of the City of West Sacramento, the Yolo Bypass carries significant excess flow from the Sacramento River via the Sacramento Weir and Bypass. If this flow remained in the Sacramento River, it would greatly overwhelm the levees protecting both the cities of Sacramento and West Sacramento. Because of this flow split of the Sacramento River into the Yolo Bypass, for Sacramento River floods, West Sacramento is susceptible to levee failures on both the Sacramento River and the Yolo Bypass.

Conditions Affecting the Reliability of Levee Performance

In addition to the problems associated with the capacity of the American and Sacramento River system, recent investigations have identified issues with the levees built to reduce the flood risk in West Sacramento. The foundation conditions and the nonstandard construction of some of these levees have resulted in issues associated with through-seepage, underseepage, and stability. The seepage and stability problems associated with the levees in many locations are so severe that these problems must be corrected before any other types of flood risk management measures can be considered. Reductions of flood levels on the order of several feet are not sufficient to offset the problems associated with seepage. Additionally, the levees were built very close to the riverbanks, with the result being that they are directly subjected to the erosive forces of the river. Because of the urban setting of these levees, many have issues with vegetation, encroachments, and a lack of access for maintenance and flood fighting. In addition, in some locations, the height of the levees does not meet the current State standard for urban levees. Figure 2-2 shows the locations of specific levee issues. These specific levee issues are discussed below.

Seepage and Underseepage

The poor construction of most of the levees in the West Sacramento area leads them to have problems with seepage through them. The levees were constructed of material dredged from the river and placed in a trench excavated in the natural ground between two starter dikes obtained from excavation placed along each side of the trench. Because of this, the embankment material consists of pervious sands and gravels that transmit water under flood conditions. This leads to the development of floodwater seepage through the levee embankment and eventually to damages to the levee. Internal erosion can cause piping of levee material from the embankment and landside slope failure. In addition, the area

protected by the levee could be affected by excessive seepage of water from the river. During the 1986 floods, numerous areas of seepage through the levee leading to landside slope failures were observed.

In addition to seepage through the levees, the integrity of these levees is also potentially compromised by underseepage. Underseepage occurs when water seeps through permeable sand and gravel lenses underlying a levee. In the project area, numerous such lenses underlie and cross beneath the existing levee system because the flood plain on which the levees are built is crisscrossed by former river channels, meanders, oxbows, and current and former point bars. Under high water stages, areas protected by levees can still flood due to underseepage through these highly permeable sand and gravel layers. These layers are also easily eroded, and may cause the levee to collapse due to internal erosion, or piping. If the permeable sand layers in the foundation are covered by an impervious blanket, water pressure can develop at the base of the impervious blanket. If this pressure is suddenly released, due to blanket failure or other cause, rapid piping will undermine the levee embankment, leading to failure.

Levee Stability

Stability problems were observed during high water stages on both the landside and waterside slopes. The materials used to construct the levees were not selected for their suitability, merely their availability as dredge from the riverbed. The construction methods were also inadequate: the levee material was not compacted but was constructed with clamshells or dredged, with assorted objects such as dead trees indiscriminately buried in the levee embankments. Seepage through the levee embankment and underseepage through its foundation raises the water pore pressure at the landside levee toe leading to sloughing and sliding of the landside levee slope. Landside slope failures have been observed during high river stages in areas where impervious soils cover the sandy and gravelly layers in the levee foundation due to high gradients at the levee toe. These slope failures have also been observed in areas where water was seeping through the levee embankment above the toe of the levee.

Levee Erosion

Because of the deposits of hydraulic mining debris that washed into the American and Sacramento River valleys, early levee builders constructed the flood control works by dredging material from the river beds and placing it on the bank near the river. This served several purposes. First, the resulting levee provided a degree of protection from flooding. Second, it removed material from the river bed, causing the channel to convey more water. And finally, by placing the levees close to the river's edge, the river flow was confined, speeding its flow, and causing it to erode away the material that had been deposited by hydraulic mining, further increasing the river's channel capacity.

The levees continue to confine the flow into a relatively narrow channel, contributing to erosion and degradation of the river channel. However, most of the sediment deposited in the river channels has been depleted and the Sacramento River is sediment-starved. As a result, the energy of the flow contributes to erosion of riverbanks and levees along the river. Channel erosion and degradation could have detrimental effects on the levees by undercutting the foundation materials, particularly if the riverbank materials are easily erodible. The erosion of the riverbank adjacent to levee embankments may also increase underseepage through the foundation soils. It can also reduce the stability of the levee slopes by undermining the levee embankment and eroding the levees themselves. Significant erosion can lead to the failure of the levee.

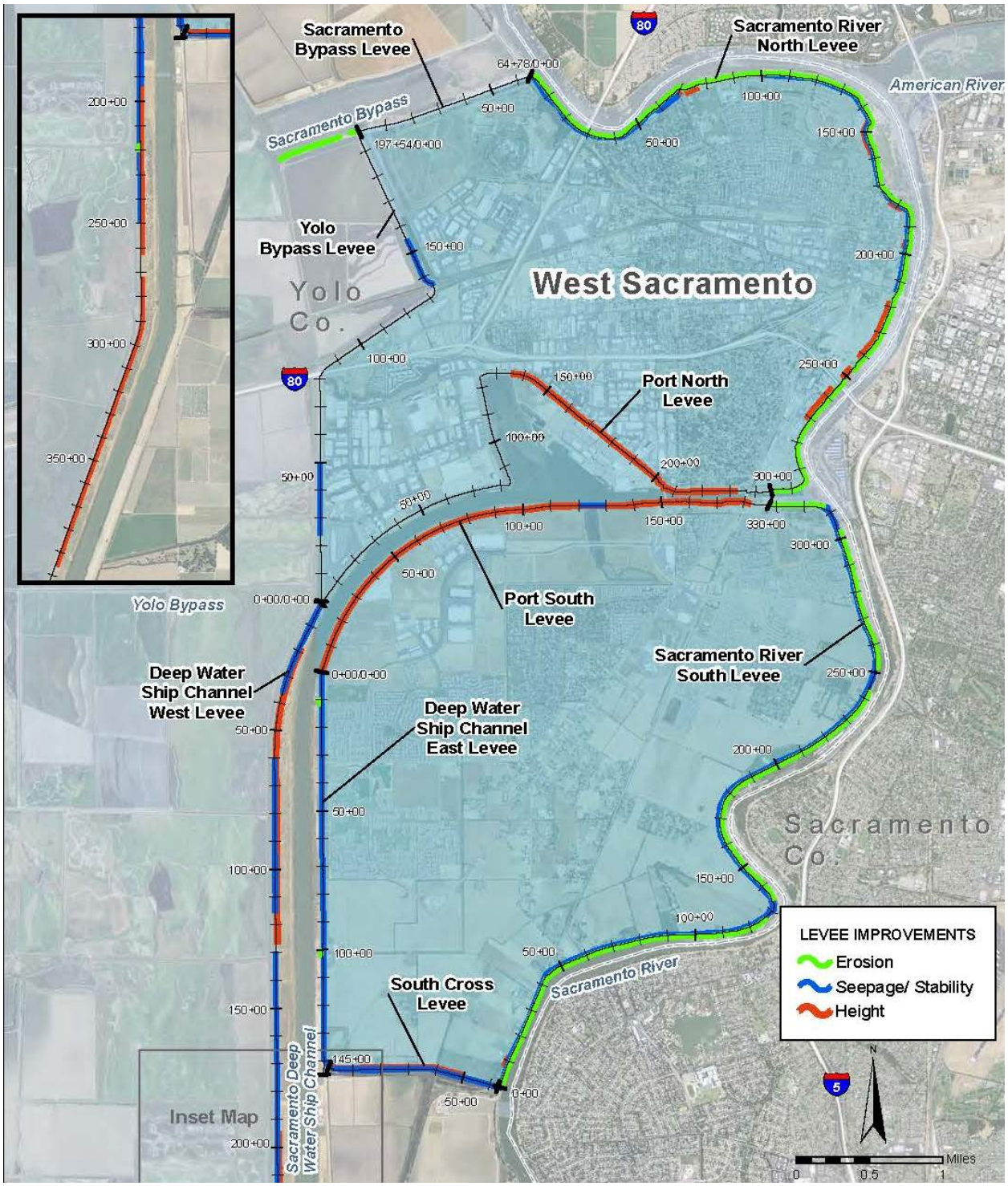

Figure 2-2: Locations of needed levee improvements.

Empirical evidence and prototype experience indicate that stream bank erosion in the area can be both gradual and episodic. Some erosion occurs almost every year, with major losses occurring with large flood events. A sedimentation analysis was not completed for this study. However, a sediment study of the Sacramento River from Colusa to Freeport is near completion under the Sacramento River Bank Protection Project (NHC, 2012). The main objective of this sediment study was to investigate sediment transport processes and geomorphic trends along the lower Sacramento River and its major tributaries and distributaries. A HEC-6T sediment transport model was developed for the study reaches of the Sacramento, Feather, and American Rivers to estimate degradational or aggradational trends over the next 50 and 100 years.

For the entire study reach of the Sacramento River (RM 79-46), the average bed elevation decreases by 0.02 ft for the 50-year simulation period and decreases by 0.10 ft for the 100-year simulation period. Despite a few significant (on the order of feet) localized vertical adjustments in the channel geometry (mostly associated with infilling of deep pools and scour of elevated riffles), the study reach of the Sacramento River appears to be generally stable, with a slight degradational trend.

Levee Overtopping

Although the levees in the West Sacramento area have not been overtopped in recent flood events, several floods have come close. However, it is possible that a large enough flood event could occur that would overtop the West Sacramento levees. Because the West Sacramento area levees were not originally built to modern engineering standards, levee overtopping would potentially lead to failure of the levee and cause devastating flooding.

The State has established a standard for urban flood protection in California. This standard applies to cities with populations greater than 10,000. This standard would require levees to have a top elevation equal to the mean 0.5% (1/200) ACE water surface profile, plus three feet of freeboard, plus an allowance for wave run-up, plus one foot to account for climate change. Portions of the Sacramento area levees do not meet this standard.

Vegetation and Encroachments

In many locations in the study area, vegetation and encroachments exist on or near the levees. Various types of vegetation exist on the levees, including native vegetation, landscaping, and gardens. Additionally, many types of encroachments exist on or near these levees. These include houses, utilities, stairs, fences, outbuildings, retaining walls, and swimming pools. These are not isolated cases on the levees, but represent a large-scale, nearly ubiquitous condition. Many of the encroachments were granted permits for construction in the past, while some were built without any prior knowledge or approval from any governing agency.

Most California levees were built close to the stream channel in order accelerate stream flow and the scour of hydraulic mining debris. As a result, trees and shrubs on levees now provide the only remaining waterside habitat for many sensitive wildlife species. In some cases, brush and trees on the levee slopes are the last remnants of the riparian forest that historically extended along the valley floor adjacent to the Sacramento River. Extensive destruction of California's Central Valley riparian forests has occurred due to agricultural and urban development in the last 150 years, leading to an 89% decline in riparian forest habitat abundance in the Central Valley.

Vegetation on and adjacent to levees is problematic because:

- Levee visibility is reduced, making it challenging for maintenance and inspection crews to identify problems in levee integrity such as the presence of burrowing animals, cracks, slumping, and seepage.
- Levee accessibility is reduced as vegetation can block access to the levee crest or landside of the levee for flood fighting and maintenance access purposes.
- Through-levee seepage can be initiated by the roots of riparian vegetation, which can also impair the general integrity of the levee.
- Wind throw of trees can produce large holes, gaps or weak spots in levees, displacing relatively large amounts of earth. This can affect the strength of the levee, or if on the waterside, increase the risk of scour.
- Slope stability is impaired when the roots of trees or other riparian vegetation accelerate erosion problems along levee toes, a particularly critical part of the levee in terms of slope stability.
- Burrowing animals are drawn to levees by riparian vegetation. Established burrows are detrimental to levees because they weaken levees and provide conduits for seepage and piping. Heavy vegetation may also reduce the visibility of burrows.

In April 2009, the Corps issued Engineering Technical Letter (ETL) 1110-2-571, Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures; this ETL expired in April 2014. Subsequently in April 2014, ETL 1110-2-583, Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures was issued. This guidance calls for the removal of wild growth, trees, and other vegetation, which might impair levee integrity or flood-fighting access in order to reduce the risk of flood damage. In certain instances, to further enhance environmental values or to meet State or Federal laws and/or regulations, the local sponsor may request a variance from the standard vegetation guidelines set forth in this ETL. (Note – WRRDA 2014 (PL 113-121) contains language that will affect the guidelines presented in ETL 1110-2-583; implementation guidance is expected within one year).

ETL 1110-2-583 requires that a reliable corridor of access to, and along, levees, floodwalls, embankment dams, and appurtenant structures be maintained. This corridor must be free of obstructions to assure adequate access by personnel and equipment for surveillance, inspection, maintenance, monitoring, and flood-fighting. In the case of flood fighting, this access corridor must also provide the unobstructed space needed for the construction of temporary flood-control structures. Access is typically by four-wheel-drive vehicle, but for some purposes, such as maintenance and flood-fighting, access is required for larger equipment, such as tractors, bulldozers, dump trucks, and helicopters.

In March 2009, the Central Valley Flood System Improvement Framework (Framework) was completed based on an earlier draft of the ETL. The Framework was developed collaboratively by the California Levees Roundtable, a partnership of Federal, State, and local agencies formed in 2007 to address vegetation issues affecting the State-Federal levee system in California's Central Valley. The Roundtable included senior level officials representing the Corps Headquarters, South Pacific Division, and the Sacramento District; the CVFPB; DWR; National Marine Fisheries Service (NMFS); USFWS; CDFG; FEMA; Reclamation District (RD) No. 2068; and SAFCA. The Roundtable agencies agreed to work together to draft a phased system-wide levee vegetation plan, with short and long-term elements. The vegetation plan transitioned into the recently adopted Framework. The Roundtable recognized that vegetation management is only one of many issues that threaten levees and broadened its scope to address many threats to levee integrity. The Framework was an interim document that expired in 2012.

The Central Valley Flood Protection Plan (CVFPP) was finalized in June 2012. The Levee Vegetation Management Strategy established in the CVFPP replaces the Framework and is summarized below:

- The State proposes adherence to USACE guidance for new levee construction, such as a setback levee, bypass, or ring levees located away from the river channel.

- Vegetation present on the system, except for the lower waterside slope, will be trimmed to provide for visibility and access, as originally defined in the Framework. Vegetation that was introduced, allowed, required as mitigation, or endorsed by a previous USACE action as necessary to comply with environmental requirements, and or was present at project completion when the non federal sponsor assumed O&M responsibilities, will not be removed (unless changed conditions cause such vegetation to pose an unacceptable threat or it creates a visibility problem within the vegetation management zone).

- Vegetation present on the system will be evaluated, based on accepted engineering practice, and as part of the routine O&M responsibilities, trees and other woody vegetation will be monitored to identify changed conditions that could pose an unacceptable threat.

- DWR will implement and will advise local maintainers in their implementation of an adaptive vegetation management strategy that will include a long term vegetation life cycle management plan. This will allow existing trees and other vegetation to live out their normal life cycles but will result in the gradual elimination of trees from the vegetation management area zone through removal. Throughout their lives and after their deaths the trees will be periodically evaluated and if found to pose an unacceptable threat to levee integrity will be removed in coordination with the resource agencies.

  The CVFPP states that long term compatibility of the CVFPP vegetation strategy and USACE vegetation policy is potentially achievable when framed in the following context:

  "Through long term implementation of life-cycle management on the landside slope, crown, and upper waterside slope of the State Plan of Flood Control levees, the CVFPP levee vegetation management strategy will gradually (over a period of decades) result in levees clear of woody vegetation, consistent with USACE vegetation policy, except for lower waterside vegetation – which is mostly the same part of the levee where USACE has indicated that variances are appropriate."

Levee Problems at Specific Locations

Levee problems occur at many locations within the project area. It is convenient to describe the specific problems of the West Sacramento area by organizing the discussion around the basins and the reaches associated with the various bodies of water involved. Flooding problems and levee performance issues are found in both the North and South Basins. A description of the levee performance issue by each reach per basin is provided below. Index points are presented in Figure 2-3.

North Basin

Sacramento River North - This reach is highly urbanized with a residential street, a county road, and railroad tracks located along portions of the levee crest. The levee in this reach has issues with seepage, stability, erosion, over-topping, and vegetation. Two index points (1 and 2) were designated in this reach. The geotechnical levee performance curves for index points 1 and 2 indicate that this reach has a probability of failure of 95.6 and 99.4 percent, respectively, with water up to the top of the levee.

Yolo Bypass Levee - This reach is predominantly urbanized with industrial and commercial properties adjacent to the levee; The CHP Academy is located east of the levee in the northern section. The levee in this reach has issues with seepage and stability. Index point 3 was designated in this reach. The geotechnical levee performance curves indicate that this reach has a probability of failure of 99.9 percent with water up to the top of the levee.

Port North Area – The reach includes industrial, commercial and residential properties and includes the Port of West Sacramento. The eastern portion of this reach includes the decommissioned Stone Lock. The reach has issues with overtopping and vegetation.

Sacramento Bypass Levee - This reach is the south levee of the Sacramento Bypass; the California Highway Patrol Academy is located immediately south of the levee. The levee in this reach has issues with seepage, stability, and erosion. Index point 4 was designated in this reach. The geotechnical levee performance curves indicate that this reach has a probability of failure of 80.9 percent with water up to the top of the levee.

South Basin

Sacramento River South - This reach includes residential and rural properties. A county road runs along the levee crest. The levee in this reach has issues with seepage, stability, erosion, and vegetation. Two index points (5 and 6) were designated in this reach. The geotechnical levee performance curves for index points 5 and 6 indicate that this reach has a probability of failure of 69.6 and 42.6 percent, respectively, with water up to the top of the levee.

South Cross Levee - This levee is along the southern portion of the project area and connects the Sacramento River South Levee and the Deep Water Ship Channel East levee. Residential and rural properties are included in this reach. The levee in this reach has issues with seepage, stability, and overtopping.

Deep Water Ship Channel East Levee -This reach is located along the east side of the DWSC. This reach contains residential and rural properties. The levee in this reach has issues with seepage, stability, and erosion.

Deep Water Ship Channel West Levee - This reach is located on the west side of the DWSC. The levee provides flood risk management for West Sacramento from the Yolo Bypass. The levee in this reach has issues with seepage, overtopping, and erosion. Index point 7 was designated in this reach. The geotechnical levee performance curve indicates that this reach has a probability of failure of 99.2 percent with water up to the top of the levee.

South Port Levee - This reach includes industrial, commercial and residential properties. The reach has issues with underseepage, levee overtopping, and vegetation. Index point 8 was designated in this reach. The geotechnical levee performance curve indicates that this reach has a probability of failure of 23.1 percent with water up to the top of the levee.

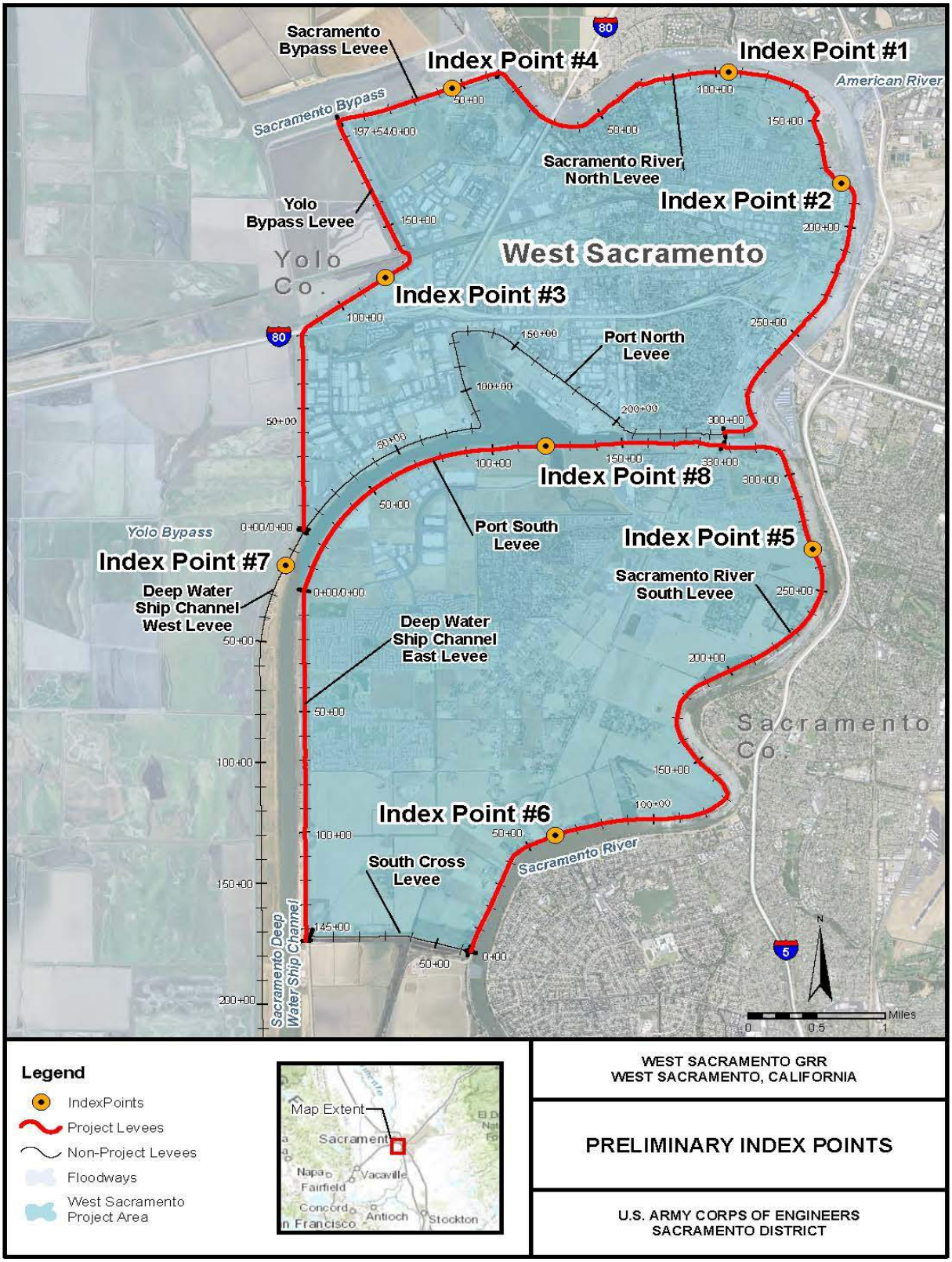

Figure 2-3: Locations of Index Points.

2.3.2 Problem – The Consequences of Flooding in the Study Area are Catastrophic

If flooding were to occur within the study area the consequences would be catastrophic. The flooding would rapidly inundate an urbanized area with minimal warning or evacuation time. The study area includes two major highways and a railroad line that would be impassable should a flood occur. The effects of flooding in the study area could be felt on a regional, state, and national level.

Population at Risk

As depicted in Figure 2-1 a significant portion of the City of West Sacramento, both the north and south basin, is inundated from a hypothetical breach along the Sacramento River levee in the north basin beginning with the 4% (1/25) ACE event. The 2% (1/50), 1% (1/100), 0.5% (1/200), and 0.2% (1/500) ACE events result in greater inundated area and greater flood depths. Virtually the entire population of West Sacramento, 48,000, would be at risk as a result of a levee breach during a 4% (1/25) ACE event. Flood depths for a 4% (1/25) ACE event could be up to 10 feet.

Life Safety

Life safety information was taken from the USACE Levee Screening Tool (LST) for use in this study. The Levee Screening Tool supports the levee screening process by facilitating a preliminary assessment of the general condition and associated risks of levees in support of the USACE Levee Safety Program. (RMC, 2011)

The LST determines a screening risk index that considers routine inspection results and ratings coupled with a review and evaluation of historical performance data, as-built drawings, economic and life loss consequences, historic and current hydraulic and hydrology data, and other data. This helps determine the potential for failure and the consequences of failure. The culmination of the LST process is a screening risk index and risk classification that can be weighed against other screened levee segments in the portfolio.

Life safety can be evaluated using the consequence portion of the Levee Screening Tool (LST). Readily available data and information are used along with limited analysis to assess the potential consequences. Consequence estimates focus on loss of life, but also include population at risk, number of structures, and direct monetary damage estimates to structures. The following is a description of the consequence results:

- **Population at Risk (Day/Night)**. These values represent the computed total number of people that would get wet if they did not evacuate when a levee breach occurred and water inundated the entire leveed area up to the maximum profile elevation of the levee segment being screened.

- **Exposure Weighted Life Loss Estimates**. Computed “average” life loss estimates for each scenario that represent the loss of life caused by breach of the levee based on the movement of people in and out of the leveed area throughout the day.

RMC 2011 – USACE Levee Screening Tool - Risk Management Center, 2011

The overall data for life safety and life loss estimates can be found in Table 2-3. This information comes from a series of Levee Screening Tool Presentations by the Sacramento District. It is important to note that these numbers are still preliminary and subject to change after presented to the Levee Safety Oversight Group (LSOG).

Table 2-3: Life Safety and Life Loss Information (from USACE's Levee Screening Tool)

West Sacramento	
Population at Risk (Day)	50,720
Population at Risk (Night)	48,821
Loss of Life (Day)	124
Loss of Life (Night)	90

Health and Safety

Flooding in urban areas can cause serious health and safety problems for the affected population. The most obvious threat to health and safety is the danger of drowning in flood waters. Swiftly flowing flood waters can easily overcome even good swimmers. If flooding occurs suddenly, people may become trapped in their homes, and drown. Additionally, when people attempt to drive through flood waters, their vehicles can be swept away in as little as 6 inches of water.

Virtually surrounded by water the City of West Sacramento has developed a comprehensive flood warning system and evacuation plan. The City monitors weather conditions and water levels in the Sacramento River to determine the flood warning and alert stages and evacuation triggers of potential flood events. Emergency evacuation routes have been identified throughout the city. Public schools have been identified as temporary care and shelter facilities. The schools will also serve as pickup points for residents without transportation. Residents who have no place to go will be transported to one of the American Red Cross Shelters in Woodland or Sacramento.

In the California Central Valley, the risk of a large flood is seasonal. The majority of rainfall occurs in the October through March rainy season, making the area most vulnerable to winter floods. The temperature range in the rainy months is shown in the Table 2.3.

Table 2.3: Average Temperature Range in the Rainy Season.

Month	Low (°F)	High (°F)
October	50.6	78.2
November	42.8	63.7
December	37.7	53.9
January	38.8	53.8
February	41.9	60.5
March	44.2	64.7

Standing or working in water which is cooler than 75 °F (24 °C) will remove body heat more rapidly than it can be replaced, resulting in hypothermia. Hypothermia (decreased body temperature) develops more slowly than the immediate effects of cold shock. Survival curves show that an adult dressed in average clothing may remain conscious for an hour in 40°F water and perhaps 2-3 hours in 50°F water. Physical activity such as swimming or other struggling in the water increases heat loss, reducing survival time to minutes. Without thermal protection, swimming is not possible and the victim, though conscious, is soon helpless. Without a life jacket, drowning is unavoidable.

During a flood, local water systems may become contaminated, either through the loss of power to a public water supply or if a private well is flooded. A variety of sources of contamination include animal and human waste, dead and decaying animals, or chemicals accidentally released during flooding. Water supply contamination can lead to a number of waterborne illnesses. Food exposed to floodwaters or stored without refrigeration during extended loss of power during flooding can lead to foodborne illnesses.

Additionally, adverse water quality effects due to levee failure in which flooding occurs in urban, suburban, and agricultural areas would likely be considerable and could include bacterial and chemical (e.g., pesticides, petroleum products, heavy metals) contamination. Indirect effects to water quality from flooding could include damage to water supply systems, damage to sewage and sewer systems, insufficient supply of drinking water and water for washing, increase in waterborne infections, and overflow of toxic waste sites. Because of the uncertainty of such an event and its magnitude, the effects are unpredictable and therefore a precise determination of significance is considered too speculative and cannot be made.

Liquefied petroleum gas tanks and underground storage tanks can break away from their supports and float in flood waters, causing hazards from their released contents. Floods can damage fire protection systems, delay response times of emergency responders, and disrupt water distribution systems. All of these factors lead to increased danger from fires.

Sediment and soil deposited by floodwaters may be contaminated if there was disruption of septic systems, sewage disposal systems, water treatment systems, agricultural animal waste or fertilizers, dislodged industrial chemicals, or spilled fuel oil, gasoline or diesel fuel. Dust from the dried soil could pose health hazards; special precautions would be necessary during removal of the soil.

Wild animals and insects can become displaced from their natural habitats during flooding. Encounters with raccoons, possums, and squirrels can result in bites that require medical attention or may lead to rabies. Dead animals can sometimes be found in homes after a flood, leading to odor and excessive flies. These carcasses can serve as reservoirs for disease-causing organisms. Bees, wasps, and hornets may have their nests disturbed by wind, rain, or flood waters. These insects can be very aggressive. Snakes will also have their nests disturbed by flooding, and are prone to seek shelter in abandoned homes, vehicles, furniture and equipment.

Buildings damaged by flooding can become contaminated with mold and fungi if they do not dry out quickly enough. These molds and fungi can pose serious health risks.

Workers who respond to flooded areas are at the most risk of illness, injury, or death. These workers include utility workers, law enforcement, emergency medical personnel, firefighters, and military and government personnel. According to the Occupational Safety and Health Administration, some of the hazards associated with working in flooded or recently flooded areas include:

- Electrical hazards
- Carbon monoxide
- Burns from fires caused by energized line contact or equipment failure
- Structural instability
- Hazardous materials
- Musculoskeletal hazards
- Heavy equipment operation
- Drowning
- Hypothermia
- Falls from heights
- Fire
- Exhaustion
- Dehydration
- Biohazards

Evacuation Routes

With much of the area within the 100-year flood plain, the City of West Sacramento has developed a comprehensive flood warning system and evacuation plan. The City of West Sacramento has a FEMA Community Rating System (CRS) Class 8 rating on a scale of 1-10. This rating is based on Public Information, Mapping and Regulation, Flood Damage Reduction, and Flood Preparedness. The City of West Sacramento utilizes stream gauges in the Sacramento River to determine the Flood Warning and Alert stages.

The City of West Sacramento is almost surrounded by potential floodways. As a result, there are limited evacuation routes, most of which lead to areas that could also be potentially inundated during a large flood event. Evacuation routes for West Sacramento include Interstate 80 to the east and west, Highway 50 to the east, and Jefferson Boulevard, which provides evacuation routes from the South Basin north into the North Basin or to the south.

Review of the Flood Emergency Preparedness Mapping document prepared for the City of West Sacramento by Wood Rogers indicate that a levee failure along the Sacramento River south of the Sacramento Bypass would result in the northern portion of West Sacramento having an evacuation time of less than 24 hours. A levee failure on the Sacramento River South levee near the northern portion of Southport would isolate the majority of the Southport area from the primary evacuation route in less than 8 hours. Based on the limited evacuation routes and the limited evacuation time there is a significant risk to life and safety to the residents of West Sacramento.

Evacuation preparation can be made days in advance for predictable rain events. For example a 0.2% Annual Chance Exceedance (ACE)(1/500 year event) rain storm would be identified by meteorologists and residents could be given notice approximately 7 days in advance. As a significant rain event nears, warning and evacuation efforts would be increased and reiterated. This would allow time for evacuation of immobile residents and other people with special evacuation needs (hospitals, rest homes, jails, elderly individuals, schools) via the established routes.

Flood Damages

Damageable property in the West Sacramento area flood plains consists of commercial, industrial, residential, public buildings, and autos. Many businesses would be forced to close, at least temporarily, during flooding and cleanup afterward, resulting in lost revenues and wages. Physical damages caused by inundation losses or flood fighting preparation costs are the main types of flood damages within the flood plain. Physical damages include damages to, or loss of, buildings and their contents, raw materials, goods in process, and finished products awaiting distribution. Other physical damages include damages to lot improvements such as damages to roads, utilities and bridges, and cleanup costs. Additional costs are incurred during flood emergencies for evacuation and reoccupation, flood fighting, and disaster relief. Emergency cleanup costs are not included at this time but won't change plan selection. Loss of life or impairment of health and living conditions are intangible damages that cannot be evaluated in monetary terms and have not been included in this analysis.

As described in the preceding section the project area is subject to flooding from several sources that can result in inundation of a substantial portion of the project area. Without Project damages are based on damages due to levee failure to residential structures and contents, non-residential structures and contents (commercial, industrial, and public) and automobiles. Other damage/benefits categories, including emergency costs, will be addressed in the Final West Sacramento GRR.

The North Basin of West Sacramento is very urbanized with commercial, industrial, residential, and public buildings. Interstate Highway 80 and U.S. Highway 50 traverse the area. The Union Pacific Railroad main line also traverses the North Basin. Other facilities include the California Highway Patrol Academy, situated on a 457-acre site just south of the Sacramento Bypass, U.S. Postal Service Regional Distribution Center, the Regional Department of Water Resources flood fight facility, and the Port of West Sacramento. The South Basin of West Sacramento contains urban (commercial, industrial, residential, and public buildings) and rural farm lands.

Figure 2-4: The Sacramento River Facing Downstream toward the I Street Bridge

Table 2-5: Number of Structures by Category in 0.2% Exceedance Probability Floodplain.

Structure Count By Damage Category	
Damage Category	**Structure Count**
Commercial	485
Industrial	484
Public	99
Residential	17,419
TOTAL	**18,487**

Table 2-6: Total Value of Damageable Property – Structures and Contents (October 2013 Price Level).

CATEGORY	VALUE OF DAMAGEABLE PROPERTY ($ THOUSANDS)		
	Structures	Contents	Total
Commercial	406,000	284,000	690,000
Industrial	695,000	556,000	1,251,000
Public	159,000	72,000	231,000
Residential	1,692,000	846,000	2,538,000
TOTAL	**2,952,000**	**1,758,000**	**4,710,000**

Annual Chance Exceedance (ACE) event damages, sometimes referred to as single event damages were computed in HEC-FDA. Single event damages assume that a breach from a specific probability event occurs; it does not take into account the likelihood of this event actually happening. Single event damages are useful in that they show the magnitude of consequences; within a particular consequence area, should a specific flood event occur in that area. Table 2-7 shows the damages that may occur for a range of events within the West Sacramento study area; damages are displayed for each index point. These damages include automobiles, structures, and contents.

Table 2-7: Annual Chance Exceedance (ACE) Event Damages by Index Point.

Index Point/Reach	ACE EVENT DAMAGES (IN $1,000S, OCTOBER 2013 PRICE LEVEL						
	50%	10%	4%	2%	1%	0.5%	0.2%
1	1,049,353	1,455,924	2,294,502	2,600,304	3,267,255	3,509,772	3,625,157
2	1,217,337	2,268,607	2,611,998	2,828,239	3,440,803	3,597,358	2,685,232
3	1,470,145	3,239,104	3,580,671	3,654,576	3,724,909	3,770,528	3,820,014
4	109,940	2,668,044	3,345,850	3,529,505	3,675,331	3,735,549	3,804,217
5	1,252,397	3,111,848	3,257,936	3,349,896	3,563,669	3,588,213	3,643,764
6	879,527	1,290,274	2,136,922	2,673,978	3,285,973	3,419,807	3,483,323
7	0	532,996	2,223,259	2,842,560	3,276,901	3,441,088	3,532,101
8	0	0	0	0	0	254,088	1,678,117

Expected annual damages (EAD) is the metric used to describe the consequences of flooding on an annual basis considering a full range of flood events – from high frequency/small events to low frequency/large events over a long time horizon. Table 2-8 displays the EAD results for each index point and by major damage category. The EAD results for Index Point 3 on the Yolo Bypass (highlighted in Table 2-8) are higher than from any other water source (Sacramento River, Sacramento Bypass, and Deep Water Ship Channel). Estimated annual damages associated with a levee breach along the Yolo Bypass are estimated to be approximately $288 million.

Table 2-8: Expected Annual Damages (EAD) by Index Point (October 2013 Price Level).

Index Point/Reach	WITHOUT PROJECT EXPECTED ANNUAL DAMAGES (EAD) (IN $1,000S, OCTOBER 2013 PRICE LEVEL, 50 YEAR PERIOD OF ANALYSIS)					
	AUTO	COM	IND	PUB	RES	TOTAL
1	3,756	17,666	35,822	5,191	34,253	96,960
2	1,147	3,943	7,772	1,264	13,788	27,914
3	11,733	41,299	82,815	12,850	139,565	288,263
4	10	38	72	12	123	255
5	2,985	9,558	19,487	2,987	36,993	72,012
6	2,564	7,008	13,956	1,940	42,582	58,050
7	7,093	19,551	41,001	5,963	93,541	167,150
8	443	2,005	3,883	525	4,172	11,028

Emergency Costs

During and after a flood event, the public costs for emergency services, evacuation, securing infrastructure, and clean-up can be substantial. For example, considering the costs associated with evacuation, there are significant costs (and therefore, economic losses) related to temporary movement of a population away from a flood-impacted area. Evacuation and its associated costs can take place before, during, or after a flood event.

In order to simulate the economic impact of these emergency costs, a series of economic models was developed. Thirteen distinct models were developed for thirteen categories of emergency costs. The basis for the data to be used in the models was an expert elicitation. The thirteen categories of emergency costs are as follows:

- Evacuation
- Debris
- Education
- Medical
- Police and Fire
- Incarceration
- Legislative
- Judicial
- Telecommunications
- Natural Gas Supply
- Water Supply Utility
- Wastewater Utility
- Electrical Utility

The complete estimates of emergency costs for these thirteen categories will be detailed in the Economics Appendix of the final report.

Critical Infrastructure

A significant amount of critical infrastructure is located within the study area. Critical infrastructure is a term used by governments to describe assets that are essential for the functioning of a society and economy. Most commonly associated with the term are facilities for:

- Electricity generation, transmission and distribution.
- Gas production, transport and distribution.
- Oil and oil products production, transport and distribution.
- Telecommunication.

- Water supply and wastewater.
- Agriculture, food production and distribution.
- Heating.
- Public health (hospitals, ambulances).
- Transportation systems (fuel supply, railway network, airports, harbors, inland shipping).
- Financial services (banking, clearing).
- Security services (police, military).

The following lists include some of the critical infrastructure facilities in the study area:

Essential Services

- Regional USPS mail processing center,
- USACE Bryte Yard Facility
- The regional Department of Water Resources Flood Fight facility
- The California Highway Patrol Academy (a key facility in state emergencies)
- West Sacramento City Hall
- Police Stations (2)
- Fire Stations (5)
- Bryte Bend Water Treatment Plant

At Risk Population Facilities

- St. Claires Home for the Elderly
- River Bend Nursing Facility

In addition to these facilities the following transportation systems are also located in the study area:

- Union Pacific Main Railroad Line
- AMTRAK
- Interstate 80
- U.S. Highway 50
- The Port of West Sacramento

Impacts to critical infrastructure from a flood event would have significant local, regional, and statewide impacts since several significant transportation routes, including Interstate 80, U.S. Highway 50, and the Union Pacific Rail Road, pass through West Sacramento. The proximity of West Sacramento to the California State Capitol Building and associated state functions further exacerbates the potential impact of a flood event.

Interstate 80 and U.S. Highway 50 are important highways that link the San Francisco Bay Area and Sacramento to points to the east. Because the project area could potentially have deep flooding the impacts to travel could be significant. Flooding impacts to these highways would have significant impacts to the travelers and freight moving through the area.

A major corridor of the Union Pacific Rail Road (UPRR) passes through West Sacramento. The railroad moves freight to and from the San Francisco Bay and Sacramento areas to points to the east. This includes freight from overseas brought into the Port of Oakland. Disruption of this important transportation corridor could have significant impacts. AMTRAK passenger trains and Sacramento to San Francisco commuter trains also utilize the UPRR corridor.

Table 2-9: Critical Infrastructure at Risk in West Sacramento.

Critical Infrastructure at Risk	
Essential Services Facilities	**13**
At Risk Population Facilities	**10**

2.4 PLANNING OPPORTUNITIES

There is an opportunity to increase public awareness of the flood risk and ongoing residual risk and there are opportunities to incorporate waterfront recreation with the levee system.

2.5 PLANNING OBJECTIVES

The Federal objective is a general statement and, as indicated above, is not specific enough for direct use in plan formulation. The water and related land resource problems and opportunities identified in this study are refined and stated as specific planning objectives to provide focus for the formulation of alternatives. These planning objectives reflect the problems and opportunities and represent desired positive changes in the without-project conditions. The planning objectives, which are applicable over a 50-year planning horizon, are specified as follows:

- Reduce the probability of flooding in the study area as measured by a reduction in the Annual Exceedance Probability (AEP).
- Reduce the consequences of flooding in the study area as measured by the reduction in Expected Annual Damages (EAD), the population at risk, life safety concerns and availability of evacuation routes.
- Reduce the impacts to critical infrastructure in the study area measured by the reduction in damages and availability of emergency facilities during flood events
- Encourage wise use of the flood plain measured by the strength of the Floodplain Management plan, and ability to direct flood flows away from urban areas to bypass floodplains.
- Educate the public about ongoing residual risk measured by increased public awareness as result of annual notifications of residual flood risk.

2.6 PLANNING CONSTRAINTS

Unlike planning objectives that represent desired positive changes, planning constraints limit plan formulation. No planning constraints have been identified for this study.

2.7 LOCAL CONCERNS

Local concerns represent desired positive changes and/or restrictions that are important to various stakeholders, but cannot be classified as either an objective or a constraint. While not incorporated directly into the plan formulation or analysis, these concerns and goals can help compare plans that have similar outputs. These concerns are:

1. If feasible, plans should achieve the minimal 200-year urban level of protection standard as defined by the State of California, to the extent that is in the Federal interest.
2. Plans should strive for no or minimal loss of riparian vegetation. In some areas, the trees and shrubs on or near levees provide the only waterside habitat that remains for many sensitive wildlife species. According to some estimates, riparian forests in the Central Valley have

declined by as much as 98 percent during the last 150 years. The remaining trees provide important environmental, recreational, and cultural benefits.

3. Plans must be maintainable and should minimize costs for operation, maintenance, repair, rehabilitation, and replacement.

2.8 FUTURE WITHOUT-PROJECT CONDITION

The without-project condition is the most likely condition to exist in the future in the absence of a proposed water resource project. Proper definition and forecast of the future without project condition are critical to the success of the planning process. The future without-project condition constitutes the benchmark against which plans are evaluated. Other plans that have been adopted for the planning area and other current planning efforts with high potential for implementation or adoption shall be considered as part of the forecasted without project condition. The base year is 2020 and the period of analysis is 50 years.

The following general assumptions have been made in regard to the without-project condition for this study:

- In 2017 the Joint Federal Project auxiliary spillway with six submerged tainter gates at Folsom Dam will be completed and a new water control manual will be adopted.
- In 2018 the 3.5 foot Folsom Dam Mini-Raise will be completed.
- The Levee Vegetation Management Strategy presented in the Central Valley Flood Protection Plan will be in place.
- The WSLIP has constructed the levee improvements at the CHP Academy and the Rivers EIP sites. These sites received Section 408 approval for modifying federal levees but did not get approval for Section 104 crediting. At this time improvements at these sites are considered part of the without project condition.
- It is anticipated that in the near future FEMA will issue updated floodplain maps for West Sacramento. It is expected that the new FEMA maps will show portions of the City within the 100-year floodplain. Due to this new mapping within the floodplain, development in the City will be constrained until a project is put in place that provides protection from the 100-year event.

The implementation of the projects at Folsom Dam, the changing levee vegetation framework, and other studies in the area all must be considered in establishing the future without-project condition. Additionally, the ongoing efforts toward development of a comprehensive plan of flood risk management in the Central Valley make it all the more important that the West Sacramento Project not adversely affect the development of the comprehensive CVFPP. It is assumed that the West Sacramento and American River Common Features Project would be an early implementation project of the overall State plan.

In the absence of a project to address flood risk in West Sacramento most of the city would remain in the 100-year flood plain. Areas in the flood plain would remain exposed to a substantial long term risk of flooding. Significant damages to structures would be expected, as well as loss of life, injuries, illnesses, and other health and safety concerns. Flooding in the West Sacramento area could trigger an uncontrolled release of hazardous and toxic contaminants into the waterways surrounding West Sacramento. Transportation through the area would be severely hampered by a major flood. Critical

infrastructure could be rendered nonfunctional for an extended period of time after a flood. Impacts to critical infrastructure would have a significant impact on the ability of the community to react to and recover from a significant flood event. Emergency costs associated with evacuation, flood fighting, fire and police, and government disruptions would occur. Debris cleanup would be a substantial undertaking. Wildlife populations occupying these areas would be adversely affected by flooding.

2.8.1 Floodplains

At the present time, West Sacramento is not mapped in the FEMA Regulatory (100-year) floodplain. Based on analysis conducted as part of this investigation as well as other investigations by the State of California, the levee system for the West Sacramento area has a high probability of failure in multiple locations. FEMA may remap these basins into the regulatory floodplain which would affect flood insurance rates and requirements.

2.8.2 Sacramento

The American River Common Features GRR is evaluating recommendations for various improvements to the levees along the east side of the Sacramento River, directly across from the West Sacramento study area. However, for evaluation purposes, these improvements are not included in the future without project conditions assumptions since these improvements are not authorized .

2.8.3 Future Development in Floodplain

The floodplain for the West Sacramento North Basin is mostly developed. There are plans for various infill projects and development of the Bridge District, a former industrial area located between the Tower and US Highway 50 Bridges on the eastern side of the North Basin. The Bridge District will include commercial and residential development.

The South Basin (Southport) of West Sacramento is comprised of a total of 7,120 acres. The City of West Sacramento, based on the understanding that the City was outside the 100-year floodplain, has developed plans for future development in Southport. The Southport Framework Plan includes creating four pedestrian – oriented villages. Each village contains its own community services, shops, schools, parks, and residential neighborhood. The villages will be connected through a roadway system as well as pedestrian/bike trails. Various densities of residential development, ranging from rural estates to high density, are planned. Some areas of the southern portion of Southport will remain agricultural. Residential and commercial development has occurred in the northern and central portion of the basin. Several other portions of Southport have undergone initial development in the form of horizontal construction, including laying out utilities, such as water and sewer lines. The Sacramento Area Council of Governments in 2007 predicted that the population of West Sacramento would increase by 64% from 2007 to 2030, with a population of 73,500 in 2030.

2.8.4 Consequences

In summary, a flood in West Sacramento would cause massive damages. Flooding in the West Sacramento area, could be very deep leading to significant damages to the $4.53 billion worth of damageable property in the study area. Single-event damages for the 1% (1/100) ACE flood are anticipated to exceed $3.6 billion. Significant loss of life would be expected, as well as injuries, illnesses, and other health and safety problems. Transportation through the area would be severely hampered by a major flood. Critical infrastructure would be rendered nonfunctional for an extended period of time after a flood. Power and water supply could be interrupted for a substantial period of time. Emergency

costs associated with evacuation, flood fighting, fire and police, and government disruptions would occur. After floodwaters have receded, debris cleanup would be a substantial undertaking.

2.8.5 Vegetation

As part of the CVFPP the State of California has developed a Levee Vegetation Management Strategy, a flexible and adaptive integrated vegetation management strategy that meets public safety goals and protects and enhances sensitive habitats within the Central Valley. This study assumes that the Levee Vegetation Management Strategy presented in CVFPP will be a part of the future without-project condition, forming the basis for the formulation of modifications to the Federal project that may be required to address the new requirements of the Corps ETL. (Note – WRRDA 2014 (PL 113-121) contains language that will affect the guidelines presented in ETL 1110-2-583; implementation guidance is expected within one year).

The Levee Vegetation Management Strategy established in the CVFPP is summarized below:

- The State proposes adherence to USACE guidance for new levee construction, such as a setback levee, bypass, or ring levees located away from the river channel.

- Vegetation present on the system, except for the lower waterside slope, will be trimmed to provide for visibility and access, as originally defined in the Framework.

- Vegetation present on the system will be evaluated, based on accepted engineering practice, and as part of the routine O&M responsibilities, trees and other woody vegetation will be monitored to identify changed conditions that could pose an unacceptable threat.

- DWR will implement and will advise local maintainers in their implementation of an adaptive vegetation management strategy that will include a long term vegetation life cycle management plan. This will allow existing trees and other vegetation to live out their normal life cycles but will result in the gradual elimination of trees from the vegetation management area zone through removal. Throughout their lives and after their deaths the trees will be periodically evaluated and if found to pose an unacceptable threat to levee integrity will be removed in coordination with the resource agencies. This strategy, will gradually, over a period of several decades, result in levees that are clear of woody vegetation, consistent with the Corps ETL, except for vegetation on the lower waterside slope.

This study assumes that the Levee Vegetation Management Strategy presented in CVFPP will be a part of the future without-project condition, forming the basis for the formulation of modifications to the Federal project that may be required to address the new requirements of the Corps ETL For the future without-project condition, the expectation is that the CVFPP Levee Vegetation Management Strategy will slowly bring levees in compliance with the ETL, with the exception of vegetation on the lower waterside slope. For the purposes of formulating a project, the ETL will be taken into consideration, and its requirements factored into any alternatives.

3 - ALTERNATIVES

This chapter describes the formulation of alternative plans to address the planning objectives identified in Section 2.17:

The planning objectives, which are applicable over a 50 year planning horizon, are specified as follows:

- Reduce the probability of flooding in the study area measured by a reduction in the Annual Exceedance Probability.
- Reduce the consequences of flooding in the study area as measured by the reduction in Expected Annual Damages, population-at-risk, life safety concerns, and availability of evacuation routes.
- Reduce the impacts to critical infrastructure due to flooding in the study area measured by the reduction in damages to and availability of emergency and other critical facilities during flood events.
- Encourage wise use of the flood plain, measured by the strength of the Floodplain Management plan and other city land use and development policies, and minimize both the monetary and non-monetary aspects related to the probability and consequences of flooding.
- Educate the public about ongoing residual risk measured by increased public awareness as a result of annual notifications of residual flood risk and an increase in the percent insured.

In this chapter, management measures (individual actions that can be taken) to address these planning objectives are described and screened for completeness, efficiency, effectiveness, acceptability and implementability. Alternative plans are then formulated based on combinations of retained measures.

3.1 PLAN FORMULATION RATIONALE

A wide variety of management measures were developed to address the planning objectives. These measures were evaluated and screened based on completeness, efficiency, effectiveness, acceptability, and implementability. Formulation strategies were then developed to combine these measures into alternative plans that address various combinations of the planning objectives while avoiding identified planning constraints. Based upon these strategies, which are discussed in Section 3.11, various combinations of the measures were assembled to form an array of preliminary plans. The preliminary plans were then evaluated, screened, and reformulated, resulting in a final array of alternatives. From the final array of alternatives, a tentatively selected plan is identified.

3.2 MANAGEMENT MEASURES

A management measure is a feature or activity at a site, which addresses one or more of the planning objectives. A wide variety of measures was considered. The measures are listed in Table 3.1 along with the objective each addresses.

Table 3.1: Measures and Objectives

	OBJECTIVE ADDRESSED				
	REDUCE THE PROBABILITY OF FLOODING WITHIN THE STUDY AREA	**REDUCE CONSEQUENCES OF FLOODING WITHIN THE STUDY AREA**	**REDUCE RISK TO CRITICAL INFRASTRUCTURE WITHIN THE STUDY AREA**	**ENCOURAGE WISE USE OF THE FLOODPLAIN**	**EDUCATE THE PUBLIC ABOUT ONGOING RISK**
Measures To Reduce Flood Stages					
Upstream storage on the American River	X		X		
Transitory storage on the Sacramento River	X		X		
Reoperation of Upstream Reservoirs	X		X		
Sacramento Weir and Bypass Improvements	X		X		
I Street Diversion Structure on Sacramento River	X		X		
Yolo Bypass Improvements	X				
Offstream storage on Deer Creek	X		X		
Deep Water Ship Channel Closure Structure[1]	X		X		
Measures to Reduce Levee Seepage and Underseepage					
Seepage Berms	X		X		
Relief Wells	X		X		
Slurry/Cutoff Walls	X		X		
Sheet Pile Walls	X		X		
Removal of Ditches Adjacent to levees	X		X		
New Setback Levee	X		X	X	
Measures to Address Levee Stability					
Widen/Flatten Levee Slopes	X		X		
Stability Berms	X		X		
Full Levee Degrade and Reconstruction	X		X		
New Setback Levee	X		X	X	
Measures to Achieve Urban Levee Level of Protection					
Raise Levees in Place	X		X		
Raise levees with Adjacent Levees	X		X		

	OBJECTIVE ADDRESSED				
	REDUCE THE PROBABILITY OF FLOODING WITHIN THE STUDY AREA	**REDUCE CONSEQUENCES OF FLOODING WITHIN THE STUDY AREA**	**REDUCE RISK TO CRITICAL INFRASTRUCTURE WITHIN THE STUDY AREA**	**ENCOURAGE WISE USE OF THE FLOODPLAIN**	**EDUCATE THE PUBLIC ABOUT ONGOING RISK**
Add Floodwalls to Existing Levees	X		X		
Remove Levees and Construct Floodwalls	X		X		
Construct Partial Floodwalls	X		X		
Construct New Setback Levees	X		X	X	
Measures to Address Erosion					
Waterside Armoring of Levee Slopes (Sac Bank-type repair)	X		X		
Launchable Rock Trench	X		X		
BioEngineering Armoring of Slopes	X		X		
Non-Structural Measures					
Permanent Relocation		X	X	X	
Raising Structures in Place		X	X	X	
Flood Proofing of Existing Structures		X	X	X	
Floodplain Management		X	X	X	X
Providing Floodplain Information to Regulatory Agencies			X	X	X
Annual Publication of Residual Risk			X	X	X
Improve Flood Warning System		X	X	X	
Improve Emergency Evacuation Plans		X	X	X	
Add Evacuation Routes		X	X	X	

1 -The DWSC Closure Structure provides flood risk management for West Sacramento and the Port of West Sacramento by reducing flood stages in the DWSC. Implementation of this alternative would reduce the need to improve the DWSC west levee downstream of the structure, improve the DWSC East levee north of the structure, and improve the Port North and Port South levees.

3.3 MEASURES TO REDUCE FLOOD STAGES

3.3.1 Upstream Storage on the American River

This measure includes construction of a dam on the North Fork of the American River near the town of Auburn. This measure is assumed to be similar in scope to the authorized Auburn Dam project which was designed to be about 650 feet high and impound a reservoir of 2.3 million acre feet. When operated with Folsom Dam downstream, it would provide greater than a 200-year level of flood protection to the Sacramento Metropolitan area. The project would yield about 270,000 acre feet for water supply and 600 gigawatt hours (GWh) annually. This measure would have adverse impacts on environmental resources through the loss of about 500 to over 2,000 acres of oak woodland, chaparral and coniferous forests.

3.3.2 Transitory Storage on the Sacramento River

Transitory storage on the Sacramento River provides some reduction in stage primarily along the Sacramento River to the north of West Sacramento. Three alternative locations were investigated as potential sites for transitory storage (or off-stream storage). These locations are shown in Figure 3-1.

3.3.2.1 Robbins Basin (RD1500)

Floodwaters would be diverted into the basin via an un-gated or gated weir at RM 69.50 on the Sutter Bypass that would be 5,280 feet long. To successfully perform, the basin would be empty at the start of weir flow. To assure that the basin is empty; all levees surrounding the basin would be improved. The target stage for diverting water into the basin would be the minimum elevation of the surrounding existing condition levees, 40.4 feet (NGVD29) for a storage space of approximately 988,000 acre-feet. Exit gates and/or a weir would also be needed to drain the water from the basin after the flood peak. They would be located at the lowest spot in the basin, in the left levee (facing downstream) of the Sacramento River at about RM 85.00, about one mile upstream of the Fremont Weir. The total cost for implementing transitory storage in the Robbins Basin would be $1,066,000,000. These costs include: construction of intake and outtake structures for water to enter and leave the detention basin, costs to improve the perimeter levees around the detention basin to current standards, and costs to acquire real estate easements for water storage and to purchase and/or relocate existing properties in the basins. The stage in the Sacramento River at RM 70 (about halfway between the Cross Canal and American River confluences) would be reduced by up to 2.3 feet for the 0.5% (1/200) ACE event.

3.3.2.2 Nicolaus Basin (RD 1001)

Floodwaters would be diverted into the basin via a gated weir approximately 500 feet long at RM 8.501 on the Feather River. To assure that the basin is empty at the start of weir flow, all levees surrounding the basin would be improved. The target stage for diverting water into the basin would be equal to the minimum elevation of the surrounding existing condition levees, 42.0 feet (NGVD29), for a storage space of 25,000 acre-feet. Exit gates and/or weir would also be needed to drain the water from the basin after the flood peak. The exit gates or weir would be located at the lowest spot in the basin, along the left levee (facing downstream) of the Sacramento River. The total cost for implementing transitory storage in the Nicolaus Basin would be approximately $545,000,000. The stage in the Sacramento River at RM 70 would be reduced by up to 1.8 feet for the 0.5% (1/200) ACE event.

3.3.2.3 Elkhorn Basin (RD 537, 827, 785, 1600)

Floodwaters would be diverted into the basin via an ungated 10,560-foot long weir at RM 69.00 on the Sacramento River. For this alternative to perform successfully it is necessary to ensure that the basin

would be empty at the start of weir flow; therefore all levees surrounding the basin would be improved. The target stage for diverting water would be the minimum elevation of the surrounding existing condition levees, 30.27 feet (NGVD29), for a storage space of 225,000 acre-feet. Exit gates and/or a weir would also be needed to drain the water from Elkhorn Basin after the flood peak. The total cost for implementing transitory storage in the Elkhorn Basin would be $401,000,000. The stage in the Sacramento River at RM 70 would be reduced by up to 0.9 foot for the 0.5% (1/200) ACE event.

Table 3.2: Comparison of Costs for Transitory Storage on the Sacramento River and Levee Raising ($ millions).

ALTERNATIVE	CONSTRUCTION COST
Robbins Basin	$1,066
Nicolaus Basin	$545
Elkhorn Basin	$401

The evaluations of transitory storage measures conducted for these basins indicate that these measures do not reduce water surface elevations on the levees that protect the urbanized basins within the study area enough to alleviate the need to improve the levees. Therefore, levee improvements would still be needed within the study area to reduce the considerable risk of flooding that exists. When the cost of the transitory storage measures are added to the cost of the urban levee improvements, the combined cost of these measures makes this option less efficient than other potential plans that would focus on measures within the study area. Therefore transitory storage in upstream basins measures have been eliminated from further consideration.

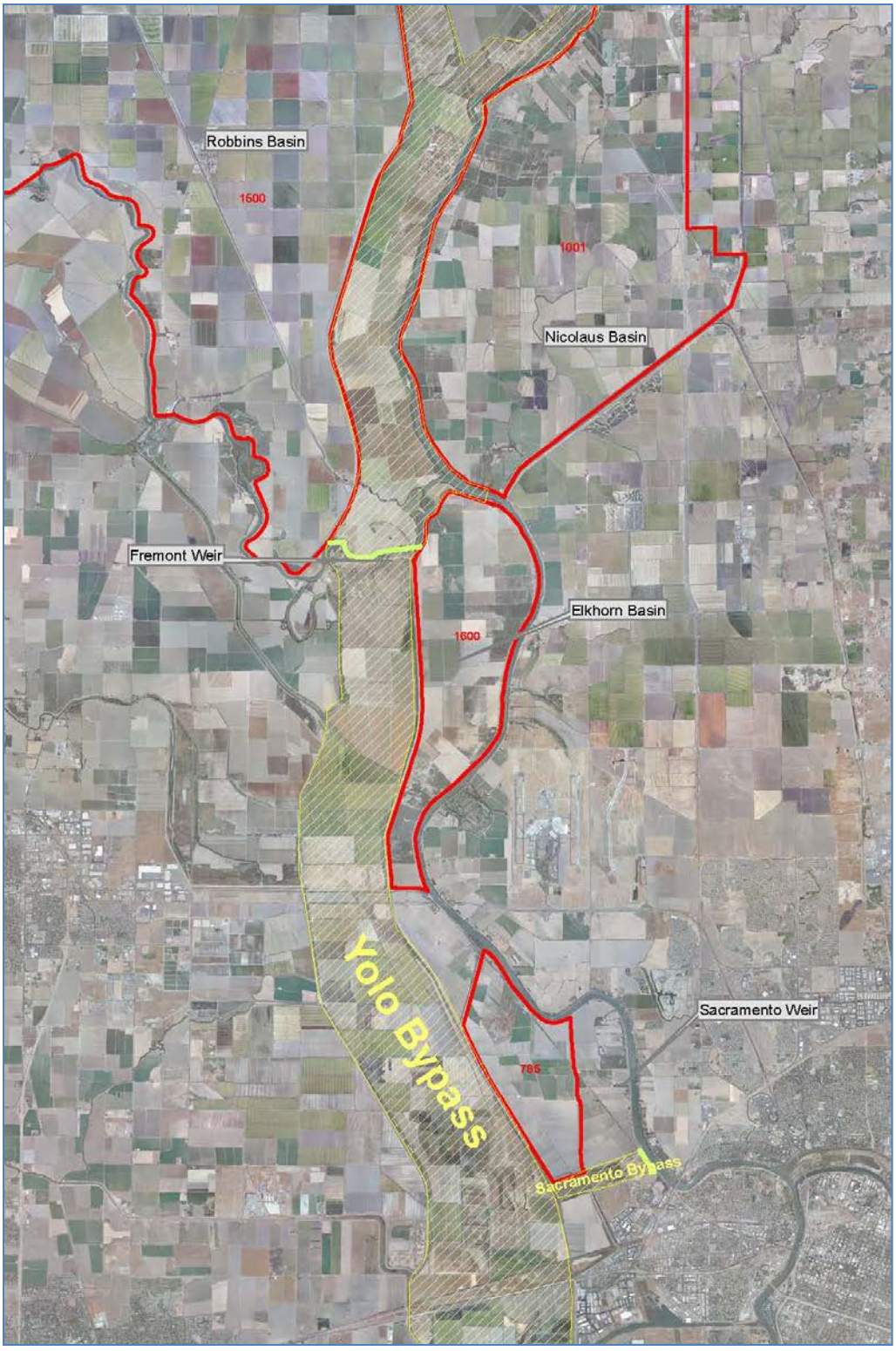

Figure 3.1: Transitory Storage Areas

3.3.3 Reoperation of Upstream Reservoirs

Reoperation of SRFCP reservoirs upstream of the study area in the Sacramento River basin was considered. Major reservoirs upstream of the study area include Shasta Lake, Lake Oroville, Folsom Lake, and New Bullards Bar Reservoir. The operation of Folsom Lake is the subject of another study, so it was not considered as a measure for this study. The remaining reservoirs control approximately 11,000 square miles of the 27,000 square mile Sacramento River basin. This is about 40% of the drainage area. The flood storage is a small component of these dams' storage, since they are also water supply reservoirs. These dams were completed prior to the largest floods in Sacramento; therefore, their designs are based on hydrology that does not take these large floods into account. Because the flood storage component of these dams is small, reoperation of the upstream reservoirs would only have a small impact on reducing water surface elevations in the project area. Reoperation of these upstream reservoirs would not substantially reduce the flood risk to the West Sacramento area; therefore, this measure has been removed from further consideration.

3.3.4 Sacramento Weir and Bypass Improvements

The report, Sacramento Bypass Expansion Conceptual Design and Cost Estimates[1], provided a conceptual project description and a cost estimate for widening the Sacramento Bypass. This expansion would increase the length of the Sacramento Weir by 1,500 feet to increase the flow into the bypass while reducing the flows in the Sacramento River and widen the Sacramento Bypass to provide additional conveyance capacity to the Yolo Bypass. A new trestle bridge would also be constructed across the widened bypass to provide continued service to the Yolo Shortline Railroad during construction. The total project cost was estimated to be $439 million. This measure reduces water surface elevations in the Sacramento River through downtown West Sacramento and Sacramento and reduces the extent of levee raising. In addition, this measure provides regional benefits in the form of reduced water surface elevations in the Sacramento River to communities downstream of the study area. Therefore, this measure is being carried forward.

3.3.5 I Street Diversion Structure

This measure includes the construction of a diversion structure just upstream of the existing I Street Bridge on the Sacramento River. This diversion structure would restrict flows going down the Sacramento River past the cities of Sacramento and West Sacramento, and would cause a portion of the flows from the Sacramento and American Rivers to be backed upstream through the Sacramento Bypass out to the Yolo Bypass. The Sacramento Bypass and Weir would be widened to accommodate the increased flows to the bypass system. The effect of this diversion structure would be to reduce the water surface elevation of the Sacramento River downstream of the structure to the point at which seepage, stability, height, and erosion improvements would not be needed in order to safely convey the 200 year design event. This measure is being carried forward.

3.3.6 Yolo Bypass Improvements

This measure is described in the report, Lower Sacramento River Regional Project Conceptual Design and Cost[1]. It consists of lengthening the Fremont Weir, and widening the Yolo and Sacramento Bypasses to increase the amount of flood water conveyed through these facilities and reduce the amount of flood water conveyed through the Sacramento River channel downstream of the Bypass. This would reduce the

[1] SAFCA, 2009. Sacramento Bypass Expansion Conceptual Design and Cost Estimates (September 2009).

extent of the levee raising work that is needed to meet the State 200-year flood protection requirements. This measure would consist of the following features:

- Redesign and reconstruction of the Fremont Weir.
- Construction of a new setback levee along the eastern edge of the Yolo Bypass extending from the Fremont Weir to the north levee of the Sacramento Bypass.
- Construction of a weir and Closure Structure in the Sacramento Deep Water Ship Channel south of I-80.
- Removal of existing Sacramento River Flood Control Project levees in the lower reach of the Yolo Bypass.
- Redesign and reconstruction of the Sacramento Weir.
- Widening the Sacramento Bypass

The estimated cost of the measures for the comprehensive bypass improvements was $4.5 billion. In addition, the measures would not reduce the water surface elevations in the study area enough to reduce seepage under and through the levee nor address the stability issues. Therefore, the measure is incomplete because it does not alleviate the need to implement other measures to address the seepage, stability, erosion, and vegetation and encroachment issues with the existing levees and was not carried forward.

3.3.7 Offstream Storage on Deer Creek

This measure would involve the transfer of water from one basin to another to meet flood risk management goals. Deer Creek is a tributary of the Cosumnes River that comes within 10 miles of Folsom Reservoir. Water can be conveyed to Deer Creek via gravity flow. This measure would provide additional storage by diverting floodwaters from the American River watershed to the adjacent Cosumnes/Mokelumne Rivers system. Flood flows would be temporarily stored in a detention basin on Deer Creek and released into the Delta via the Cosumnes and Mokelumne Rivers after flood peaks had passed on those rivers. The measure would consist of several features:

- A six-bay radial gate overflow section outlet works adjacent to the west side of Folsom Reservoir's Mormon Island Dam.
- A connecting channel extending from the Folsom Reservoir Outlet Works to the detention basin approximately 8 miles to the south.
- A 600,000 acre-foot detention basin to store diverted flood flows from the American River, created by a 141-foot high random fill embankment dam.
- Channel modifications and revetment protection along Deer Creek, Cosumnes River, and the Delta to accommodate extended flood releases.

This measure could have substantial vegetation and associated wildlife impacts. This would require a long-term commitment to mitigation, maintenance, and monitoring of mitigation efforts. Detention basin releases would significantly extend flooding along the Cosumnes River and in the Franklin Pond area. Additional flood easements would be acquired along the Cosumnes River to mitigate for these extended flood releases. The detention basin is located in the vicinity of several hazardous waste sites. Flood storage in the basin could affect groundwater flows under these sites or receive contaminated flows from the site. A plan to monitor shallow groundwater would need to be implemented, and groundwater entering or leaving the area would be checked for contamination.

This measure was considered in the 1991 American River Watershed Feasibility report and was dismissed because of high costs. At that time, the estimated construction cost for the Deer Creek facilities was $1.6 billion. That cost, escalated to present worth, is $2.9 billion. In addition, since the time that this measure was first investigated, substantial development has taken place in Folsom in the vicinity of the channel that would connect Deer Creek with Folsom Reservoir. Avoiding this development or relocating the homes and businesses that now occupy the area would add substantial costs. For the reasons stated above this measure is not being carried forward.

3.3.8 Deep Water Ship Channel (DWSC) Closure Structure

This measure would include construction of a Closure Structure in the DWSC that would provide flood risk management for West Sacramento and the Port of West Sacramento from flood flows in the DWSC. The Port of West Sacramento is considered critical infrastructure. Implementation of this alternative would reduce the need to improve the DWSC west levee downstream of the structure, improve the DWSC East levee north of the structure, and improve the Port North and Port South levees. This measure is being carried forward.

3.4 MEASURES TO REDUCE LEVEE SEEPAGE AND UNDERSEEPAGE

Levee underseepage and, to a lesser extent, levee through-seepage problems have been identified at many locations in the Sacramento levee system. When the seepage velocity is great enough, erosion can occur because the frictional drag exerted on the soil particles is strong enough to entrain the particles in the water flow. Seeping water thus removes soil, starting from the exit point of the seepage, and erosion advances up gradient. This erosion of the soil, also known as "piping", can lead to failure of the structure and to sinkhole formation. Vertically upwards seepage is a source of danger on the downstream side of sheet piling and beneath the toe of a dam or levee.

Underseepage problems can be corrected through the use of slurry cutoff walls, sheet pile cutoff walls, seepage berms, and relief wells. Through-seepage can be corrected by constructing cutoff walls or stability berms. Using cutoff walls in locations where through-seepage is a concern addresses both through-seepage and underseepage. Therefore, the following discussion focuses exclusively on underseepage remediation. Since all of these measures are being carried forward evaluation of the existing levee and subsurface conditions will determine which measure or combination of measures will be utilized at a specific location.

3.4.1 Seepage Berms

Seepage berms are wide embankments placed outward from the levee landside toe to lengthen the underseepage path and thereby lower the exit gradient of seepage through permeable layers under the levees to acceptable levels. Berms typically extend from 80 feet (a minimum berm width) to 300 feet from the landside toe of the levee. The thickness of the berm depends on the severity of the seepage flow but generally begins at 5 feet near the landside levee toe for a 100-foot berm or 7.5 feet for a 300-foot berm and tapers to a thickness of 3 feet at the end of the berm. This measure is being carried forward.

3.4.2 Relief Wells

Relief wells provide protection against excessive levee underseepage by providing a lower resistance pathway for underseepage to exit to the ground surface at the landside toe of the levee without creating sand boils or piping levee foundation materials. Relief wells are an option for addressing underseepage

only in reaches where continuous sand and gravel layers have been identified by geotechnical explorations and analyses. Relief wells are also the measure of last resort where other measures cannot be implemented or are determined to be incomplete.

Relief wells require periodic maintenance and frequently suffer loss in efficiency over time for a variety of reasons. These can include clogging of well screens by carbonate incrustation and iron deposition, intrusions of muddy surface waters, or bacterial growth. Relief wells may malfunction for a variety of reasons including vandalism, breakage, or excessive deformation of the well screens due to ground movements, corrosion or erosion of the well screen, and a gradual loss in efficiency with time. Most relief wells undergo some loss in capacity probably due to the slow movement of foundation fines into the filter pack with a corresponding reduction in permeability.

Relief wells are constructed near the landside toe of the levee to provide pressure relief beneath surface fine-grained soils (clay or silt "blanket"). The wells are constructed using drilling equipment to bore a hole vertically through the fine-grained blanket layer and into the coarse-grained aquifer layer beneath. Pipe casings and filters are installed to allow the pressurized water to flow to the ground surface, thereby relieving the pressures beneath the clay blanket. A collection pipe or ditch is used to carry seepage water to a surface drain.

Relief wells generally are spaced at 50- to 100-foot intervals. They can be used to avoid obstructions on the land side of the levee toe (such as buildings or trees) that otherwise would have to be removed for the construction of seepage berms. Although during elevated river stages relief wells conduct water to the surface without pumping (artesian flow), pumping costs are incurred to convey the collected water back into the river. Additional maintenance costs associated with the wells include annual inspections, periodic video surveying, well performance testing, cleaning, and miscellaneous repairs. Monitoring wells (piezometers) are installed between relief wells to allow monitoring to ensure that hydraulic pressure is being relieved.

This measure is being carried forward.

3.4.3 Slurry/Cutoff Walls

Cutoff walls reduce underseepage by providing a barrier of low-permeability material through the levee and levee foundation where sandy or gravelly soils of higher permeability can transmit seepage during high water stages. The cutoff wall depths necessary to limit underseepage at the design water surface elevation are determined by geotechnical analysis. Cutoff walls are generally installed to depths that will tie in with existing impervious or lower permeability soil layers beneath the levee foundation.

Cutoff walls can be constructed by a number of methods to suit site conditions and schedule requirements. The most common methods include the installation of cutoff walls consisting of a soil-cement-bentonite mix, cement-bentonite mix, or a soil-bentonite mix using conventional trench methods, deep soil mixing, or trench remixing deep. The soil-cement-bentonite mix is used where the cutoff wall is constructed through the centerline of a levee that has been constructed with potentially unstable soil materials. In that case, if the encapsulating material begins to slough, the soil-cement-bentonite wall can provide structural stability. Soil bentonite walls can be installed through the centerline of an adjacent levee where the mass of the joint structure significantly reduces the potential for instability.

Cutoff walls are typically constructed using an excavator with a long-stick boom capable of digging a trench to a maximum depth of approximately 80 feet. However, use of clam shell excavators can extend this distance by as much as 30 feet to reach depths as great as 110 feet. Bentonite slurry is pumped into the trench during excavation to prevent caving. The soil and bentonite, or soil, cement, and bentonite

mixtures are blended to achieve the required cutoff wall strength and permeability, and the mixture is backfilled into the trench. Construction of a conventional slurry cutoff wall through the center of the levee typically requires that the existing levee be degraded as much as one-third of the levee height to prevent hydraulic fracturing. Select fill is used to rebuild the levee.

Deep soil mixing cutoff walls can reach depths of 200 feet. They are constructed by parallel augers drilling vertically through the levee and substrate. Cement and bentonite are pumped into the interconnected holes as the augers are inserted and withdrawn. The levee is normally degraded as necessary to create a 30-foot flat top width on which the equipment operates.

Trench remixing deep cutoff walls can be constructed to depths similar to those of deep soil mixing walls. The trench remixing method uses a cutter chain on a wide shaft (similar to a large chain saw) set vertically into the foundation soil. Cement and bentonite are pumped into the shaft at various depths as the cutters move along the wall alignment. Again, the levee is normally degraded as necessary to create a 30-foot flat top width on which the equipment operates.

This measure is being carried forward.

3.4.4 Sheet Pile Walls

Sheet pile walls consist of a row of interlocking vertical pile segments driven to form an essentially straight wall. Sheet piles can consist of hot- or cold-rolled steel, aluminum, or vinyl. Hot-rolled steel sheet piles have tighter interlocks than do cold-rolled sheet piles and, therefore, do a better job of controlling seepage. Additionally, interlocks can be treated to help them seal. This measure is being carried forward.

3.4.5 Removal of Ditches Adjacent to Levees

In some areas along the DWSC East levee, there are ditches located adjacent to the landside toe of the levee. These ditches pose problems for the levees in that seepage from flood waters has a shorter path to the landside of the levee. This shorter path results in exit gradients that can cause material to be removed from the foundation of the levee, causing internal erosion of the soil. Replacing the ditch with a pipe or culvert or moving the ditch further from the toe of the levee could manage the seepage and resulting soil loss. This measure is being carried forward.

3.4.6 Construct New Setback Levee

In some areas where there is available real estate, such as along the Sacramento River in the South Basin, construction of a new setback levee could be an option. The new levee would be designed to address seepage with slurry cutoff walls and/or seepage berms as conditions warrant. This measure is being carried forward.

3.5 MEASURES TO ADDRESS LEVEE STABILITY

Many of the measures designed to address seepage problems will also address stability problems, if seepage pressures are seen to be the cause of those stability problems. These measures would include seepage cutoffs like slurry walls or sheet pile walls. Measures that specifically address stability issues include widening and flattening levee slopes, construction of stability berms, and full levee degrade and reconstruction. Since two of these measures are being carried forward, evaluation of the existing levee and subsurface conditions will determine which measure or combination of measures will be utilized at a specific location.

3.5.1 Widen and Flatten Levee Slopes

Some levees within the study area have landside slopes that are considered too steep to remain stable when subjected to prolonged high water conditions. This condition can be addressed by flattening the affected levee slopes to achieve at least a 3 horizontal to 1 vertical (3H:1V) geometry. This measure is being carried forward.

3.5.2 Stability Berms

A stability berm adds weight to the landside toe of the slope. The method is used when land is available on the landside of the levee. Stability berms can be several hundred feet wide and several feet thick. This measure is being carried forward.

3.5.3 Full Levee Degrade and Reconstruction

In areas where the available construction footprint is limited due to existing infrastructure and development, a full levee degrade may be used to reduce stability issues. The levee would then be reconstructed using geotextile materials placed in alternating layers with soil in three foot intervals. This measure is not being carried forward because it is not cost effective compared to other measures to address levee stability.

3.5.4 Construct New Setback Levee

In some areas where there is available real estate, such as along the Sacramento River in the South Basin, construction of a new setback levee could be an option. The new levee would be designed according to Corps criteria to address seepage concerns. This measure is being carried forward.

3.6 MEASURES TO ADDRESS EROSION

Waterside armoring of the levees to prevent erosion and subsequent damage to the levee can be accomplished using riprap and vegetation.

3.6.1 Waterside Armoring of Levee Slopes

One measure consists of placing riprap on the bank in a manner similar to that used for the Sacramento River Bank Protection Project. This measure is generally the least environmentally damaging and is cost effective. This measure is being carried forward.

3.6.2 Launchable Rock Trench

Another measure includes a launchable trench filled with rock, designed to deploy once erosion has removed the bank material beneath it. This measure is being carried forward.

3.6.3 Bioengineered Armoring of Slopes

Another measure being considered is bioengineering, which uses plant material to stabilize the eroded slope and prevent further loss of material. This measure is being carried forward because it could be cost effective in some locations.

3.7 MEASURES TO ADDRESS LEVEE HEIGHT

In some locations in the study area, the levees lack the height to meet the State's 200-year flood protection requirements. Measures to address levee height fall in three general categories: construct a

new levee, levee raises, and floodwalls. In some areas where there is available real estate, such as along the Sacramento River in the South Basin, construction of a new setback levee could be an option. The new levee would be designed to address height concerns. Levee raises can be accomplished by adding more embankment material to the top of the levee (providing that the width of the levee is adequate) or by widening the existing levee to gain the required height and width. Floodwalls can be added to the top of an existing levee, or the existing levee can be removed and a floodwall can be constructed in its place. These methods of levee raising can also be combined with various seepage and stability measures, depending on what problems exist in specific locations. All of these measures are being carried forward because they could be utilized to address problems at specific locations.

3.8 MEASURES TO ADDRESS VEGETATION AND ENCROACHMENTS

Addressing the Corps policy on vegetation and encroachments is another major variable to be considered in the formulation of measures. The Corps' levee guidance requires an assessment of encroachments on levee slopes, including utilities, fences, structures, retaining walls, driveways, and excessive vegetation. Where such encroachments constitute a threat to the stability of a levee or its maintenance, they must be removed or rendered into an acceptable condition. Measures to address vegetation issues include: the complete removal of waterside vegetation and widening the existing levee, construction of a new adjacent levee that would require the approval of a variance to the ETL (to leave the remaining waterside vegetation), or construction of a new setback levee.

Additionally, the woodlands remaining on the waterside of the levees along the Sacramento River are predominately native tree species. These trees are a remnant of the historic riparian ecosystem in the valley. Because of the wide-scale reduction in riparian woodlands over the past century, this ecosystem is now confined to a series of narrow corridors extending along the waterside margins of the Sacramento River and its tributaries. These corridors provide the primary, and in some regions the only, habitat link between the woodland patches that survive on the valley floor and the undeveloped woodlands of the foothills of the Coast Range and Sierra Mountains. Several special status fish species, including Chinook salmon and Green Sturgeon, use the Sacramento River and are likely to rear in the floodplain habitat along the margins of the waterside slope and berm of the project area levees.

Because of the amount of available undeveloped land, construction of setback levees along the Sacramento River in the South Basin provides a means to preserve vegetation on the waterside of the existing levees while providing an opportunity to restore ecosystem function in the area.

3.9 NON-STRUCTURAL MEASURES

Risk reduction and risk education are objectives that can be addressed through the implementation of non-structural measures. These measures are included in the five basic approaches to non-structural flood risk management (Figure 3.2).

3.9.1 Zoning

Avoidance of using the floodplain for activities other than those compatible with periodic flooding is a risk reduction measure. Floodplain development requirements can be instituted, such as land-use controls that minimize new unsafe development in high-risk areas. In addition to these measures, the non-Federal interest is required to publicize floodplain information and provide this information to zoning and other regulatory agencies.

3.9.2 Building Codes

Building codes can promote construction techniques that reduce damages to future construction due to flooding. These techniques include the raising of structures and flood proofing.

3.9.3 Outreach

A wide array of measures that address the objectives of risk education and community cohesion can be employed. These can include conducting training for hospitals and schools, media dissemination of information before, during, and after construction, development of a school curriculum on flooding, community workshops on flooding, and the establishment of websites that educate the public of flood risk, and flood warning and evacuation plans. In addition to these measures, the non-Federal interest is required to inform affected interests of the protection afforded by the project.

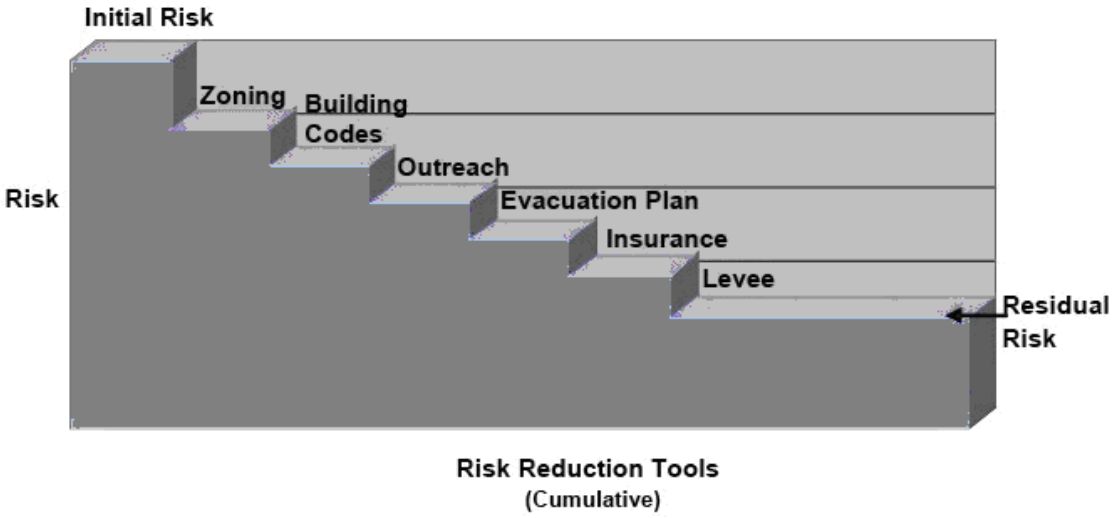

Figure 3.2: Implementation of Flood Risk Management Solutions.

3.9.4 Evacuation Plan

Robust and effective evacuation plans and warning systems are essential in order to get people out of harm's way, should the need arise. The City of West Sacramento has established a flood warning and evacuation plan based on weather conditions and water levels at the I Street gauge on the Sacramento River.

3.9.5 Insurance

Insurance is a way to mitigate losses to those who are subject to flooding by providing indemnification through forms of public and private insurance.

3.9.6 Removing Structures from the Floodplain

Another non-structural measure is to remove the structures from the floodplain. There are three measures that accomplish this. The first is permanent relocation of all residents and businesses affected by flooding. The second is raising affected structures above flood elevations. The third is flood proofing of structures. These measures are generally most effective when the number of structures affected by flooding is small. The urbanization in West Sacramento is fairly concentrated, particularly in the north

basin. Most of the urban area is in the 0.5% (1/200) ACE floodplain. There are approximately 18,500 structures in West Sacramento in the 0.5% (1/200) ACE floodplain.

Permanent relocation, raising-in-place, and floodproofing of existing structures are non-structural measures that would face significant obstacles to implementation given the concentrated urbanization of most of West Sacramento. Relocating structures would disrupt community cohesion. Relocating approximately 48,000 residents would be nearly impossible and raising or floodproofing every structure would change the character of the city and would face opposition from residents.

The first line of defense against flood risk should be to avoid or minimize damages through land-use controls and regulations for safe floodplain development. Figure 3..2 shows the order in which solutions for flood risk management would ideally implemented.

Table 3.Table 3.3 summarizes the non-structural measures. The measures identified in the column Authorized Project are those from previous West Sacramento authorizations. The measures identified under State Programs, are those included in the State of California's Public Law 84-99 Eligibility Retention and Flood System Improvement Framework or the FloodSAFE California program. Based on this, a determination was made as to whether these measures would be considered a part of the No Action plan or could be non-structural measures included as a part of a plan for reauthorization.

Table 3.3: Non-Structural Measures.

MEASURE	AUTHORIZED PROJECT	STATE PROGRAMS	NO ACTION	NON-STRUCTURAL ALTERNATIVE
Zoning				
Floodplain Management	*	X	X	X
Provide Floodplain Information to Regulatory Agencies	*	X	X	X
Building Codes				
Local Building Codes		X	X	
Outreach				
Annual Publication of Residual Risks	*	X	X	X
Evacuation Plan				
Telemeter Stream Flow Gages				X
Modifications to Flood Warning System				X
Insurance				
National Flood Insurance Program	*		X	X
Removing Structures from the Floodplain				
Permanent Relocation				X
Raising in Place				X
Flood Proofing Existing Structures				X

* Required items of local cooperation

3.10 PRELIMINARY SCREENING OF MEASURES

A preliminary screening of the measures identified was done in an attempt to reduce the number of candidate measures before combining them into alternatives. Screening level cost estimates were

developed for some of the measures described. These estimates included construction costs and real estate costs. Experience with recent construction project costs and professional judgement were also utilized in the preliminary screening of measures. The goal was to screen out measures that would not be cost-effective. A measure may be ruled out for general use in this preliminary screening, but if circumstances in a particular area warrant special treatment, that measure may be employed if it satisfies the need.

An estimate of environmental mitigation costs was also made. The purpose of developing these costs was to indicate a relative level of environmental impact for each measure. It is important to realize that appropriate environmental mitigation may not be possible for a particular measure. Therefore, the costs are not reported herein, but were used to develop a qualitative estimate of the degree of impact, high, medium, or low.

Table 3-4: Measures Screening Criteria and Metrics.

	MEASURE SCREENING CRITERIA	METRIC
1	Impacts to Waterside Vegetation	Number of acres affected by measure
2	Effect on Critical Habitat for a Listed Species	Number of acres of critical habitat affected by measure
3	Number of Required Residential Relocations	Number of residential parcels
4	Amount/Cost of Real Estate	Preliminary real estate appraisal
5	Effectiveness	Does the measure respond to one or more objectives?
6	Efficiency	Ability of measure to address the problem for the least cost
7	Expected Reduction in Annual Flood Damages	Economic benefits
8	Life Safety Metric	How well measure would reduce flood risk (qualitative assessment at this stage) measured in residual risk

Table 3-5: Summary of Management Measures Retained or Dropped

MEASURES	RETAINED	DROPPED	RATIONALE
Measures to Reduce Flood Stages			
Upstream storage on the American River	X		Although it does not reduce stages enough to preclude levee improvements on the Sacramento River in the study area, it is an effective method of reducing the flood risk to the downstream communities.
Transitory storage on the Sacramento River		X	Is not effective because it does not reduce stages enough to preclude levee improvements on the Sacramento River in the study area.
Reoperation of Sacramento River Watershed reservoirs upstream of the study area		X	Is not effective because it does not reduce stages enough to preclude levee improvements on the Sacramento River downstream of the American. Distance to reservoirs is too great and there are too many unregulated tributaries in between.
Reoperation of American River Watershed reservoirs upstream of the study area		X	Folsom Dam Modification Water Control Manual update is already implementing authorized modifications to the flood control space.
Sacramento Weir and Bypass Improvements	X		Provides regional benefits in the form of reduced water surface elevations in the Sacramento River in the study area and to communities downstream of the study area, however, does not reduce water surface elevations enough to eliminate the need to address geotechnical concerns (stability and seepage) on levees along the Sacramento River.
Improvements to the Yolo Bypass		X	Because of the costs associated with the Yolo Bypass improvements this measure is neither cost effective nor efficient. Implementation of this measure does not reduce water surface elevations enough to eliminate the need to address geotechnical concerns (stability and seepage) on levees along the Sacramento River.
Offstream storage on Deer Creek		X	Is not cost efficient because substantial development has taken place in the area where this alternative would be located. High costs would be incurred in relocating these communities.
Construct Diversion Structure on Sac River near I Street Bridge	X		Effective because it reduces water surface elevation in the Sacramento River downstream to the extent that seepage, stability and erosion issues are addressed and levee improvements are not needed.

MEASURES	RETAINED	DROPPED	RATIONALE
DWSC Closure Structure	X		Protects urban areas and the Port of West Sacramento and reduces extent of levee improvements (improvements to the Port North and South levees are not needed).
Measures to Address Seepage and Underseepage			
Seepage Berms	X		Existing residential and commercial development immediately adjacent to the levee toe make this measure more costly than other seepage reduction measures in most areas. Retained for use in areas with land available on the landside of the levee.
Relief Wells	X		Effective method of addressing residual seepage without jeopardizing levee integrity.
Slurry Walls	X		Effective method of reducing levee seepage and underseepage.
Sheet Pile Walls	X		Can be an effective construction technique for deep cutoff of seepage if local conditions warrant.
Removal of Ditches Adjacent to levees	X		Effective at lengthening seepage path to meet seepage criteria.
Construct New Levees	X		Can be effective where the cost of real estate is not prohibitive.
Measures to Address Levee Stability			
Widen/Flatten Levee Slopes	X		Effective method of improving levee stability.
Stability Berms	X		Can be utilized if there is not existing residential and commercial development immediately adjacent to the levee toe. Otherwise, this measure is much more costly than other stability improvement measures.
Full Levee Reconstruction		X	Not a cost effective construction technique to address stability.
Construct New Levees	X		Can be effective where the cost of real estate is not prohibitive.
Measures to Achieve State Urban Levee Performance			
Raise Levees in Place	X		Effective method of increasing levee performance.
Raise levees with Adjacent Levees	X		Can be effective where the cost of real estate is not prohibitive.
Add Floodwalls to Existing Levees	X		Effective method of increasing levee performance.

MEASURES	RETAINED	DROPPED	RATIONALE
Remove Levees and Construct Floodwalls		X	Other measures that achieved the same result were more cost effective. High environmental effects.
Construct Partial Floodwalls		X	Other measures that achieved the same result were more cost effective.
Construct New Levees	X		Can be effective where the cost of real estate is not prohibitive.
Measures to Address Erosion			
Waterside Armoring of Levee Slopes (Sac Bank-type repair)	X		Effective method of reducing erosion potential on the levee.
Launchable Rock Trench	X		Effective method of reducing erosion potential on the levee.
Biotechnical Armoring of Slopes	X		Used in areas with a wide natural bank. Would not be used on levee slopes. Effective method to reduce erosion.
Non-Structural Measures			
Permanent Relocation		X	Too costly to relocate the City of West Sacramento out of the floodplain.
Raising in Place		X	Significantly more costly than improving levees, would alter the character of the community, does not address evacuation concerns.
Flood Proofing of Existing Structures		X	Significantly more costly than improving levees would alter the character of the community does not address evacuation concerns.
Floodplain Management	X		Item of local cooperation provided by non-Federal sponsor.
Providing Floodplain Information to Regulatory Agencies	X		Supports effective land use policies.
Annual Publication of Residual Risks	X		Item of local cooperation provided by the non-Federal sponsor.
Improvements to Flood Warning System	X		Provides advance notice of flood risk and potentially increases warning time.
Federal Flood Insurance Program	X		Promotes community resilience.

3.11 PLAN FORMULATION STRATEGIES

Plan formulation is the process of putting together plans that meet the planning objectives and avoid the planning constraints. Often, the plan formulation process emphasizes structural details, costs, project outputs, safety, reliability, and other matters that are quantifiable. However, formulation must be balanced by environmental, social, institutional, and other information. To overlook such information runs the risk of developing plans that cannot be implemented. In an effort to balance the technical evaluations with those evaluations that are less so, the formulation process begins with the development of strategies. A plan formulation strategy is a systematic way of combining measures into plans based on selected criteria. The inspiration for a strategy may be institutional, as in laws, policies, regional plans, or other institutional realities. It may be technical, as in formulating the least cost plan. Or it may be inspired

by issues important to stakeholders or local objectives and constraints. A strategy becomes the recipe for formulating a plan. And during iterations of the planning process, strategies can become more precise. The development of strategies usually begins with screened management measures. The combinability, dependency, and mutual exclusivity of the measures are evaluated, and then a strategy is applied to combine measures into candidate plans.

With the objectives, constraints and local concerns in mind, the following plan formulation strategies have been developed. The strategies reflect a different emphasis within the planning objectives and planning constraints. The themes included the following:

Combine measures that improve levee performance

- *Improve conveyance*
- *Fix levees in place by various methods*

Combine measures that reduce flood stages

- *Improve upstream storage*
- *Reduce flow which reaches study area*

Combine measures which improve levee performance and reduce flood stages

- *Identify measures which together provide optimal storage and conveyance opportunities*

The West Sacramento basin, as defined in the National Levee Database (NLD), is 44,700 acres bounded by the Sacramento Bypass, Sacramento River, Elk Slough, Sutter Slough, Minor Slough, Sacramento Deep Water Ship Channel (DWSC), and Yolo Bypass. This large basin is separated by the existing South Cross levee that delineates densely urban areas from rural; 95% of the population within West Sacramento basin is north of the South Cross levee, with 5% south of the cross levee. The West Sacramento project considered improvements to the entire basin as discussed in Alternative 0.5D below. In consideration of wise use of floodplains and Executive Order (EO) 11988 the project team determined that improving the existing South Cross Levee, instead of improving the levees to the south that surround the entire basin, would be a more prudent way to address flood risk for West Sacramento. Improving the South Cross levee establishes a southern boundary for West Sacramento that aligns with the current city limit and does not encourage development in the approximately 31,400 acres of potentially developable land located south of the South Cross levee. This strategy adequately addresses EO 11988 concerns without constructing a mid-cross levee, as presented in Alternative 0.5C below.

3.12 PRELIMINARY ARRAY OF ALTERNATIVES

The Corps is required to consider “No Action” as one of the alternatives for selection in order to comply with the requirements of the National Environmental Policy Act (NEPA). With the No Action Plan, it is assumed that no additional features would be implemented by the Federal Government or by local interests to achieve the planning objectives, over and above those elements of the Common Features project that will have been implemented prior to reauthorization of the project. Since the No Action Plan is required to be included among the candidate plans in the final array of alternatives, it is described in more detail later in this chapter. The no action plan and the future without-project condition are assumed to be the same alternative for this study.

Preliminary Alternative 0.5A – North Basin Protection Plan - This alternative would focus FRM on the northern basin of West Sacramento. It would include improvement of the existing levees that provide

FRM for the North Basin by either improving the levees in place or constructing a new levee adjacent to the existing levee. The Yolo Bypass and the Sacramento River North Levees would be fixed in place. The DWSC West levee would be improved in place. This alternative was not carried forward because it does not adequately meet the objective of reducing the population at risk of flooding and reducing the damages associated with flooding.

Table 3-6: Preliminary Alternative 0.5A – North Basin Protection Plan - Proposed Improvement Measures by Reach

WATERWAY/REACH	SEEPAGE MEASURES	STABILITY MEASURES	EROSION PROTECTION MEASURES	OVERTOPPING MEASURES
Sacramento River North Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port North	--	--	--	Flood Wall or Raise Levee in Place
Yolo Bypass Levee	Slurry Wall	Slurry Wall	--	--
Sacramento Bypass Training Levee	--	--	Waterside Armoring Bank Protection	--
Sacramento River South Levee	--	--	--	--
South Cross Levee	--	--	--	--
Deep Water Ship Channel East Levee	--	--	--	--
Deep Water Ship Channel West Levee	Slurry Wall or Seepage Berm	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port South Levee	--	--	--	--

Preliminary Alternative 0.5B – South Basin Protection Plan - This alternative would focus FRM on the southern basin of West Sacramento. Except for the Sacramento River South Levee, improvement of the existing levees that provide FRM for the South Basin by either improving the levees in place or constructing a new levee adjacent to the existing levee. A setback levee would be constructed along the Sacramento River South reach. This alternative was not carried forward because it does not adequately meet the objective of reducing the population at risk of flooding and reducing the damages associated with flooding.

Table 3-7: Preliminary Alternative 0.5B – South Basin Protection Plan - Proposed Improvement Measures by Reach

Waterway/Reach	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
Sacramento River North Levee	--	--	--	--
Port North	--	--	--	--
Yolo Bypass Levee	--	--	--	--
Sacramento Bypass Training Levee	--	--	Waterside Armoring Bank Protection	--
Sacramento River South Levee	Slurry Wall and Seepage Berm	Slurry Wall and Seepage Berm	Waterside Armoring Bank Protection	Raise Levee in Place
South Cross Levee	Relief Wells	Stability Berm	--	Raise Levee in Place
Deep Water Ship Channel East Levee	Slurry Wall	Slurry Wall	--	Raise Levee in Place
Deep Water Ship Channel West Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port South Levee	Slurry Wall	Slurry Wall	--	Raise Levee in Place

Preliminary Alternative 0.5C – Mid- Cross Levee Alternative – This alternative would provide structural FRM improvements for both the northern and southern basins of West Sacramento while maintaining existing undeveloped floodplain. It would include improvement of the existing levees by either improving the levees in place or constructing a new levee adjacent to the existing levee. An approximately 4.25-mile long new cross levee would be constructed from below the Bridgeway Lakes development and connecting to the Sacramento River Levee just north of the Bee's Lake area. The DWSC East Levee would be improved from the Port South Levee to the new cross levee. Improvements to the levee along the Sacramento River in the South Basin would include construction of a setback levee from the Barge Canal to the new cross levee. This alternative was not carried forward for the reasons presented in Section 3-13.

Table 3-8: Preliminary Alternative 0.5C – Mid- Cross Levee Alternative - Proposed Improvement Measures by Reach.

WATERWAY/REACH	SEEPAGE MEASURES	STABILITY MEASURES	EROSION PROTECTION MEASURES	OVERTOPPING MEASURES
Sacramento River North Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port North	--	--	--	Flood Wall or Raise Levee in Place
Yolo Bypass Levee	Slurry Wall	Slurry Wall	--	--
Sacramento Bypass Training Levee	--	--	Waterside Armoring Bank Protection	--
Sacramento River South Levee (north of intersection with Cross Levee)	Slurry Wall and Seepage Berm	Slurry Wall and Seepage Berm	Waterside Armoring Bank Protection	Raise Levee in Place
Sacramento River South Levee (south of intersection with Cross Levee)	--	--	--	--
South Cross Levee	--	--	--	--
Mid-Cross Levee (New)	Slurry Wall	New Levee	Waterside Armoring Bank Protection	New Levee
Deep Water Ship Channel East Levee (North of intersection with Cross Levee)	Slurry Wall	Slurry Wall	--	Raise Levee in Place
Deep Water Ship Channel East Levee (South of intersection with Cross Levee)	--	--	--	--
Deep Water Ship Channel West Levee	Cutoff Wall or Seepage Berm	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port South Levee	--	--	--	--

Preliminary Alternative 0.5D – West Sacramento Basin Alternative – This alternative would provide structural FRM improvements for both the northern and southern basins of West Sacramento. It would include improvement of the existing levees by either improving the levees in place or constructing a new levee adjacent to the existing levee. Improvements to the levee along the Sacramento River in the South Basin would include construction of a setback levee. The DWSC East and the Sacramento River South Levees would be extended 20 miles to the south of the South Cross Levee for flood risk

management for the southern portion of West Sacramento Basin. This alternative was not carried forward because it was not cost effective.

Table 3-9: Preliminary Alternative 0.5D – West Sacramento Basin Alternative - Proposed Improvement Measures by Reach.

WATERWAY/REACH	SEEPAGE MEASURES	STABILITY MEASURES	EROSION PROTECTION MEASURES	OVERTOPPING MEASURES
Sacramento River North Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port North	--	--	--	Flood Wall or Raise Levee in Place
Yolo Bypass Levee	Slurry Wall	Slurry Wall	--	--
Sacramento Bypass Training Levee	--	--	Waterside Armoring Bank Protection	--
Sacramento River South Levee (Extended 20 miles south)	Slurry Wall or Seepage Berm	Slurry Wall or Seepage Berm	Waterside Armoring Bank Protection	Raise Levee in Place
South Cross Levee	Relief Wells	Stability Berm	--	Raise Levee in Place
Deep Water Ship Channel East Levee (Extended approximately 20 miles south)	Slurry Wall	Slurry Wall	--	Raise Levee in Place
Deep Water Ship Channel West Levee (Extended approximately 20 miles south)	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port South Levee	--	--	--	--

3.12.1 Preliminary Alternative 1: Improve Levees

Alternative 1 involves the construction of levee remediation measures to address seepage, slope stability, erosion, and overtopping concerns identified for the various reaches.

Due to environmental, real estate, and hydraulic concerns within the West Sacramento North Basin, the improvements will predominantly be accomplished by fix in place construction methods. Along the Sacramento River in the South Basin a combination of fix in place, adjacent levee, and setback levee improvements are proposed. The purpose of this alternative would be to improve the flood management system to safely convey flows to a level that maximizes net benefits. Table 3-10 summarizes the levee problems discussed above and the proposed measure for each reach.

Table 3-10: Preliminary Alternative 1 -Improve Levees Alternative - Proposed Improvement Measures by Reach

Waterway/Reach	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
Sacramento River North Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port North	--	--	--	Flood Wall or Raise Levee in Place
Yolo Bypass Levee	Slurry Wall	Slurry Wall	--	--
Sacramento Bypass Training Levee	--	--	Waterside Armoring Bank Protection	--
Sacramento River South Levee	Slurry Wall and Seepage Berm	Slurry Wall and Seepage Berm	Waterside Armoring Bank Protection	Raise Levee in Place
South Cross Levee	Relief Wells	Stability Berm	--	Raise Levee in Place
Deep Water Ship Channel East Levee	Slurry Wall	Slurry Wall	--	Raise Levee in Place
Deep Water Ship Channel West Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port South Levee	Slurry Wall	Slurry Wall	--	Raise Levee in Place

Improving the existing levees to address seepage, stability, erosion, and height issues is the first increment to reducing flood risk for the West Sacramento area; this alternative was carried forward.

3.12.2 Preliminary Alternative 2: Improve Levees and Widen the Sacramento Weir and Bypass

This alternative would include the levee improvements discussed in the Improve Levees alternative, except for the levee raises identified along the Sacramento River. Instead of the levee raises, the Sacramento Weir and Bypass would be widened to divert more flows into the Yolo Bypass. The levees along Port North, Yolo Bypass, South Cross Levee, DWSC East and West, and Port South reaches would be improved to address identified seepage, stability, erosion, and height concerns through the methods described under the Improve levees alternative. The levees along the Sacramento River would be improved to address identified seepage, stability, and erosion concerns through the measures described under the improve levees alternative. Due to environmental, real estate, and hydraulic concerns within the West Sacramento North Basin the majority of the levees would be fixed in place.

This alternative would include widening the Sacramento Bypass by approximately 1,500 feet to increase the amount of flow it conveys into the Yolo Bypass. This alternative includes replacement of the Sacramento Weir, demolition of the existing north Sacramento Bypass levee, construction of a new levee approximately 1,500 feet to the north. This alternative would reduce the amount of levee that needs to be raised along the Sacramento River.

Table 3-11: Preliminary Alternative 2 - Improve Levees and Sacramento Weir and Bypass Widening Alternative - Proposed Improvement Measures by Reach

WATERWAY/REACH	SEEPAGE MEASURES	STABILITY MEASURES	EROSION PROTECTION MEASURES	OVERTOPPING MEASURES
Sacramento River North Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Sacramento Weir and Bypass Widening
Port North	--	--	--	Flood Wall or Raise Levee in Place
Yolo Bypass Levee	Slurry Wall	Slurry Wall	--	--
Sacramento Bypass Training Levee	--	--	Waterside Armoring Bank Protection	--
Sacramento River South Levee	Slurry Wall and Seepage Berm	Slurry Wall and Seepage Berm	Waterside Armoring Bank Protection	Sacramento Weir and Bypass Widening
South Cross Levee	Relief Wells	Stability Berm	--	Raise Levee in Place
Deep Water Ship Channel East Levee	Slurry Wall	Slurry Wall	--	Raise Levee in Place
Deep Water Ship Channel West Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port South Levee	Slurry Wall	Slurry Wall	--	Raise Levee in Place

Further engineering analysis indicated that there is approximately 4,600 ft of height deficiency on Sacramento River North, out of a total reach length of 30,700 ft. The preliminary cost to widen the Sacramento Weir and Bypass is approximately $200,000,000, according to the analysis presented in the ARCF GRR. Based on this information, the limited amount of levee raising need along the Sacramento River in West Sacramento and the estimated cost to widen the Sacramento Weir and Bypass, widening of the Sacramento Weir and Bypass is not a cost effective means to address height deficiency on the Sacramento River levees in West Sacramento. This alternative is not being carried forward as part of the West Sacramento GRR. Widening of the Sacramento Weir and Bypass is being carried forward as part of the locally preferred plan for the American River Common Features General Reevaluation Report project.

3.12.3 Preliminary Alternative 3 – Improve Levees and DWSC Closure Structure

This alternative would include construction of a Closure Structure in the DWSC that would provide flood risk management for West Sacramento and the Port of West Sacramento from flood flows in the DWSC. The Port of West Sacramento is considered critical infrastructure. Implementation of this alternative would reduce the need to improve the DWSC West levee downstream of the structure, improve the DWSC East levee north of the structure, and improve the Port North and Port South levees, and address environmental impacts associated with those improvements. The other levees that provide FRM for West Sacramento would be improved by either fixing the levees in place or construction of a levee adjacent to the existing levee.

Table 3-12: Preliminary Alternative 3 - Improve Levees and DWSC Closure Structure - Proposed Improvement Measures by Reach

WATERWAY/REACH	SEEPAGE MEASURES	STABILITY MEASURES	EROSION PROTECTION MEASURES	OVERTOPPING MEASURES
Sacramento River North Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port North	--	--	--	--
Yolo Bypass Levee	Slurry Wall	Slurry Wall	--	--
Sacramento Bypass Training Levee	--	--	Waterside Armoring Bank Protection	--
Sacramento River South Levee	Slurry Wall and Seepage Berm	Slurry Wall and Seepage Berm	Waterside Armoring Bank Protection	Raise Levee in Place
South Cross Levee	Relief Wells	Stability Berm	--	Raise Levee in Place
Deep Water Ship Channel East Levee North of Structure	--	--	--	--
Deep Water Ship Channel East Levee South of Structure	Slurry Wall	Slurry Wall	--	Raise Levee in Place
Deep Water Ship Channel West Levee North of Structure	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Deep Water Ship Channel West Levee South of Structure	--	--	--	--
Port South Levee	--	--	--	--

Improving the existing levees to address seepage, stability, erosion and height issues is the first increment to reducing flood risk for the West Sacramento area. The Closure Structure reduces the extent and impacts of levee improvements, and provides protection to the Port of West Sacramento. For these reasons this alternative was carried forward.

The Closure Structure will be a sector gated structure with 200-foot wide opening, constructed in the DWSC approximately 500 feet north of the South Basin Main Drain Pumping Plant. The structure will be constructed of conventionally reinforced and post tensioned concrete supported on a pipe pile foundation.

3.12.4 Preliminary Alternative 4 – Improve Levees, Widen Sacramento Weir and Bypass, and DWSC Closure Structure

This alternative would include construction of a Closure Structure in the DWSC that would provide flood risk management for West Sacramento and the Port of West Sacramento from flood flows in the DWSC. Implementation of this alternative could reduce the need to raise the DWSC West levee in the project area and provide hydraulic mitigation to reaches along the DWSC East and West levee south of the

project area and improve the Port North and Port South levees. This alternative also includes replacement of the Sacramento Weir, demolition of the existing north Sacramento Bypass levee, and construction of a new levee approximately 1,500 feet to the north. This measure would reduce the amount of levee that needs to be raised along the Sacramento River and the Sacramento Bypass portion of the alternative would be cost shared by both the West Sacramento and American River Common Features projects. The other levees that provide FRM for West Sacramento would be improved by either fixing the levees in place, construction of a levee adjacent to the existing levee, or construction of a new setback levee.

Table 3-13. Preliminary Alternative 4 - Improve Levees, Sacramento Weir and Bypass Widening Alternative, and DWSC Closure Structure - Proposed Improvement Measures by Reach.

WATERWAY/REACH	SEEPAGE MEASURES	STABILITY MEASURES	EROSION PROTECTION MEASURES	OVERTOPPING MEASURES
Sacramento River North Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Sacramento Weir and Bypass Widening
Port North	--	--	--	DWSC Closure Structure
Yolo Bypass Levee	Slurry Wall	Slurry Wall	--	--
Sacramento Bypass Training Levee	--	--	Waterside Armoring Bank Protection	--
Sacramento River South Levee	Slurry Wall and Seepage Berm	Slurry Wall and Seepage Berm	Waterside Armoring Bank Protection	Sacramento Weir and Bypass Widening
South Cross Levee	Relief Wells	Stability Berm	--	Raise Levee in Place
Deep Water Ship Channel East Levee North of Structure	--	--	--	--
Deep Water Ship Channel East Levee South of Structure	Slurry Wall	Slurry Wall	--	Raise Levee in Place
Deep Water Ship Channel West Levee North of Structure	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Levee Raise
Deep Water Ship Channel West Levee South of Structure	--	--	--	--
Port South Levee	DWSC Closure Structure	--	--	DWSC Closure Structure

As discussed in Alternative 2, engineering analysis indicates that there is approximately 4,600 ft of height deficiency on the Sacramento River North reach, out of a total reach length of 30,700 ft. The preliminary cost to widen the Sacramento Weir and Bypass is approximately $200,000,000, according to the analysis presented in the ARCF GRR. Based on this information widening of the Sacramento Weir and Bypass is

not a cost effective means to address height deficiency on the Sacramento River levees. The Closure Structure is being evaluated and carried forward as part of Alternative 3. Therefore, this alternative is not being carried forward as part of the West Sacramento GRR.

As previously discussed widening of the Sacramento Weir and Bypass is being carried forward as part of the locally preferred plan for the American River Common Features GRR project.

3.12.5 Preliminary Alternative 5 – Improve levees and include Southport Setback Levee

This alternative would be similar to Alternative 1 except that a setback levee would be constructed in Southport along the Sacramento River. This alternative involves the construction of levee remediation measures to address seepage, slope stability, erosion, and overtopping concerns identified for the various reaches.

Table 3-14. Preliminary Alternative 5 - Improve levees and include Southport Setback Levee - Proposed Improvement Measures by Reach

WATERWAY/REACH	SEEPAGE MEASURES	STABILITY MEASURES	EROSION PROTECTION MEASURES	OVERTOPPING MEASURES
Sacramento River North Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port North	--	--	--	Flood Wall or Raise Levee in Place
Yolo Bypass Levee	Slurry Wall	Slurry Wall	--	--
Sacramento Bypass Training Levee	--	--	Waterside Armoring Bank Protection	--
Sacramento River South – Setback Levee	Setback levee with Slurry Wall and Seepage Berm	Setback levee with Slurry Wall and Seepage Berm	Waterside Armoring Bank Protection	New Setback Levee
South Cross Levee	Relief Wells	Stability Berm	--	Raise Levee in Place
Deep Water Ship Channel East Levee	Slurry Wall	Slurry Wall	--	Raise Levee in Place
Deep Water Ship Channel West Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port South Levee	Slurry Wall	Slurry Wall	--	Raise Levee in Place

Improving the existing levees to address seepage, stability, erosion, and height issues is the first increment to reducing flood risk for the West Sacramento; this alternative was carried forward.

3.12.6 Preliminary Alternative 6: Improve Levees and Construct the I-Street Diversion Structure

This alternative would include the construction of a diversion structure just upstream of the existing I Street Bridge on the Sacramento River. This diversion structure would restrict flows going down the Sacramento River past the cities of Sacramento and West Sacramento, and would cause a portion of the flows from the Sacramento and American Rivers to be backed upstream through the Sacramento Bypass

out to the Yolo Bypass. The Sacramento Bypass and Weir would be widened to accommodate the increased flows to the bypass system. The effect of this diversion structure would be to reduce the water surface elevation of the Sacramento River downstream of the structure to the point at which seepage, stability, height, and erosion improvements would not be needed in order to safely convey the 200 year design event.

The I Street Diversion Structure would consist of a two hundred (200) foot wide, non-gated u-frame structure and four (4) sixty-two (62) foot wide tainter gates. Tie-in-T-Walls are provided on either side of the major structures to tie in to the existing levees along the Sacramento River. The structures consist of conventionally reinforced concrete, supported on pipe pile foundations. Upper sand layers within the Sacramento River will be densified with ground improvement technology to prevent liquefaction during a seismic event. The structures would be constructed in three phases utilizing internally braced Temporary Retaining Structures (TRS) for cast-in-place construction.

Table 3-15. Preliminary Alternative 6 - (I-Street Diversion Structure) Proposed Improvement Measures by Reach

WATERWAY/REACH	SEEPAGE MEASURES	STABILITY MEASURES	EROSION PROTECTION MEASURES	OVERTOPPING MEASURES
Sacramento River Levee North of Diversion Structure	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port North	--	--	--	Flood Wall or Raise Levee in Place
Yolo Bypass Levee	Slurry Wall	Slurry Wall	--	--
Sacramento Bypass Training Levee	--	--	Waterside Armoring Bank Protection	--
Sacramento River South of Diversion Structure	I Street Diversion Structure	I Street Diversion Structure	I Street Diversion Structure	I Street Diversion Structure
South Cross Levee	Relief Wells	Stability Berm	--	Raise Levee in Place
Deep Water Ship Channel East Levee	Slurry Wall	Slurry Wall	--	Raise Levee in Place
Deep Water Ship Channel West Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port South Levee	Slurry Wall	Slurry Wall	--	Raise Levee in Place

3.12.7 Workshops

In order to develop Alternative 6 to an adequate level of detail to compare it to the other alternatives, within the schedule and budget as outlined by the planning modernization initiative (complete a study for under $3 million, in 3 years and with 3 levels of review (3x3x3) as identified in memorandum from Major General Walsh on 8 February 2012), qualitative information was obtained. This information was obtained through a series of workshops in which a panel of experts were gathered to assess the risks associated with unknown and unanalyzed aspects of the proposed I Street Diversion Structure alternative. The panel was asked to identify measures to mitigate the risks and then assign rough costs to

the mitigation. Workshop 1 addressed the construction and operation of the structure. Workshop 2 addressed environmental effects associated with the structure and the overall alternative. Workshop 3 addressed regional or system effects of the structure and the overall alternative. A summary for the three workshops is presented below.

The Structural and Environmental workshops (Workshops 1 and 2) identified risks which the panel believed could be mitigated through design refinements and resource agency coordination. The System workshop (Workshop 3) however, identified several issues that would screen out the alternative. These issues include the following:

- The initial cost identified by the PDT for addressing Yolo Bypass hydraulic mitigation was not adequate. A physical modification to the bypass would be needed to reduce the water surface elevation to effectively mitigate for the additional flows redirected to the bypass by the diversion structure. The costs for this physical modification greatly increase the overall alternative cost to the point that the alternative is more costly (see Table 3-19) than the other alternatives.
- The implementation time for this alternative would leave the densely populated areas of Sacramento and West Sacramento at risk of flooding for an unacceptable period of time. Construction of the widened Sacramento Weir and Bypass and the Diversion Structure would need to be completed, which could take 10-20 years, before a reduced risk of flooding for the urban areas would be realized. This approach does not follow addressing the worst problems first, and
- The Diversion Structure is not consistent with the CVFPP, in that the CVFPP is founded on the principals of reducing long term flood risks and maintenance costs through multi-objective planning, sustainability, flexibility and restoration of natural biological processes, floodplains, and fluvial processes to the extent possible. It is unlikely that the State would partner with USACE on a structure that is not consistent with the CVFPP. This alternative was therefore not carried forward for further evaluation.

3.12.8 Preliminary Alternative 7: Upstream Storage on the American River

This alternative involves construction of a flood control dam near the town of Auburn on the north fork American River for the purpose of attenuating flows continuing downstream into Folsom Reservoir and the lower American River. The basis for this alternative is the 1996 American River Watershed Investigation Supplemental Information Report updated to current price levels and understanding of downstream levee work. The location of the dam is driven by the shape of the canyon; costs for seismic considerations are not a driver. Additionally, levee improvements to address seepage, stability, erosion, and height concerns are included where they exist in various stretches of levees protecting the City of West Sacramento.

Construction of a detention facility upstream of Folsom Dam on the American River at the Auburn Damsite has previously been studied, has twice been determined to be the NED (preferred) plan, and has twice not been authorized. Following completion of the American River Watershed Project, Supplemental Information Report (SIR), which proposed the Auburn Dam as the NED plan, Congress directed the Corps to consider measures that included increasing flood storage at Folsom Dam.

Public response stemming from the last time Auburn Dam was recommended by the Corps was strongly opposed. Over 2500 comments were submitted from individuals during the public review of the 1996 Supplemental Information Report. Of these, over 87% opposed any kind of dam at Auburn, 10% wanted a multi-purpose reservoir, while the remainder, less than 2%, supported the recommended plan.

In addition, in December 2008, the State Water Resources Control Board revoked the Bureau of Reclamation's rights to develop water at Auburn, arguing that improvements elsewhere in the system mean that the Auburn Dam Project is not needed to provide adequate flood control for the region. Absent legislation to the contrary, the Bureau of Reclamation would be required to apply for new water rights to construct Auburn Dam.

The previous analysis for justification of the Auburn Dam assumed there would be little downstream levee work required on the Sacramento River levees. Additional soil boring investigations conducted since the 1991 and 1996 SIRs along with actual recorded levee performance during the 1997 flood event have determined that the levees along the Sacramento River are in worse condition than was assumed at the time of the previous studies. The Sacramento River levees have problems with through and under levee seepage as well as erosion concerns. The 1997 flood event increased the District's level of understanding of the flood risk threatening the Cities of Sacramento and West Sacramento, specifically with regard to levee under-seepage. The cost of levee improvements to address levee under-seepage is much more expensive than envisioned in the earlier reports.

A preliminary cost estimate was developed by escalating the reported cost of Auburn Dam from the 1996 SIR report. The current cost to construct Auburn Dam was estimated to be $1.8 billion. This estimate is likely very low since it was developed for a single purpose flood control dry dam. A dam constructed today would most likely be a multipurpose dam and the costs would be allocated among various purposes. In order to make this alternative complete, additional cost to cover erosion protection measures along the American River and the other improvements to the levees protecting Sacramento would need to be added. These costs would be approximately $1.4 billion, which, combined with the dam construction cost, would total $3.2 billion. This estimate was annualized and compared to the annual benefits and determined to be justified. This preliminary alternative was not carried forward because it does not address the high frequency flood risk associated with the poor performance of levees in the study area and does not reduce risk for the highest risk area along the Sacramento River since this area is dominated by Sacramento River flows. Additionally, West Sacramento receives very few benefits from Auburn Dam because its greatest risk drivers are the Sacramento River and the Yolo Bypass. However, this alternative could be considered in a follow-on study to consider ways to reduce the residual risk in the study area.

Table 3-16. Preliminary Alternative 7 – (Auburn Dam) - Proposed Levee Improvement Measures by Reach

WATERWAY/REACH	SEEPAGE MEASURES	STABILITY MEASURES	EROSION PROTECTION MEASURES	OVERTOPPING MEASURES
Sacramento River North Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port North	--	--	--	Flood Wall or Raise Levee in Place
Yolo Bypass Levee	Slurry Wall	Slurry Wall	--	--
Sacramento Bypass Training Levee	--	--	Waterside Armoring Bank Protection	--
Sacramento River South Levee	Slurry Wall and Seepage Berm	Slurry Wall and Seepage Berm	Waterside Armoring Bank Protection	Raise Levee in Place
South Cross Levee	Relief Wells	Stability Berm	--	Raise Levee in Place
Deep Water Ship Channel East Levee	Slurry Wall	Slurry Wall	--	Raise Levee in Place
Deep Water Ship Channel West Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port South Levee	Slurry Wall	Slurry Wall	--	Raise Levee in Place

3.12.9 Preliminary Alternative 8: Maximum Plan

The Maximum Plan to reduce flood risk for the city of West Sacramento and the surrounding area would include most of the measures previously discussed. Due to the fact that the City of Sacramento is the capital of the State of California, has several hundred thousand residents residing and working in the floodplain, critical infrastructure of State and National value, and is one of the most at risk urban areas in the country for flooding, the focus of this Maximum Alternative would be to identify all means possible to reduce the risk of flooding and not constrain the plan by net benefits or performance. Therefore, the Maximum Plan would include all the levee improvements along the Sacramento River, as well as the Yolo Bypass, DWSC, South Cross Levee, Port North and Port South. The alternative would include widening of the Sacramento Weir and Bypass. This alternative would also include construction of a dam upstream on the American River near the town of Auburn which would further reduce the risk of flooding from a 0.5% (1/200) ACE year to about a 0.25% (1/400) ACE event. Additional levee raises along the Sacramento River would also be included to increase the performance of these levees to a comparable level to that of the American River flood management system with an upstream dam in place.

Table 3-17. Preliminary Alternative 8 – (Maximum Plan) - Proposed Levee Improvement Measures by Reach

WATERWAY/REACH	SEEPAGE MEASURES	STABILITY MEASURES	EROSION PROTECTION MEASURES	OVERTOPPING MEASURES
Sacramento River North Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port North	--	--	--	Flood Wall or Raise Levee in Place
Yolo Bypass Levee	Slurry Wall	Slurry Wall	--	--
Sacramento Bypass Training Levee	--	--	Waterside Armoring Bank Protection	--
Sacramento River South Levee	I Street Diversion Structure and Cutoff Wall	I Street Diversion Structure and Cutoff Wall	I Street Diversion Structure and Bank Protection	I Street Diversion and Sacramento Bypass and Weir Widening
South Cross Levee	Relief Wells	Stability Berm	--	Raise Levee in Place
Deep Water Ship Channel East Levee	Slurry Wall	Slurry Wall	--	Raise Levee in Place
Deep Water Ship Channel West Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port South Levee	Slurry Wall	Slurry Wall	--	Raise Levee in Place

3.12.10 Preliminary Alternative 9: Non-Structural Alternative

The non-structural alternative would consist of measures such as Floodplain Management, Providing Floodplain Information to Regulatory Agencies, Annual Publication of Residual Risks, Telemeter Stream Flow Gages, Modifications to Flood Warning System, National Flood Insurance Program. These measures reduce the consequences of flooding, but do not reduce the probability of flooding and therefore do not significantly reduce the overall risk of flooding.

Several non-structural flood risk management elements could be added to any of the final array of flood risk management alternative plans to further reduce flood risk and flood damages. Whereas structural project features, such as levees and channel improvements, can reduce the risk of flooding, non-structural features can reduce the consequences of flooding. The combination of both structural and non-structural elements should ideally be used to reduce the flood risk to an area.

3.13 Screening of Preliminary Array of Alternatives

Federal planning criteria were used as the screening structure for the first level screening of the preliminary array of alternatives.

3.13.1 Completeness

The definition of “completeness” from the Planning Guidance Notebook is, “the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the

realization of the planning objectives, including actions by other Federal and non-federal entities." The study further defines a complete and effective alternative as one that best meets the study objectives of reducing flood risk and damages and minimizes the resulting residual flood risk to public and life safety. Completeness is evaluated using metrics for public and life safety developed during the study as well as assessing all potential effects of the recommended plan and accounting for mitigation of those effects.

3.13.2 Effectiveness

Within identified constraints of the study, each alternative in the draft array addresses all of the planning objectives regarding FRM and life safety to varying degrees. No further evaluation and screening was necessary for this criterion.

3.13.3 Efficiency

This criterion is defined in terms of cost efficiency of economic residual annual damages and FRM analysis for annual net benefits. As part of the analysis for cost efficiency, the NED Plan is identified as the alternative that reasonably maximizes annual net benefits. The draft array of alternatives will be screened for cost efficiency using economic criteria. Class 4 parametric cost estimates were developed for the alternatives. The confidences range for this type of cost estimate is +/- 50% - 200%.

3.13.4 Acceptability

The local sponsor, the Central Valley Flood Protection Board (CVFPB) along with the West Sacramento Area Flood Control Agency [WSAFCA] and the public are highly aware of the West Sacramento area's flood risk. The sponsors and community continue their support and acceptance of the flood risk management efforts. The alternatives are acceptable because they are compatible with existing laws, regulations, and public policies.

3.13.5 Evaluation Metrics

The evaluation metrics, as part of the multi-objective planning process to support the study objectives, were developed as a screening analysis tool to assist in organizing and evaluating alternatives across the system of planning accounts. These planning accounts are USACE tools used to categorize benefits of a project. The four accounts used are listed below.

- National Economic Development (NED).
- Environmental Quality (EQ).
- Regional Economic Development (RED).
- Other Social Effects (OSE) – public and life safety.

The evaluation metrics were partly aligned with the evaluation criteria established during the study process. The metrics were developed to permit evaluation of the project beyond the traditional single account of NED. The metrics permitted the evaluation of the project by the other accounts of EQ, RED, and OSE with an emphasis on the study objective of public and life safety.

Table 3-18. Evaluation Metric Criteria and Study Objectives.

STUDY OBJECTIVES	EVALUATION METRIC
(a) Reduce the risk to life, health, and public safety due to flooding	Remaining population at risk within the floodplains of each basin
	Number of evacuation routes available with each alternative
(b) Reduce the risk of property damage due to flooding	NED Costs for each alternative
	NED Benefits for each alternative
(c) Reduce the risk of damage to critical infrastructure due to flooding	Number of critical Infrastructure features within the residual floodplain of each basin
(d) Encourage the wise use of the floodplain	Calculate the remaining potentially developable floodplain with each alternative described as the acres of land with 3 feet of flooding or less
(e) Educate the public about ongoing residual risk in the West Sacramento Area.	Sponsor's efforts to increase awareness via floodplain notification

Table 3-19: Evaluation of Costs and Benefits of the Preliminary Array of Alternatives (in $1,000s) [1,2]

	FIRST COSTS	ANNUAL COST	ANNUAL BENEFITS	NET BENEFITS	B/C
Alt 0.5A. North Basin Plan	1,029,120	54,863	175,800	120,937	3.2
Alt 0.5B. South Basin Plan	1,410,858	81,210	98,100	16,890	1.2
Alt 0.5C. Mid-Cross Levee	2,191,353	142,273	256,900	114,627	1.8
Alt 0.5D – West Sacramento Basin	3,699,752	324,128	271,310	(52,798)	0.8
Alt 1 – Improve Levees	1,708,109	104,043	256,859	152,816	2.5
Alt 2 – Improve Levees and Widen Sacramento Bypass	1,878,634	115,356	255,376	140,025	2.2
Alt 3 – Improve Levee and DWSC Structure	1,961,058	123,058	256,859	133,801	2.1
Alt 4 - Improve Levee, DWSC Structure, Widen Sac Bypass	2,131,583	139,623	255,376	115,753	1.8
Alt 5 – Improve Levee and Southport Setback	1,513,961	88,732	256,859	168,127	2.9
Alt 6 - I Street Diversion Structure	2,242,641	149,516	255,376	105,860	1.7
Alt 7 – Upstream Storage on American	3,508,109	304,833	256,859	(47,974)	0.8
Alt 8 – Maximum Plan	4,878,634	553,238	255,376	(297,862)	0.5

[1] Based on October 2013 price levels, 3.5 percent rate of interest, and a 50-year period of analysis.
[2] Preliminary Costs were based on a combination of estimates developed for the GRR, previous USACE studies, and costs developed by private consultants.

Table 3-20 displays the extent to which the preliminary alternatives meet the planning criteria and the results from this screening.

Table 3-20: Screening of Preliminary Array of Alternatives

PRELIMINARY ALTERNATIVE	COMPLETENESS (STAND ALONE)	EFFICIENCY (COST EFFECTIVE)	EFFECTIVENESS (MEETS OBJECTIVES)	ACCEPTABILITY (IMPLEMENTABILITY)	CARRIED FORWARD?
0.5A. North Basin Plan	No	Yes, but does not maximize net benefits	No, leaves a population of approximately 19,000 in the South Basin at risk of flooding	No	No
0.5B. South Basin Plan	No	Yes, but does not maximize net benefits	No, leaves a population of approximately 29,000 in the North Basin at risk of flooding	No	No
0.5C. Mid-Cross Levee	Yes	No	No, leaves about 800 people at risk in the unprotected portion of the South Basin	No	No
0.5D. West Sacramento Basin	Yes	No	Yes	No	No
1. Improve Levees	Yes	No, alternative 5 provides same benefits at a lower cost	Yes	Yes, but ETL issues need to be addressed	**Yes**
2. Improve Levees & Widen Sacramento Weir and Bypass	Yes	No – Raising levees is more cost effective than bypass widening	Yes	Yes, but ETL issues need to be addressed. Potential hydraulic impacts to Yolo Bypass	No (The bypass feature is being carried forward as the LPP for the ARCF Project)
3. Improve Levee and Construct DWSC Closure Structure	Yes	No, alternative 5 provides same benefits at a lower cost	Yes	Yes, but ETL issues need to be addressed	**Yes**

PRELIMINARY ALTERNATIVE	COMPLETENESS (STAND ALONE)	EFFICIENCY (COST EFFECTIVE)	EFFECTIVENESS (MEETS OBJECTIVES)	ACCEPTABILITY (IMPLEMENTABILITY)	CARRIED FORWARD?
4. Improve Levee , Widen Sacramento Weir and Bypass and Construct DWSC Closure Structure	Yes	No – Raising levees is more cost effective than bypass widening	Yes	Yes, but ETL issues need to be addressed. Potential hydraulic impacts to Yolo Bypass	No (The bypass feature is being carried forward as the LPP for the ARCF Project)
5. (LPP) Improve levees and include South Setback Levee along Sacramento River South reach	Yes	Yes, improving levees is first increment and most cost effective	Yes	Yes, ETL issues need to be addressed but Southport setback levee reduces total environmental impact and can provide location for mitigation	**Yes**
6. Improve Levees and Construct I-Street Diversion Structure	Yes	No	Yes	No, potential hydraulic impacts to Yolo Bypass. Long construction time would leave urban areas vulnerable to flooding. Lack of local support	No
7. Upstream Storage on American River	Yes	No, NED plan in two prior studies, however cost of downstream features have increased significantly	Yes	No, Congressional support and public support lacking	No
8. Maximum Plan	Yes	No	Yes	Partially	No
9. Non-Structural	No	Yes	No	No	No

The evaluation of the cost and benefits of the revised preliminary array of alternatives identified Alternatives 0.5A, 0.5C, 1, 2, 3, 4, and 5 as having the highest net benefits. The following alternatives were not carried forward into the final array of alternatives based on the rationale presented below:

- Alternative 0.5A, the North Basin Protection Plan, was not carried forward into the final array of alternatives because it does not adequately meet the objective of reducing the population at risk of flooding and reducing the damages associated with flooding. Protecting only the North Basin would leave approximately 19,200 people and damages totaling $124,700,000 annually at risk of flooding in the unprotected South Basin. This alternative would leave a significant residual risk by not addressing the flood risk in the Southern Basin, thus making it unacceptable to the non-Federal sponsors.

- Alternatives 2 and 4 include widening of the Sacramento Bypass. This feature was determined not to be incrementally justified for West Sacramento as it provides more benefits to the ARCF project, and was carried forward into the ARCF final array of alternatives; therefore, Alternatives 2 and 4 were not carried forward into the final array of alternatives for the West Sacramento study.

- Alternative 0.5C, the Mid-Cross Levee Alternative, in addition to having less net benefits than several other alternatives, was also not carried into the final array of alternatives for the following reasons:

  Alternative 0.5C maintains approximately 1,900 acres of existing undeveloped city land; however, approximately 800 people and associated property are left at risk in the unprotected portion of the South Basin. In addition, it leaves the two southern evacuation routes from the South Basin, Jefferson Boulevard and River Road, in the unprotected portion of the basin. Removal of these two evacuation routes is significant due to the limited evacuation routes that exist for West Sacramento as a whole. Alternative 0.5C would also disrupt community cohesion by isolating part of the older developed portions of the South Basin from the protected area north of the Mid-Cross Levee; as a result there would be much resistance to this plan from the residents of West Sacramento.

  There are also significant hydraulic concerns associated with the implementation of the Mid-Cross levee alternative. If the existing levee along the Sacramento River failed, or was breached or removed, there could be significant flooding concerns for the areas downstream of West Sacramento. Flood waters from a breach along the unimproved Sacramento River levee would inundate the unprotected portion of the South Basin and could overtop or breach the unimproved South Cross levee, resulting in floodwaters inundating a significant portion of the approximately 31,400 acre basin south of the South Cross levee. In addition, failure of the Sacramento River South levee and inundation of the unprotected portion of Southport south of the Mid-Cross levee could disrupt the functionality of the Sacramento River Flood Control System, particularly the function of the Sacramento Bypass and the flow split of the American and Sacramento Rivers into the Yolo Bypass. Potential disruption of the functionality of the Sacramento River Flood Control system is of particular concern because of the highly urbanized areas in the project vicinity. The setback levee associated with Alternative 0.5C and the potential to draw more water down the Sacramento River, with less going through the Sacramento Weir to the Sacramento and Yolo Bypass, would result in potentially significant hydraulic impacts to the highly urbanized Pocket area of Sacramento. Construction of the Mid-Cross levee alternative would create a much larger area between the Sacramento River and the Mid-Cross setback levee than that proposed by the Southport project, with potentially significant hydraulic impact concerns associated with more water flowing down the Sacramento River. In addition, potential disruption of the functionality of the existing Sacramento River Flood Control System is counter to the objectives of the State of California Central Valley Flood Protection Plan which, in part, promotes greater utilization of the Yolo Bypass thru widening of the Fremont and Sacramento Weir while improving the existing levees along the Sacramento River. Because of the risk of significant hydraulic impacts the existing Sacramento River right bank levee would need to be maintained, and should be improved to the authorized level of protection. Improvement and maintenance of this levee would add significant costs to Alternative 0.5C.

Based on the rationale presented above, Alternatives 1, 3, and 5 were carried forward to the final array of alternatives for further evaluation and comparison.

3.14 FINAL ARRAY OF ALTERNATIVES

Based on the results of the evaluation of the preliminary array of alternatives, alternatives 1, 3 and 5 were carried forward to the final array of alternatives for further evaluation and comparison.

3.14.1 Final Alternative 1: Improve Levees

Alternative 1 would include the construction of levee improvements to address seepage, stability, erosion, and height concerns for the Sacramento River, Yolo Bypass, Port North and Port South levees, South Cross Levee, and the DWSC East and West Levees. This alternative combines construction of levee improvements while maintaining the present alignment in its existing location (fix in place) as well as the construction and realignment of the levee onto an adjacent levee landward of the existing levee. Due to environmental, real estate, and hydraulic constraints within the West Sacramento North Basin, the improvements will be predominantly be accomplished by fix in place construction methods. Along the Sacramento River in the South Basin a combination of fix in place and adjacent levee improvements are proposed. The purpose of this alternative would be to improve the flood management system to safely convey flows to a level that maximizes net benefits.

The following sections contain more detailed information on the specific features and reaches included in this alternative.

3.14.1.1 North Basin

Sacramento River North Levee

The Sacramento River North levee needs to be repaired to address seepage, stability, erosion and height concerns. To address seepage concerns a slurry wall will be constructed through the levee crown. Degradation of the levee crown is necessary to create a large enough working platform (approximately 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids. Depending on the depth of the slurry wall needed to address the seepage issue the slurry wall would be installed by one of two methods. The conventional slot trench method, utilizing a long boom excavator can install a slurry wall to a depth of approximately 85 feet. For slurry walls of greater depth the Deep Soil Mixing (DSM) method would be utilized. The DSM method involves a crane supported set of two to four mixing augers used to drill through the levee crown and subsurface to a maximum depth of approximately 140 feet. For both methods, once the slurry has hardened it is capped and the levee embankment reconstructed with impervious or semi-impervious soil.

The proposed levee section consists of 20-foot wide levee crown with 2H:1V to 3H:1V side slopes. Where the existing levee does not meet the levee design requirements, slope flattening, crown widening, and or levee raise is required. This improvement measure addresses deficiencies with slope stability, geometry, and levee crest access and maintenance.

To begin levee embankment grading, the area is cleared, grubbed, stripped, and where necessary portions of the existing embankment are removed to allow for bench cuts and keyways to tie in additional embankment fill. Excavated and borrow material (from nearby borrow sites) must be

stockpiled at staging areas. Haul trucks and front end loaders bring borrow materials to the site and graders spread material evenly according to levee design plans. Sheepsfoot rollers compact the material. The existing levee centerline may be shifted landward where permitted or a short (less than 5 feet tall) reinforced concrete retaining wall may be constructed at the landside levee toe to prevent increased levee footprint width.

The primary erosion protection measure consists of waterside armoring of the levees to prevent erosion and subsequent damage to the levee. This measure consists of placing rock revetment on the river's bank, and in some locations on the levee slope, to prevent erosion. The extent of the revetment would be based on site-specific analysis. When necessary, the eroded portion of the bank would be filled and compacted prior to the rock placement. The sites would be prepared by clearing and stripping the site prior to construction. Small vegetation and deleterious materials would be removed. Bank protection would be placed around existing trees on the lower portion of the slope. Trees on the upper portion of the slope would be removed during degrading of levees for slurry cutoff walls and bank protection would be placed following reconstruction of the levee. Temporary access ramps would be constructed, if needed, using imported borrow material that would be trucked on site.

Revetment would be imported from an offsite location via haul trucks or barges. Revetment transported by haul trucks would be temporarily stored at a staging area located in the immediate vicinity of the construction site. A loader would be used to move revetment from the staging area to an excavator that would place the material on site. Rock required on the upper portions of the slopes would be placed by an excavator located on top of the levee. Rock placement from atop the levee would require one excavator and one loader for each potential placement site.

Revetment transported by barges would not be staged, but placed directly on site by an excavator. Rock required within the channel, both below and slightly above the water line at the time of placement, would be placed by an excavator located on a barge. The excavator would construct a large rock berm in the water up to an elevation slightly above the mean summer water surface. A planting trench would be established on this rock surface for revegetation purposes. Construction would require two barges: one barge would carry the excavator, while the other barge would hold the stockpile of rock to be placed on the channel slopes.

The bank protection would be placed via the methods discussed above on the existing bank at a slope varying from 2V:1H to 3V:1H, depending on site specific conditions. After rock placement has been completed, a small planting berm would be constructed in the rock, when feasible, to allow for some revegetation of the site outside of the vegetation free zone required by ETL 1110-2-571.

In addition a new levee with a sheet pile wall would be constructed on the Sacramento River side of the Stone lock to close the connection between the Sacramento River and the barge canal. The new levee would also connect the Sacramento River North and South levees. To construct the new levee, a coffer dam would be constructed on the river side of the construction footprint and the new levee would be constructed in the dry area. Initially a sheet pile wall would be placed on the east side of the construction area. The levee would be constructed west of the sheet pile wall. Construction of the levee and sheet pile wall would require the removal of 1.7 acres of riparian habitat along the outlet of the Barge Canal. It would also require the relocation of three power poles and two storm drains, and the removal of concrete infrastructure.

Port North Levee

A floodwall or levee raise with embankment fill would be constructed to address levee height concerns. The area would be cleared and grubbed and excavation would occur to provide space to construct the footing for the floodwall. The floodwall would be constructed on the waterside hinge and would range in height from 1 to 4 feet. The floodwall would be constructed from pre-fabricated materials or be constructed in place.

Yolo Bypass Levee

Along the Yolo Bypass levee seepage and stability concerns were identified. A cutoff wall will be installed to address the seepage and stability concerns. Depending on the location the cutoff wall will be constructed either by the conventional slot trench method or by the deep soil mixing method as described above for the Sacramento River North levee section.

Sacramento Bypass Training Levee

The training dike that extends out from the south Sacramento Bypass levee into the Yolo Bypass has erosion concerns. Bank protection would be placed on the training dike to address the erosion concerns as described above for the Sacramento River North levee section.

3.14.1.2 South Basin

Sacramento River South Levee

The Sacramento River South levee also needs to be repaired to address seepage, slope stability, erosion, and height concerns. Improvements to the levee would be constructed through a combination of fix in place and adjacent levee methods. The measures that would be implemented for the Sacramento River South levee would be: 1) installation of cutoff walls and seepage berms to address seepage and stability concerns; 2) stability berms to address slope stability concerns; and 3) bank protection to address erosion concerns. Improvements on the Sacramento River South levee would also include construction of a levee and seepage and berm around (on the land side) the Bees Lake area to address the concerns mentioned above and avoid environmental impacts to the Bees Lake area and changes to hydrology in the area. The levees would be constructed as described above for the Sacramento River North levee. In areas where it has been determined by geotechnical investigations that a cutoff wall does not completely remove the through and underseepage concerns, a seepage berm would be constructed. The seepage berm would extend out from the landside levee toe and would vary in width from 70 to 100 feet, tapering down from a five-foot thickness at the levee toe to a three foot thickness at the toe of the berm. The primary erosion protection measure would consist of waterside armoring of the levees to prevent erosion and subsequent damage to the levee. The erosion protection would be constructed as described in the Sacramento River North levee section.

South Cross Levee

The South Cross levee needs to be improved to address seepage and overtopping concerns. The measures that would be implemented for the South Cross levee would be: 1) a stability berm to address seepage and slope stability concerns; 2) relief wells to address seepage concerns; and 3) a levee raise to address height concerns. The measures would be constructed as described in Sections 3.4, 3.5, and 3.7 above.

Deep Water Ship Channel East Levee

The Deep Water Ship Channel East levee needs to be improved to address seepage, slope stability, and height concerns. The measures that would be implemented for the DWSC East levee would be: 1) installation of cutoff walls to address seepage and stability concerns and; 2) a levee raise to address height concerns. Both cutoff wall construction methods, conventional open trench and deep soil mixing described in Section 3.4, would be utilized to address the seepage and stability concerns. Levee raising would be implemented where required and would be constructed as described in Section 3.7.

Deep Water Ship Channel West Levee

The Deep Water Ship Channel West levee needs to be improved to address seepage, slope stability, erosion, and height concerns. The measures that would be implemented for the DWSC East levee would be: 1) installation of cutoff walls and seepage berms to address seepage and stability concerns and; 2) a levee raise to address height concerns; and 3) bank protection to address erosion concerns. The conventional open trench cutoff wall described for The Sacramento River North levee would be utilized to address the seepage and stability concerns. Levee raising would be implemented where required and would be constructed as described in Section 3.7.

Bank protection would be placed as described for the Sacramento River North levee. At various locations from the South Cross levee south to Prospect Island in the Delta, a distance of approximately 19 miles, a cutoff wall and bank protection would be constructed. The bank protection would address erosion and would be placed on the Yolo Bypass side of the levee.

Port South Levee

The Port South levee needs to be improved to address overtopping, seepage, and slope stability concerns. The measures that would be implemented for the South Port Levee would be: 1) installation of cutoff walls to address seepage and stability concerns, and 2) levee raising to address overtopping concerns. The cutoff wall would only be constructed for a small section adjacent to Lake Washington.

Table 3-21: Final Alternative 1 – Costs

REACH IMPROVEMENTS	RISK SOURCE THAT IMPROVEMENTS PROTECT AGAINST	ALTERNATIVE 1 (IN $1,000s, OCTOBER 2013 PRICE LEVEL, 50-YEAR PERIOD OF ANALYSIS, 3.50% DISCOUNT RATE)			
		PROJECT COSTS	AVERAGE ANNUAL COSTS	O&M COSTS[1]	TOTAL AVERAGE ANNUAL COSTS
Sacramento Bypass Training Levee	Sacramento Bypass	7,753	331	N/A	331
Yolo Bypass	Yolo Bypass	18,547	791	N/A	791
DWSC West - Yolo Bypass to DWSC Structure	Yolo Bypass	69,657	2,969	N/A	2,969
DWSC West - DWSC Structure South 18 miles	Yolo Bypass	277,460	11,828	N/A	11,828
DWSC East	Yolo Bypass	114,170	4,867	N/A	4,867
DWSC East - Structure to South Levee	Yolo Bypass	N/A	N/A	N/A	N/A
Port North Levee	Sacramento River	45,453	1,938	N/A	1,938
Port South Levee	Sacramento River	24,731	1,054	N/A	1,054
Sacramento River North Levee - IMPROVE LEVEES	Sacramento River	571,547	24,365	N/A	24,365
Sacramento River South Levee - IMPROVE LEVEES	Sacramento River	539,592	23,003	N/A	23,003
Sacramento River South Levee – SET BACK LEVEES	Sacramento River	N/A	N/A	N/A	N/A
Stone Lock	Sacramento River	39,129	1,668	N/A	1,668
South Cross Levee	Yolo Bypass	68,272	2,910	N/A	2,910
DWSC Structure	Yolo Bypass	N/A	N/A	N/A	N/A
Total	--	**1,776,311**	**75,724**	**106**	**75,830**

[1] O&M costs only applied to complete project

3.14.2 Final Alternative 3: Improve Levees and Construct DWSC Closure Structure

This alternative would include construction of a Closure Structure in the DWSC that would provide flood risk management for West Sacramento and the Port of West Sacramento from flood flows in the DWSC. Implementation of this alternative would reduce the need to improve the DWSC West levee downstream of the structure and improve the DWSC East levee and the Port North and Port South levees north of the Closure Structure. The other levees that provide FRM for West Sacramento under Alternative 3 would be improved as discussed in Alternative 1. The Sacramento River, Yolo Bypass, and South Cross levees would be improved to address identified seepage, slope stability, erosion, and height concerns. Because

of the urban nature of much of the project area, the proximity of development to the levees, and cost, the majority of the levee repairs would be fixed in place. For the South Basin, a combination of fix in place and adjacent levee measures are being proposed depending on the location. The adjacent levee would be constructed where there are fewer real estate constraints, where the existing levee does not meet or exceed minimum levee standards, and/or where vegetation and erosion are considerations.

3.14.3 West Sacramento North Basin

The primary issues in the North Basin are erosion, seepage, and slope stability with minimal levee height concerns. The measures that would be implemented under Alternative 3 for the levees in the North Basin would be: (1) installation of cutoff walls to address seepage and slope stability concerns; (2) levee raises to address height concerns; (3) constructing the DWSC Closure Structure to address seepage, slope stability, height, and erosion concerns; and (4) erosion protection to address erosion concerns. Measures 1, 2, and 4 are described above in Section 3.14.1, and the DWSC Closure Structure is discussed below in Section 3.14.3.6.

3.14.3.1 Sacramento River Levee

The measures for the Sacramento River North levee would be consistent with Alternative 1. Sacramento River North levee improvements are proposed to address seepage, stability, erosion, and levee height concerns. The measures that would be implemented under Alternative 3 for the Sacramento River North levee would be: (1) installation of cutoff walls to address seepage and slope stability concerns; (2) a levee raise to address overtopping; and (3) bank protection measures to address erosion concerns. The description of construction of these measures can be found above in the description of Alternative 1.

3.14.3.2 Port North Levee

The primary issue in the Port North area is overtopping concerns. The DWSC Closure Structure would eliminate the need to construct floodwalls. The description of the Closure Structure is discussed below.

3.14.3.3 Yolo Bypass Levee

The measures for the Yolo Bypass levee would be consistent with Alternative 1. Along the Yolo Bypass there are seepage and slope stability problems at various locations. Cutoff walls would be implemented under Alternative 3 to address seepage and slope stability concerns. A conventional open trench cutoff wall would be constructed and the levee would be reconstructed to meet current Corps standards.

3.14.3.4 Sacramento Bypass Training Levee

The measures for the training levee would be consistent with Alternative 1. Under Alternative 3, bank protection is proposed to address erosion. Bank protection would be implemented as described in Alternative 1.

3.14.3.5 West Sacramento South Basin

The primary issues for the levees in the South Basin are erosion, seepage, and slope stability, with minimal levee height concerns. The measures that would be implemented under Alternative 3 for the levees in the South Basin would be: (1) installation of cutoff walls or seepage berms to address seepage

and slope stability concerns; (2) levee raises to address height concerns; (3) erosion protection to address erosion concerns; and (4) construction of the DWSC Closure Structure to address seepage, slope stability, height, and erosion concerns. Measures 1, 2, and 3 are described above Section 3.14.1 and the DWSC Closure Structure is discussed below in this section.

3.14.3.6 Deep Water Ship Channel Closure Structure

The construction of a Closure Structure on the DWSC would provide flood protection for the areas north of the structure, including the City and Port of West Sacramento, while eliminating many miles of levee improvements both north and south of the Closure Structure. This is the only identified means by which protection of the Port of West Sacramento can be accomplished. Permanent flood structures on the southern periphery of the port area would be in continuous conflict with port operations and temporary structures are considered to be impractical due to the time and effort required for placement under emergency scenarios.

The main components of the DWSC Closure Structure would include:

- Sector gate monolith with pipe pile foundation;
- Structural steel sector gates;
- Sector gate operating machinery;
- Tie-in levees;
- End cell dolphins;
- Graving site;
- Ring levee; and
- Structural steel bulkheads and needle/needle girder system.

The DWSC Closure Structure would be a sector gated structure with a 200 foot wide opening, a base elevation of -37.0 feet, and top of structure elevation of 34.0 feet. The structure would consist of conventionally reinforced concrete and post tensioned concrete supported on a pipe pile foundation. The concrete structure would use float-in construction. The concrete shell would be built similar to barge type construction in a graving site adjacent to the project site. The float-in design eliminates the need for cofferdams, structure site dewatering systems, and a structure site bypass.

The DWSC Closure Structure would be located in the DWSC approximately 500 feet north of the South Basin Main Drain Pumping Plant. This location avoids potential issues that may result from the discharge of drainage during gate closure, and is far enough away from the large horizontal curve in the DWSC that large vessels would not be required to negotiate the Closure Structure and the horizontal curve either simultaneously or in quick succession. Tie-in levees would be constructed on either side of the structure to tie into the existing levees along the channel.

3.14.3.7 Sacramento River Levee

The measures for the Sacramento River South levee would be consistent with Alternative 1. Sacramento River South levee improvements are needed to address seepage, slope stability, and erosion concerns. The measures that would be implemented under Alternative 3 for the Sacramento River South levee

would be: (1) installation of cutoff walls and seepage berms to address seepage and slope stability concerns and (2) bank protection measures to address erosion concerns. The description of these measures can be found in Section 3.14.1 above.

3.14.3.8 South Cross Levee

The measures for the South Cross levee would be consistent with Alternative 1. South Cross levee improvements would address seepage and levee height concerns. The measures that would be implemented under Alternative 3 for the South Cross levee would be: (1) installation of cutoff walls and seepage berms to address seepage concerns and (2) levee raises to address height concerns. The description of these measures can be found above in Section 3.14.1

3.14.3.9 Deep Water Ship Channel East Levee

The measures for the DWSC East levee would be consistent with Alternative 1, with one exception. Under Alternative 1, DWSC East levee remediation measures were proposed to address seepage, slope stability, and height concerns. Under Alternative 3, these levee improvements would occur only from the Closure Structure south to the South Cross levee; there would be no need to implement these measures north of the Closure Structure. The DWSC Closure Structure described above would prevent flood water from flowing north through the DWSC into the City of West Sacramento and the Port of West Sacramento, and would eliminate the need to improve the levee north of the structure. The measures that would be implemented under Alternative 3 for the DWSC East levee would be: (1) installation of cutoff walls to address seepage and slope stability concerns; (2) a levee raise to address inadequate levee height; and (3) the DWSC Closure Structure to address seepage, slope stability, and height concerns. A conventional open trench cutoff wall and/or a seepage berm would be constructed south of the Closure Structure to address the seepage and slope stability problems, as described above in Section 3.2. Levee raising would be implemented where required, and would be constructed as described above in Section 3.7. The Closure Structure would be constructed as described above.

3.14.3.10 Deep Water Ship Channel West Levee

The measures for the DWSC West levee would be consistent with Alternative 1, with a few exceptions. Under Alternative 1, the DWSC West levee remediation measures were proposed to address seepage, slope stability, height, and erosion concerns for the levee extending approximately 18 miles south of the South Cross levee. Under Alternative 3, there would be no need to construct cutoff walls or seepage berms or install bank protection south of the DWSC Closure Structure. The Closure Structure would prevent flows from flowing north if there was a break in the DWSC West levee. The measures that would be implemented under Alternative 3 for the DWSC West levee would be: (1) installation of cutoff walls to address seepage and slope stability concerns; (2) a levee raise to address height concerns; (3) the DWSC Closure Structure to address seepage, slope stability, and height concerns; and (4) bank protection to address erosion concerns. The conventional open trench cutoff wall would be constructed from north of the Closure Structure. A seepage berm, cutoff wall, height increase, and bank protection would be not be necessary downstream of the Closure Structure. The cutoff wall, bank protection, and levee raise would be constructed upstream of the Closure Structure as described above in Section 3.14.1

3.14.3.11 Port South Levee

The primary issues for the Port South levee are overtopping, seepage, and slope stability. These issues would be addressed with the construction of the DWSC Closure Structure. Constructing the DWSC

Closure Structure, as described above, would eliminate the need to implement the levee improvement measures because it would prevent floodwater from reaching the Port South levee.

Table 3-22: Final Alternative 3 – Costs

REACH IMPROVEMENTS	RISK SOURCE THAT IMPROVEMENTS PROTECT AGAINST	ALTERNATIVE 3 (IN $1,000s, OCTOBER 2013 PRICE LEVEL, 50-YEAR PERIOD OF ANALYSIS, 3.50% DISCOUNT RATE)			
		PROJECT COSTS	AVERAGE ANNUAL COSTS	O&M COSTS[1]	TOTAL AVERAGE ANNUAL COSTS
Sacramento Bypass Training Dike	Sacramento Bypass	8,692	371	N/A	371
Yolo Bypass	Yolo Bypass	20,776	886	N/A	886
DWSC West - Yolo Bypass to DWSC Structure	Yolo Bypass	77,646	3,310	N/A	3,310
DWSC West - DWSC Structure South 18 miles	Yolo Bypass	N/A	N/A	N/A	N/A
DWSC East	Yolo Bypass	N/A	N/A	N/A	N/A
DWSC East - Structure to South Levee	Yolo Bypass	42,745	1,822	N/A	1,822
Port North Levee	Sacramento River	N/A	N/A	N/A	N/A
Port South Levee	Sacramento River	N/A	N/A	N/A	N/A
Sacramento River North Levee – IMPROVE LEVEES	Sacramento River	628,838	26,807	N/A	26,807
Sacramento River South Levee – IMPROVE LEVEES	Sacramento River	601,844	25,657	N/A	25,657
Sacramento River South Levee – SET BACK LEVEES	Sacramento River	N/A	N/A	N/A	N/A
Stone Lock	Sacramento River	43,711	1,863	N/A	1,863
South Cross Levee	Yolo Bypass	76,022	3,241	N/A	3,241
DWSC Structure	Yolo Bypass	517,724	22,071	N/A	22,071
Total	--	**2,017,997**	**86,027**	**1,306**	**87,333**

[1] O&M costs only applied to complete project

Final Alternative 5 – Improve Levees and include Southport Setback levee along Sacramento River South Reach

Alternative 5 involves the construction of levee remediation measures to address seepage, slope stability, erosion, and overtopping concerns identified for the various reaches. The other levees that provide FRM for West Sacramento would be improved as described for Final Alternative 1 by either fixing the levees in

place or constructing a levee adjacent to the existing levee. The Southport Setback levee along the Sacramento River South reach constructed as an Early Implementation Project by the State and WSAFCA under a 408 permit would be included in this alternative.

3.14.4 West Sacramento North Basin

The primary issues in the North Basin are erosion, seepage, and slope stability, with minimal levee height concerns. The measures that would be implemented under Alternative 3 for the levees in the North Basin would be: (1) installation of cutoff walls to address seepage and slope stability concerns; (2) levee raises to address height concerns; and (3) erosion protection to address erosion concerns. These measures are described above in Section 3.14.1.

3.14.4.1 Sacramento River Levee

The measures for the Sacramento River North levee would be consistent with Alternative 1. Sacramento River North levee improvements are proposed to address seepage, stability, erosion, and levee height concerns. The measures that would be implemented under Alternative 5 for the Sacramento River North levee would be: (1) installation of cutoff walls to address seepage and slope stability concerns; (2) a levee raise to address overtopping; and (3) bank protection measures to address erosion concerns. The description of construction of these measures can be found above in the description of Alternative 1.

3.14.4.2 Port North Levee

A floodwall would be constructed to address levee height concerns. The area would be cleared and grubbed and excavation would occur to provide space to construct the footing for the floodwall. The floodwall would be constructed on the waterside hinge and would range in height from 1 to 4 feet. The floodwall would be constructed from pre-fabricated materials or be constructed in place.

3.14.4.3 Yolo Bypass Levee

The measures for the Yolo Bypass levee would be consistent with Alternative 1. Along the Yolo Bypass there are seepage and slope stability problems at various locations. Cutoff walls would be implemented under Alternative 3 to address seepage and slope stability concerns. A conventional open trench cutoff wall would be constructed and the levee would be reconstructed to meet current Corps standards.

3.14.4.4 Sacramento Bypass Training Levee

The measures for the training levee would be consistent with Alternative 1. Under Alternative 3, bank protection is proposed to address erosion. Bank protection would be implemented as described in Alternative 1.

West Sacramento South Basin

Sacramento River Levee

The measures for the Sacramento River South levee include improvements to address seepage stability, erosion and levee height concerns. The measure that would be implanted under Alternative 5 would be: (1) construct a setback levee with slurry cutoff walls and/or seepage berms to address seepage remediation; (2) rock bank protection to address erosion problems; and (3) levee raise to address overtopping concerns.

South Cross Levee

The measures for the South Cross levee would be consistent with Alternative 1. South Cross levee improvements would address seepage and levee height concerns. The measures that would be implemented under Alternative 3 for the South Cross levee would be: (1) installation of cutoff walls and seepage berms to address seepage concerns and (2) levee raises to address height concerns. The description of these measures can be found above in Section 3.14.1

Deep Water Ship Channel East Levee

The measures for the Deep Water Ship Channel East levee would be consistent with Alternative 1. The Deep Water Ship Channel East levee needs to be improved to address seepage, slope stability, and height concerns. The measures that would be implemented for the DWSC East levee would be: 1) installation of cutoff walls to address seepage and stability concerns and; 2) a levee raise to address height concerns. Both cutoff wall construction methods, conventional open trench and deep soil mixing described in Section 3.4, would be utilized to address the seepage and stability concerns. Levee raising would be implemented where required and would be constructed as described in Section 3.7.

Deep Water Ship Channel West Levee

The measures for the Deep Water Ship Channel West levee would be consistent with Alternative 1. The Deep Water Ship Channel West levee needs to be improved to address seepage, slope stability, erosion, and height concerns. The measures that would be implemented for the DWSC West levee would be: 1) installation of cutoff walls and seepage berms to address seepage and stability concerns and; 2) a levee raise to address height concerns; and 3) bank protection to address erosion concerns. The conventional open trench cutoff wall described for the Sacramento River North levee would be utilized to address the seepage and stability concerns. Levee raising would be implemented where required and would be constructed as described in Section 3.7.

Bank protection would be placed as described for the Sacramento River North levee. At various locations from the South Cross levee south to Prospect Island in the Delta, a distance of approximately 19 miles, a cutoff wall and bank protection would be constructed. The bank protection would address erosion and would be placed on the Yolo Bypass side of the levee.

Port South Levee

The measures for the Port South levee would be consistent with Alternative 1. The Port South levee needs to be improved to address overtopping, seepage, and slope stability concerns. The measures that would be implemented for the South Port Levee would be: 1) installation of cutoff walls to address seepage and stability concerns, and 2) levee raising to address overtopping concerns. The cutoff wall would only be constructed for a small section adjacent to Lake Washington.

Table 3-23: Alternative 5 – Costs

REACH IMPROVEMENTS	RISK SOURCE THAT IMPROVEMENTS PROTECT AGAINST	ALTERNATIVE 5 (IN $1,000s, OCTOBER 2013 PRICE LEVEL, 50-YEAR PERIOD OF ANALYSIS, 3.50% DISCOUNT RATE)			
		PROJECT COSTS	AVERAGE ANNUAL COSTS	O&M COSTS[1]	TOTAL AVERAGE ANNUAL COSTS
Sacramento Bypass Training Dike	Sacramento Bypass	7,770	331	N/A	331
Yolo Bypass	Yolo Bypass	18,587	792	N/A	792
DWSC West - Yolo Bypass to DWSC Structure	Yolo Bypass	69,799	2,976	N/A	2,976
DWSC West - DWSC Structure South 18 miles	Yolo Bypass	278,053	11,853	N/A	11,853
DWSC East	Yolo Bypass	114,388	4,876	N/A	4,876
DWSC East - Structure to South Levee	Yolo Bypass	N/A	N/A	N/A	N/A
Port North Levee	Sacramento River	45,538	1,941	N/A	1,941
Port South Levee	Sacramento River	24,773	1,056	N/A	1,056
Sacramento River North Levee - IMPROVE LEVEES	Sacramento River	572,570	24,409	N/A	24,409
Sacramento River South Levee - IMPROVE LEVEES	Sacramento River	N/A	N/A	N/A	N/A
Sacramento River South Levee – SET BACK LEVEE	Sacramento River	373,669	15,930	N/A	15,930
Stone Lock	Sacramento River	39,211	1,672	N/A	1,672
South Cross Levee	Yolo Bypass	68,411	2,916	N/A	2,916
DWSC Structure	Yolo Bypass	N/A	N/A	N/A	N/A
Total	--	**1,612,768**	**68,752**	**106**	**68,858**

[1] O&M costs only applied to complete project

3.14.5 Comparison of Plans and Effects

The following tables display the recommended features in each alternative and the costs and benefits associated with each alternative.

Table 3-24: Alternative 1 - Improve Levees - Proposed Levee Improvement Measures by Reach

WATERWAY/REACH	SEEPAGE MEASURES	STABILITY MEASURES	EROSION PROTECTION MEASURES	OVERTOPPING MEASURES
Sacramento River North Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port North	--	--	--	Flood Wall or Raise Levee in Place
Yolo Bypass Levee	Slurry Wall	Slurry Wall	--	--
Sacramento Bypass Training Levee	--	--	Waterside Armoring Bank Protection	--
Sacramento River South Levee	Slurry Wall and Seepage Berm	Slurry Wall and Seepage Berm	Waterside Armoring Bank Protection	Raise Levee in Place
South Cross Levee	Relief Wells	Stability Berm	--	Raise Levee in Place
Deep Water Ship Channel East Levee	Slurry Wall	Slurry Wall	--	Raise Levee in Place
Deep Water Ship Channel West Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port South Levee	Slurry Wall	Slurry Wall	--	Raise Levee in Place

Table 3-25: Alternative 3- Improve Levees and DWSC Closure Structure - Proposed Improvement Measures by Reach

WATERWAY/REACH	SEEPAGE MEASURES	STABILITY MEASURES	EROSION PROTECTION MEASURES	OVERTOPPING MEASURES
Sacramento River North Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port North	--	--	--	--
Yolo Bypass Levee	Slurry Wall	Slurry Wall	--	--
Sacramento Bypass Training Levee	--	--	Waterside Armoring Bank Protection	--
Sacramento River South Levee	Slurry Wall and Seepage Berm	Slurry Wall and Seepage Berm	Waterside Armoring Bank Protection	Raise Levee in Place
South Cross Levee	Relief Wells	Stability Berm	--	Raise Levee in Place
Deep Water Ship Channel East Levee North of Structure	--	--	--	--
Deep Water Ship Channel East Levee South of Structure	Slurry Wall	Slurry Wall	--	Raise Levee in Place
Deep Water Ship Channel West Levee North of Structure	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Deep Water Ship Channel West Levee South of Structure	--	--	--	--
Port South Levee	--	--	--	--

Table 3-26: Alternative 5 – Improve Levee and Southport Setback Proposed Improvement Measures by Reach

Waterway/Reach	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
Sacramento River North Levee	Slurry Wall	Slurry Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port North	--	--	--	Flood Wall or Raise Levee in Place
Yolo Bypass Levee	Slurry Wall	Slurry Wall	--	--
Sacramento Bypass Training Levee	--	--	Waterside Armoring Bank Protection	--
Sacramento River South Levee	Setback levee with Slurry Wall and Seepage Berm	Setback levee with Slurry Wall and Seepage Berm	Waterside Armoring Bank Protection	New Setback Levee
South Cross Levee	Slurry Wall	--	--	Raise Levee in Place
Deep Water Ship Channel East Levee	Cutoff Wall	Cutoff Wall	--	Raise Levee in Place
Deep Water Ship Channel West Levee	Cutoff Wall or Seepage Berm	Cutoff Wall	Waterside Armoring Bank Protection	Raise Levee in Place
Port South Levee	Cutoff Wall	Cutoff Wall	--	Raise Levee in Place

Preliminary, screening-level cost estimates were provided. Detailed costs were provided in several formats; the costs broken out by reach were used for this economic analysis and are summarized in Table 3-29 below. In addition to project first costs, interest during construction (IDC), which is an economic cost, was also factored into the net benefit/BCR analyses. Interest during construction for each alternative was calculated. Information regarding the construction period (number of years) for each alternative was prepared and used to compute IDC on an annual basis.

Table 3.27 presents the assurance results under both without-project and with-project conditions for each index point and alternative.

The Annual Exceedance Probability (AEP) values under with-project conditions indicate that each alternative provides significant risk reduction in terms of the chance of flooding in any given year. For example the without project AEP is about 1 in 11 chance of a damaging flood event in any given year. With improvements made to the levee, flood risk is reduced to about 1 in 111 chance of a damaging flood in any given year in all alternatives.

Table 3-27: Assurance by Exceedance Probability Event

Basin	Index Point	Assurance by Exceedence Probability Event											
		WITHOUT			ALT. 1 (IMPROVE LEVEES)			ALT. 3 (IMPROVE LEVEES AND CLOSURE STRUCTURE)			ALT.5 (IMPROVE LEVEES AND SOUTHPORT SETBACK)		
		4%	1%	0.2%	4%	1%	0.2%	4%	1%	0.2%	4%	1%	0.2%
North Basin	1 – Sac River	84%	75%	58%	97%	96%	87%	97%	96%	87%	97%	96%	87%
	2 – Sac River	93%	88%	73%	98%	97%	92%	98%	97%	92%	98%	97%	92%
	3 – Yolo Bypass	39%	23%	16%	93%	93%	92%	93%	93%	92%	93%	93%	92%
	4 – Sac Bypass	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%
South Basin	5 – Sac River	89%	85%	76%	99%	98%	98%	99%	98%	98%	99%	98%	98%
	6 – Sac River	91%	90%	89%	98%	98%	98%	98%	98%	98%	98%	98%	98%
	7 - DWSC	22%	12%	10%	96%	93%	91%	96%	93%	91%	96%	93%	91%
	8 – Port South	89%	70%	55%	96%	79%	62%	99%	99%	99%	96%	79%	62%

The local sponsor has an interest in having the repaired levees brought up to the minimum requirements needed for FEMA accreditation and to meet the Urban Levee Design Criteria (ULDC).

The Engineering Circular 1110-2-6067 serves as guidance for USACE to provide the necessary Risk and Uncertainty (R&U) rationale to certify/accredit levees for FEMA. FEMA certification was not determined at this time. Corps criteria to certify/accredit levees requires a levee to be either: a) 3 feet above the median 1% water surface elevation (WSEL) with a 90% assurance for the 1% event or b) 2 feet above the median 1% WSEL with a 95% assurance for the 1% event

By traditional FEMA methodology (Title 44 CFR Section 65.10), it is likely that the local sponsor could achieve FEMA Certification in both basins using this proposed project, and the local's ongoing efforts under the West Sacramento Levee Improvement Program (WSLIP). If determined to be needed, this additional analysis will most likely be conducted during refinement of the selected alternative or during the design phase. At a minimum this would be likely be completed by ensuring that there is 3 three feet of freeboard above the 100-yr event for all the levees in the project area.

Urban Levee Design Criteria (ULDC) is a state standard (Senate Bill 5) established by the CA Dept of Water Resources where from a hydraulic perspective; urban levees are required to have at least 3' feet of free board above the mean 200-Yr event or a combination of freeboard (2-3) and assurance (90%-95%) to contain the mean 200-Yr event. The 3 feet of freeboard was set as a target on all reaches of the West Sacramento project.

Table 3-27 (Assurance by Exceedance Probability Event) shows that Alternative 5, the Tentatively Selected Plan, provides over 90% assurance of passing the 1% ACE event, with the exception of Index Point 8 on the Port South levee. Since it is evaluated as a system, and with additional analysis needed per

EC 1110-2-6067, the project would not currently meet the Corps criteria to certify/accredit for FEMA. However, additional refinements during the feasibility level design of the project could result in the Port South levee reach meeting the criteria. The 3 feet of freeboard above the mean 200-year event was set as a target on all reaches of the West Sacramento project. Additional information on project performance is located in the Economic Appendix.

Table 3-28: Average Annual Benefits for Final Alternatives 1, 3, and 5 (in $1,000s at October 2013 Price Level, 50-Year Period of Analysis)

	FINAL ALTERNATIVE 1	FINAL ALTERNATIVE 3	FINAL ALTERNATIVE 5
Without Project Damages	288,263	288,263	288,263
With Project Residual Damages	31,400	31,400	31,400
Average Annual Benefits	256,859	256,859	256,859
Benefits Prior to Base Year	0	0	0
Total Average Annual Benefits	256,859	256,859	256,859

Average annual benefits were measured incrementally and from a "system"/residual risk/"worst first" point of view. For Alternatives 1, 3, or 5, incremental benefits were estimated using HEC-FDA results from multiple index points/major levee reaches (e.g., Yolo Bypass, Navigation levee, Sacramento River) until all reaches within the system were improved. This process resulted in the remaining (residual) risk (as measured by EAD) being the same for each alternative, and therefore the same amount of average annual benefits for each alternative. So, while the analysis at an individual index point may indicate different benefits for each alternative (e.g., Alternative 3 [control structure] shows more benefits than Alternatives 1 and 5 when measured directly at index point 8 [port]), residual risk from a "systems" perspective turns out to be the same between the alternatives since it is being dictated by flooding from a certain index point (Yolo Bypass), which outweighs residual flooding elsewhere in the system.

Table 3-29: Estimated Costs ($1,000s) for Final Alternatives 1, 3, and 5[1]

	FINAL ALTERNATIVE 1	FINAL ALTERNATIVE 3	FINAL ALTERNATIVE 5
First Costs	1,776,311	2,017,997	1,612,768
IDC	734,889	1,030,020	646,916
Total	2,511,200	3,048,017	2,259,684
Average Annual Costs	107,052	129,937	96,330
O&M	106	1,306	106
Total Average Annual Costs	107,158	131,243	96,436

Notes:
[1] Based on October 2013 price level, 3.50 percent rate of interest, and a 50-year period of analysis

Investment costs, annual costs, and annual benefits are displayed in Table 3-22 below.

Table 3-30: Comparison of Total Annual Benefits and Costs ($1000s) for Final Alternatives 1, 3, and 5[1,2]

ITEM	FINAL ALTERNATIVE 1	FINAL ALTERNATIVE 3	FINAL ALTERNATIVE 5
Investment Costs:			
FRM First Costs	1,776,311	2,017,997	1,612,768
Interest During Construction	734,889	1,030,020	646,916
Total	2,511,200	3,048,017	2,259,684
Annual Cost			
Interest and Amortization	107,052	129,937	96,330
OMRR&R	106	1,306	106
Total	107,158	131,243	96,436
Annual Benefits	256,859	256,859	256,859
Net Annual Flood Risk Management Benefits	149,701	125,616	160,423
Benefit to Cost Ratio	2.4	2.1	2.7

Notes:

[1] Based on October 2013 price levels, 3.50 percent rate of interest, and a 50-year period of analysis.

[2] Some numbers have been rounded and may be slightly different than those displayed in the appendices.

Based on the above comparison, Alternative 5 is the plan which maximizes net benefits and is therefore identified as the NED plan. The sponsor supports the NED Plan and is currently seeking approval to construct the setback levee along the Sacramento River in the South Basin through the Section 408 process.

3.15 Executive Order (EO) 11988

The objective of the study is to reduce flood risk within the study area. EO 11988 has an objective of "avoidance, to the extent possible, of long- and short-term adverse impacts associated with the occupancy and modification of the base flood plain and the avoidance of direct and indirect support of development in the base flood plain wherever there is a practicable alternative". The study is responsive to the EO 11988 objective because the proposed features focus on reducing the threat of flooding to the existing urban area, altering a very small area within the floodplain. These features would reduce the hazard and risk associated with floods thereby minimizing the effects of floods on life safety, health, and welfare, and would preserve the natural and beneficial values of the base floodplain. For these reasons the proposed plan is in compliance with EO 11988. Additional information regarding compliance with EO 11988 is presented in Chapter 4.

3.16 SYSTEM OF ACCOUNT ANALYSIS AND COMPARISON

The system of accounts is a set of categories which provide a comprehensive framework to demonstrate both the positive and negative effects of each plan. The intent is to provide decision makers with plan

rankings based on advantages and disadvantages of each alternative. In addition, the accounts provide a visual display and assessment of the effects as required by NEPA.

3.16.1 National Economic Development (NED)

The NED account includes the estimates of project benefits and costs used to calculate net economic benefits. A full display of the analysis for the NED account is located in the Economic Appendix. This analysis establishes the economic feasibility of each plan and is used to identify Federal interest. The NED analysis dates back to the Flood Control Act of 1936 in which Congress determined that the Federal Government should participate in flood management and determine the benefits and costs of those activities. The analysis has been documented and refined over the years in various publications, including the Principles and Standards for Planning Water and Related Land Resources (P&S) and the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G). It was in the P&G that the following additional accounts were identified.

3.16.2 Environmental Quality (EQ)

The EQ account displays the effects on the ecological, cultural, aesthetic, and other attributes of natural and cultural resources. The environmental effects of the various alternatives are classified as direct and indirect. Direct effects result immediately from constructing and operating the project. Indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air, water, and other natural systems, including ecosystems. Additional information on the EQ analysis is captured in the Environmental Impact Statement (EIS) accompanying this report.

3.16.3 Regional Economic Development (RED)

The RED analysis measures changes in the distribution of regional economic activity that result from alternative plans. Changes in economic activity and employment that occur locally or regionally when a project is implemented are excluded from the NED account to the extent that they are offset through transfers of this economic activity and employment to other regions of the Nation. The effects on the regional economy, including income effects, income transfers, and employment effects not addressed in the NED account are evaluated in the RED. Two measures of the effects of the plan on regional economies are used in the account: regional income and regional employment. Additional information on the RED analysis performed for this study can be found in Attachment C of the Economic Appendix.

3.16.4 Other Social Effects (OSE)

OSE relates to the quality of life, health, and safety in the community. Destruction or disruption of the built environment, esthetic values, community cohesion, and availability of public facilities and services has also been analyzed. These include displacement effects to people and businesses, the general population (including minorities and special interest groups), and public health and safety. Assessments of beneficial and adverse effects are based on comparisons of the with project alternative to the without project alternative conditions expected to prevail in the future in the absence of the project. The social effects of the alternatives have both direct effects and indirect effects. Direct effects result immediately from constructing the project. Indirect effects result from the effects of the project on existing patterns, including ecosystem patterns, in the study area. Additional information on the OSE analysis performed for this study can be found in Attachment D of the Economic Appendix.

Table 3-31: Summary System of Accounts Comparison of Final Array of Alternative Plans

	NO ACTION	ALTERNATIVE 1	ALTERNATIVE 3	ALTERNATIVE 5
1. PLAN DESCRIPTION				
	The No Action Plan provides no physical project constructed by the Federal Government or local interests.	Alternative 1 reduces the risk of flooding within the study area by improving levees.	Alternative 3 reduces the risk of flooding to the study area by improving levees and includes the DWSC Closure Structure which limits the extent of levee improvement.	The NED plan reduces the risk of flooding to the study area by improving levees and includes the Southport Setback levee.
2. IMPACT ASSESSEMENT				
	A. National Economic Development (NED)(Costs in $1,000s, October 2013 Price Level, 3.5% Rate of interest, 50-year period of Analysis)			
1. Project Cost	$0	$2,511,200	$3,048,017	$2,259,684
2. Annual Cost	$0	$107,158	$131,243	$96,436
3. Total Annual Benefit	$0	$256,859	$256,859	$256,859
4. Annual Net Benefits	$0	$149,701	$125,616	$160,423
5. Benefit - Cost Ratio	N/A	2.4	2.1	2.7
B. Environmental Quality (EQ)				
1. Air/Noise	No construction activities present; Normal noise levels created by traffic, business, and industrial activities.	Temporary increased noise levels and air quality effects during estimated 18 year construction period.	Temporary increased noise levels and air quality effects during estimated 21 year construction period.	Temporary increased noise levels and air quality effects during the estimated 17 year construction period.
2. Water Quality	Significant impacts possible due to chemical storage area flooding.	Temporary decreased water quality due to increased turbidity during construction.	Similar as described for Alternative 1. Some increase in impacts with construction of DWSC Closure Structure.	Same as described for Alternative 1.
3. Biological Resources	Long term erosion would cause the loss of habitat along the waterways.	Loss of riparian habitat due to construction – replacement habitat will take many years	Similar to Alternative 1.	Similar to Alternative 1.

	NO ACTION	ALTERNATIVE 1	ALTERNATIVE 3	ALTERNATIVE 5
		to provide similar value to those removed.		
4. Threatened & Endangered Species	Potential loss of habitat as erosion of berms and levees will result in vegetation loss in flooded areas.	Temporary impact to endangered fish species, Valley Elderberry Longhorn Beetle, and Giant Garter Snake. Also impacts to avian species nesting and foraging habitat.	Similar to Alternative 1.	Similar to Alternative 1.
5. Cumulative Effects	No increased effects.	Increased air quality effects associated with temporary construction activity.	Similar to Alternative 1.	Similar to Alternative 1.
6. Cultural Resources & Historic Properties	Long term erosion, inundation, and/or scouring could cause adverse effects to existing cultural resources.	Potential adverse effects to existing cultural resources. Execution of a Programmatic Agreement and Historic Property Treatment plan reduces effect to less than significant.	Same as described for Alternative 1.	Same as described for Alternative 1.
C. Regional Economic Development (RED)				
1. Construction Activities	Future flooding would destroy part of infrastructure resulting in a loss in the region's ability to produce goods and services. Little to no RED benefits.	Value added: RED information will be provided in the final report.	Value added: RED information will be provided in the final report.	Value added: RED information will be provided in the final report.
2. Future Residential Development	Depending on the timing of the FEMA remapping new development must be built above the 1% flood elevation, which is not economical to	Future development associated with the construction of new homes would generate economic activity in the study area. Levee construction would	Future development associated with the construction of new homes would generate economic activity in the study area. Levee construction would	Future development associated with the construction of new homes would generate economic activity in the study area. Levee construction would

	NO ACTION	ALTERNATIVE 1	ALTERNATIVE 3	ALTERNATIVE 5
	accomplish.	decrease the risk of flooding to the established urban areas.	decrease the risk of flooding to the established urban areas.	decrease the risk of flooding to the established urban areas.
3. General Economic Gains	Emergency response and recovery activities and reconstructions and repairs. The economic stimulus generated would only be temporary and minor compared to overall losses.	The with-project regional economic impacts would emerge from more gradual spending over an extended timeframe. Levee construction is expected to take place over an 18-year period.	The with-project regional economic impacts would emerge from more gradual spending over an extended timeframe Levee construction is expected to take place over a 21-year period.	The with-project regional economic impacts would emerge from more gradual spending over an extended timeframe Levee construction is expected to take place over a 17-year period.
D. Other Social Effects (OSE)				
1. Life, Health, and Safety	Continued flood risk in the City of West Sacramento and surrounding areas.	Mitigated by Flood Warning Emergency Evacuation Plan (FWEEP).	Mitigated by Flood Warning Emergency Evacuation Plan (FWEEP).	Mitigated by Flood Warning Emergency Evacuation Plan (FWEEP).
2. Community Cohesion (displacement of people & businesses)	Future flooding would displace selected businesses and subject the community to potential catastrophic flood risk.	Increased level of protection to homes and businesses within the City of West Sacramento.	Increased level of protection to homes and businesses within the City of West Sacramento.	Increased level of protection to homes and businesses within the City of West Sacramento.
3. Residual Risk	Residual Risk remains high throughout the study area.	Residual Risk reduced in the City of West Sacramento.	Residual Risk reduced in the City of West Sacramento.	Residual Risk reduced in the City of West Sacramento.

3.17 THE TENTATIVELY SELECTED PLAN

The preliminary recommendation of the District Engineer of the Sacramento District, U.S. Army Corps of Engineers is that the NED Plan, Alternative 5, be considered the Tentatively Selected Plan (TSP) and authorized for implementation as a federal project. The estimated first cost of the NED plan is $1,612,768,000 at October 2013 price levels. The Federal portion of the estimated first cost is $1,048,299,000

The non-Federal sponsor portion of the estimated first cost is $564,469,000. The non-federal sponsor will agree to provide all lands, easements, rights-of-way, relocations, and suitable borrow and disposal

areas. The non-Federal sponsor will also assume responsibility for operating, maintaining, replacing, repairing, and rehabilitating (OMRR&R) the project. The non-Federal sponsor will publicize floodplain information in the areas concerned and provide this information to zoning and other regulatory agencies for their guidance and leadership in preventing unwise future development in the floodplain and in adopting such regulations as may be necessary to ensure compatibility between future development and protection levels provided by the project.

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4 - THE TENTATIVELY SELECTED PLAN

This chapter provides details on the selected plan and its implementation requirements. The chapter integrates the reevaluated West Sacramento Project with the previously authorized and constructed portions of the project.

4.1 FEATURES AND DESCRIPTION OF THE TENTATIVELY SELECTED PLAN

4.1.1 Plan Components

In addition to the features included in the 1999 authorization, the selected plan includes the additional features to improve the plan for flood risk management to the entire West Sacramento project area. The principal features of this plan are:

- Cutoff walls to address seepage remediation and stability problems, rock bank protection to address erosion problems, and levee raises to address overtopping issues along the Sacramento River North levee.
- Flood wall and levee raises with embankment fill to address overtopping concerns on the Port North levee.
- Cutoff walls and slope flattening to address seepage and stability concerns on the Yolo Bypass levee.
- Bank protection to address erosion concerns on the Sacramento Bypass training levee.
- Construct a sheet pile wall with embankment fill to plug gap in levee east of Stone Lock.
- Construct a setback levee with slurry cutoff walls and/or seepage berms to address seepage remediation, rock bank protection to address erosion problems, and levee raise to address overtopping issues along the Sacramento River South levee.
- Cutoff walls or seepage berm to address seepage remediation and stability problems, and levee raise to address overtopping issues along the South Cross levee.
- Cutoff walls to address seepage remediation and stability problems, and levee raise to address overtopping issues along the Deep Water Ship Channel East levee and the Port South levee.
- Cutoff walls or seepage berms to address seepage remediation and stability problems, and levee raise to address overtopping issues along the South Cross levee.
- Cutoff walls to address seepage remediation and stability problems, rock bank protection to address erosion problems, and levee raises to address overtopping issues along the Deep Water Ship Channel West levee.

Table 4-1: Tentatively Selected Plan - Proposed Levee Improvement Measures by Reach.

Waterway/Reach	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
Sacramento River North	Cutoff Wall	Cutoff Wall	Bank Protection, Launchable Rock Trench	Levee Raise
Port North	--	--	--	Flood Wall
Yolo Bypass	Cutoff Wall	Cutoff Wall	--	--
Sacramento Bypass Training Levee	--	--	Bank Protection	--
Sacramento River South Setback	Cutoff Wall or Seepage Berm	Cutoff Wall or Seepage Berm	Bank Protection	Levee Raise
South Cross Levee	Cutoff Wall or Seepage Berm	--	--	Levee Raise
Deep Water Ship Channel East Levee	Cutoff Wall	Cutoff Wall	--	Levee Raise
Deep Water Ship Channel West Levee	Cutoff Wall or Seepage Berm	Cutoff Wall	Bank Protection	Levee Raise
Port South	Cutoff Wall	Cutoff Wall	--	Levee Raise

The modifications to existing interior drainage facilities have been limited to bringing the facilities in compliance with Corps levee design criteria for penetrations through levees (upgrading discharge lines, pumps, etc. to raise the drainage over the top of levee). No assessment of the capacity of existing facilities to address the residual flooding from interior runoff was accomplished. The interior drainage plan was developed by the City of West Sacramento and is documented in the "Interior Drainage Evaluation Report" prepared for the City of West Sacramento, December 2010. Therein, the interior drainage system designed to keep West Sacramento out of the 1% (1/100) ACE floodplain is described in detail. Beyond the 1% (1/100) ACE event, residual flooding from the exterior sources would cause much more significant flooding than interior residual flooding. Residual flooding from both interior and exterior sources will be considered further under the GRR as additional increments.

In addition to the proposed levee improvement measures shown in Table 4-1, the following measures and policies would be addressed during construction:

- All levees that are out of compliance would be constructed/improved to meet the Corps' standard levee footprint. The standard levee footprint consists of:
    - A 20 foot crown width
    - A 3:1 waterside and landside slopes. If the 3:1 landside slope is not possible based on site specific conditions, then a minimum 2:1 landside slope would be established with supporting engineering analysis.

- A 20-foot landside and waterside maintenance access would be established where possible. In areas where 20 feet cannot be obtained, 10 feet is allowable.

- Compliance with ETL 1110-2-571 vegetation requirements would be established. The vegetation requirements include a vegetation free zone on the levee slopes and crown, 15 feet from both the landside and waterside levee toes, and 8 feet vertically. A variance would be sought by either the non-Federal Sponsor or the Sacramento District to allow the vegetation to remain. If granted, the variance would allow for vegetation to remain on the lower portion of the waterside slope and within the waterside 15 foot vegetation free zone. No vegetation would be permitted on the landside slope or within 15 feet of the landside toe. A vegetation variance would be requested by the Sacramento District or the non-Federal Sponsor to provide compliance for the Sacramento River portion of the project.

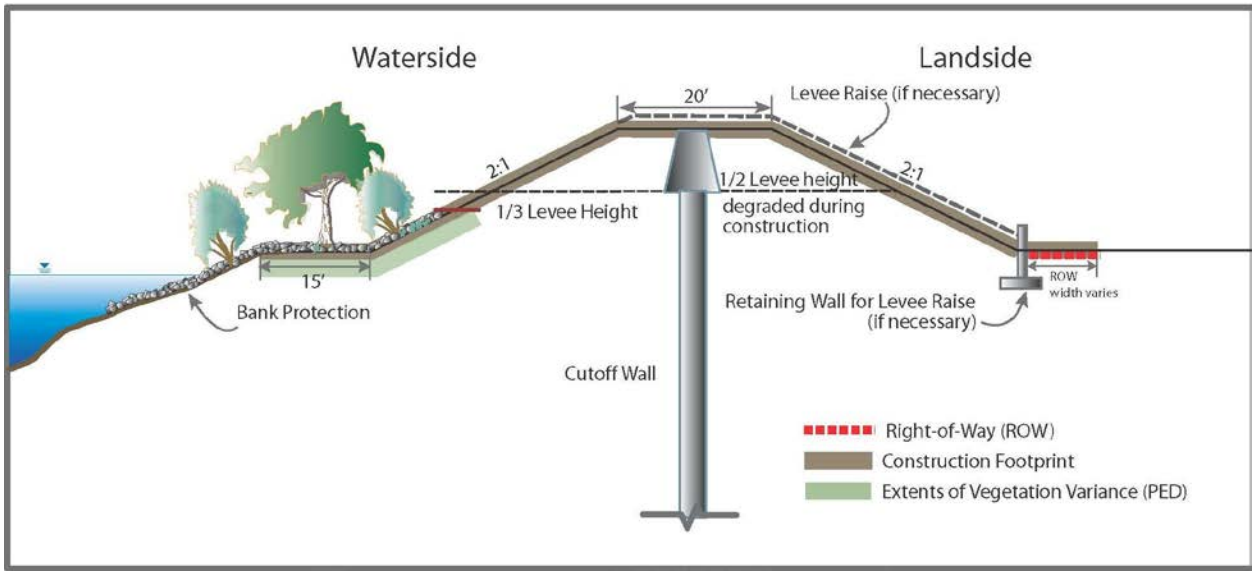

Figure 4-1: Extents of Vegetation Removal and Variance on the Sacramento River with the TSP.

- On the landside of the levee all trees would be removed from the levee slope and within 15 feet of the levee toe to comply with the Corps' ETL. Within this 15 feet, a 10-foot landside operations, maintenance, and emergency access corridor would be established. As discussed below in the Avoidance, Minimization, and Mitigation Section, trees would be planted off-site to replace those removed for construction. The removal of these trees is considered significant, because it would take many years for the replacement trees to establish to the value of those removed.

- The removal of landside trees to comply with the ETL is inconsistent with the approach the State of California has taken in the CVFPP and corresponding Programmatic Environmental Impact Report (PEIR). The Corps is currently working on a process to address the vegetation management strategy adopted by the State for feasibility studies. Impacts associated with the removal of the trees during construction to comply with the ETL would be the worst case scenario and, therefore, these impacts are being used for analysis purposes in this document.

The Corps intends to have a policy in place prior to the publication of the final West Sacramento Project EIS/EIR.

- A vegetation variance will be requested for the Sacramento River portion of the project. The majority of the Sacramento River levee within the study area requires a combination of seepage, slope stability, height, and erosion improvements in order to meet Corps criteria. Construction of the levee improvement measures will require complete vegetation removal on the levee from approximately 15 feet landward of the landside toe to approximately one-third the height of the levee on the waterside slope. On the waterside, where construction does not remove vegetation, on the lower one-third of the slope to 15 feet waterward of the waterside levee toe, the vegetation will be left in place and a Vegetation Variance Request (VVR) will be sought by the Sacramento District. The VVR requires the Corps to show that the safety, structural integrity, and functionality of the levee would be retained. An evaluation of underseepage and waterside embankment slope stability was completed for this study.

  The analysis was conducted for the index points on the Sacramento River North and Sacramento River South levees. The analysis points were chosen for the VVR analyses because they were considered to be representative of the most critical channel and levee geometry, underseepage, slope stability conditions, and vegetation conditions of the respective basins. The cross-section geometry of the index points incorporated tree fall and scour by using the maximum depth of scour for cottonwoods as approximately 11.0 feet, the associated soil removed was projected at a 2H:1V slope from the base of the scour toward both the landside, and waterside slopes. The base scour width was equal to the maximum potential diameter at breast height (dbh) of cottonwoods (12.0 feet) projected horizontally at a depth of 11.90 feet below the existing ground profile. The results show that the tree fall and scour do not significantly affect levee performance and that the levee meets Corps seepage and slope stability criteria considering the seepage and stability improvements are in place ("with project" conditions). Therefore it is a reasonable conclusion that with the VVR to allow vegetation to remain as stated above, the safety, structural integrity and functionality of the Sacramento River levee would be retained.

- Utility encroachments and penetrations would be brought into compliance with applicable Corps policy or removed depending on type or location. Utility replacements would occur by one of two methods: 1) a surface line over the levee prism, or 2) a through levee line equipped with positive closure devices.

- Private encroachments will be brought into compliance, or will be removed by the non-Federal sponsor or property owner prior to construction.

North Basin

- Sacramento River North Levee - extends for approximately 30,700 feet along the Sacramento River right bank levee from the Sacramento Bypass south to the confluence of the Barge Canal and the Sacramento River. The general improvements for this reach include erosion protection on 30,000 feet of the reach, seepage improvements with slurry wall installation ranging from 30 feet to 110 feet in depth on 18,500 feet of the reach, and height improvements consisting of embankment fill on 4,600 feet of the reach.

- Yolo Bypass Levee - extends for approximately 19,750 feet along the Yolo Bypass levee left bank from the confluence of the Sacramento Bypass and the Yolo Bypass south to the Navigation Levee (DWSC West). The general improvements for this reach include seepage improvements with slurry wall installation ranging from 40 feet to 100 feet in depth on 4,500 feet of the reach.

- Port North Area - extends for approximately 23,000 feet along the DWSC right bank from the Barge Canal west to the bend in the Navigation Levee. The general improvement for this reach include levee height improvements consisting of 8,500 feet of floodwall installation ranging from 4 to 10 feet in height and 14,000 of levee raising by embankment fill.

- Stone Locks – this area extends approximately 570 feet directly east of the inactivated Stone Locks. The improvements here will re-connect the Sacramento River North and South levees and close the connection from the Sacramento River to the inactive lock and barge canal. The general improvement for this reach is the construction of a new levee with embankment fill and sheet pile walls.

- Sacramento Bypass Training Levee – this levee extends approximately 3,000 feet southwest of the Sacramento Bypass levee into the Yolo Bypass. Erosion protection improvements will be placed on the entire reach.

South Basin

- Sacramento River South Levee - extends approximately 29,300 feet along the Sacramento River right bank levee from the confluence of the Barge Canal and the Sacramento River south to the South Cross levee. The general improvement for this reach includes construction of a setback levee with a slurry wall and berm to address seepage concerns and constructed to address levee height concerns.

- Port South Levee - extends for approximately 16,500 feet along the DWSC left bank levee from the Barge Canal west past the bend in the DWSC. The general improvement for this reach include approximately 15,000 feet of levee height improvements with embankment fill and 1,000 feet of seepage improvements with installation of a 70 foot slurry wall.

- DWSC West Levee - extends for approximately 21.4 miles along the DWSC right bank levee from the bend in the DWSC at the intersection of Port North levee and Yolo Bypass levee south to Miners Slough. The general improvement for this reach include installation of approximately 25,000 feet of slurry wall ranging from 50 feet to 85 feet in depth, approximately 75,260 feet of levee height improvements with embankment fill, and 99,000 feet of erosion protection improvements.

- DWSC East Levee - extends for approximately 5,700 feet along the DWSC left bank levee from the end of Port South levee south to South Cross levee. The general improvement for this reach includes 5,700 feet of levee height improvements with embankment fill and 5,700 feet of seepage improvements with a 50 foot slurry wall.

- South Cross Levee - extends for approximately 6300 feet from Jefferson Boulevard to the Sacramento River where it intersects the southern end of Sacramento River South levee.

The general improvements for this reach include 1,100 feet of stability berm and embankment fill to address stability and height concerns and 5,000 feet of levee improvements with relief wells to address seepage concerns and embankment fill to address height concerns. WSAFCA is currently working with USACE to include the South Cross levee into the Corps Rehabilitation and Inspection Program as a non-Federal levee Control work under the Public Law 84-99. Since this levee provides protection to the southern flank of West Sacramento from potential breaches on levees to the south along the Sacramento River and DWSC, and also forms the southern boundary for the City of West Sacramento, the West Sacramento GRR recommends that the levee be improved as part of the project and made part of the Federal levee system.

These measures are described in detail in the subsections below. Figure 4-2 identifies the recommended levee improvements for the TSP.

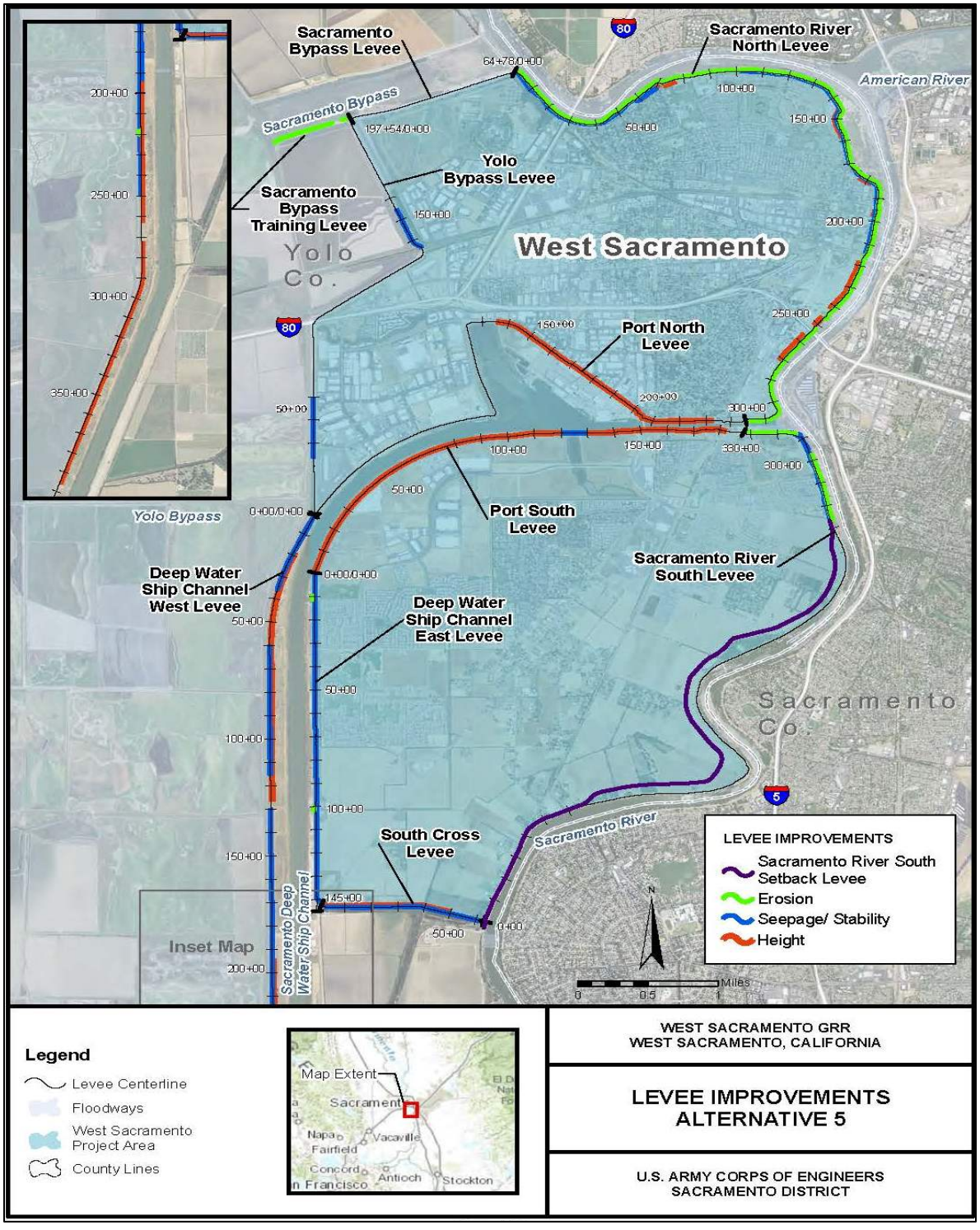

Figure 4-2: TSP Recommended Features.

The following sections include detailed descriptions of the levee improvements discussed above.

Levee Geometry

Where the existing levee cross section does not meet the levee design requirements, as discussed in Section 2.3 above, slope flattening, crown widening, and/or a levee raise is required. This improvement measure addresses problems with slope stability, geometry, overtopping, and levee toe and crest access and maintenance. The levee crown would be widened to 20 feet and a minimum 2:1 landside and waterside slopes would be established. To begin levee embankment grading, the area would be cleared, grubbed, stripped, and, where necessary, portions of the existing embankment would be excavated to allow for bench cuts and keyways to tie in additional embankment fill. Excavated and borrow material (from nearby borrow sites) would be stockpiled at staging areas. Haul trucks or scrapers would bring borrow materials to the site, which would then be spread evenly and compacted according to levee design plans.

The existing levee centerline would be shifted landward, where necessary in order to meet the Corps' standard levee footprint requirements. In some locations, a retaining wall may be constructed at the existing landside levee toe location to maintain the existing levee footprint. Retaining walls would range from 4 to 6 feet in height (full stem height) and would require landside slope benching to establish the additional fill into the levee section (Figure 2-2). The levee crown patrol road would be re-established and a new toe access corridor would be added 10 feet landward of the levee toe.

Cutoff Walls

To address seepage concerns, a cutoff wall will be constructed through the levee crown. The cutoff wall would be installed by one of two methods: (1) conventional open trench cutoff walls, or (2) deep soil mixing (DSM) cutoff walls. The method of cutoff wall selected for each reach would depend on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of approximately 85 feet. For cutoff walls of greater depth, the DSM method would be utilized.

Prior to construction of either of cutoff wall method, the construction site and any staging areas would be cleared, grubbed, and stripped. The levee crown would be degraded to approximately half the levee height to create a large enough working platform (approximately 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids.

Conventional Open Trench Cutoff Wall

Under the open trench method, a trench approximately 3 feet wide would be excavated at the top of levee centerline and into the subsurface materials up to 85 feet deep with a long boom excavator. As the trench is excavated, it is filled with a low density temporary bentonite water slurry to prevent cave in. The soil from the excavated trench is mixed nearby with hydrated bentonite, and in some applications cement. The soil bentonite mixture is backfilled into the trench, displacing the temporary slurry. Once the slurry has hardened, it would be capped and the levee embankment would be reconstructed with impervious or semi-impervious soil.

DSM Cutoff Wall

The DSM method involves a crane supported set of two to four mixing augers used to drill through the levee crown and subsurface to a maximum depth of approximately 140 feet. As the augers are inserted and withdrawn, a cement bentonite grout would be injected through the augers and mixed with the native soils. An overlapping series of mixed columns would be drilled to create a continuous seepage

cutoff barrier. Once the slurry has hardened, it would be capped and the levee embankment would be reconstructed with impervious or semi-impervious soil.

Seepage Berm

Construction of the seepage berm would consist of clearing, grubbing, and stripping the ground surface. Depending on the action alternative, soil used to construct a berm would be stockpiled from levee degradation, excavated from nearby borrow pits, or trucked on site from off-site locations (if on-site material is not adequately available). During the degrading, soil would be stockpiled at the proposed berm site. If constructing the alternative does not require levee degradation, all soil material used to construct a berm would come from nearby borrow sites. At the borrow sites, bulldozers would excavate and stockpile borrow material. Front-end loaders would load haul trucks, and the haul trucks would transport the borrow material to the site. The haul trucks would then dump the material, and motor graders would spread it evenly, placing approximately 3 to 5 feet of embankment fill material. Material used for berm construction would have greater permeability than the native blanket material. However, depending on material availability, a lower permeability material may be used. Adjustments to berm width would be made in such cases, as appropriate. During the embankment placement, material would be placed in a maximum of 1- to 2-foot loose lifts, thereby allowing the compactors to achieve the specified compaction requirements. Sheepsfoot rollers would compact the material, and water trucks would distribute water over the material to ensure proper moisture for compaction and reduction of fugitive dust emissions. The new seepage berm would be hydroseeded following construction.

Seepage berms may have an optional feature of a drainage relief trench under the toe of the berm. Drained seepage berms would include the installation of a drainage layer (gravel or clean sand) beneath the seepage berm backfill and above the native material at the levee landside toe. A drained seepage berm may decrease the overall footprint of the berm.

Bank Protection

Bank protection on the Sacramento River would be addressed by standard bank protection. The standard bank protection measure for the Sacramento River consists of placing rock protection on the bank to prevent erosion. This measure entails filling the eroded portion of the bank, when necessary, and installing revetment along the waterside levee slope and streambank from streambed to a height determined by site-specific analysis. The sites would be prepared by removing vegetation along the levee slopes at either end of the site for construction of a temporary access ramp, if needed. The ramp would then be constructed using imported borrow material that would be trucked on site.

The placement of rock onto the levee slope would occur from atop the levee and/or from the water side by means of barges. Rock required within the channel, both below and slightly above the water line at the time of placement, would be placed by an excavator located on a barge. Construction would require two barges: one barge would carry the excavator, while the other barge would hold the stockpile of rock to be placed on the channel slopes. Rock required on the upper portions of the slopes would be placed by an excavator located on top of the levee. Rock placement from atop the levee would require one excavator and one loader for each potential placement site. The loader brings the rock from a permitted source and stockpiles it near the levee in the construction area. The excavator then moves the rock from the stockpile to the water side of the levee.

The revetment would be placed via the methods discussed above on existing bank at a slope varying from 2V:1H to 3V:1H depending on site specific conditions. After revetment placement has been

completed, a small planting berm would be constructed in the rock when feasible to allow for some revegetation of the site.

4.2 DESIGN AND CONSTRUCTION CONSIDERATIONS

Construction of the TSP is proposed to take approximately 19 years. The construction reaches have been prioritized based on a variety of factors, including the condition of the levee, the potential damages that would occur due to levee failure, and construction feasibility considerations, such as the availability of equipment at any given time. The tentative construction sequence and duration are shown in Table 4-2. The durations are for construction activities only, and do not include the time needed for design, right-of-way, utility relocation, etc.

It is estimated that approximately (9) million cubic yards of borrow material could be needed to construct the project. Because the project is in the preliminary stages of design, detailed studies of each alternative borrow needs have not been completed. For the purposes of NEPA/CEQA a worst case scenario is being evaluated for the volume of borrow material needed. Actual volumes exported from any single site would be adjusted to match demands for fill.

To identify locations for borrow material, soil maps and land use maps were obtained for a 20-mile radius surrounding the project area. The criteria used to determine potential locations were based on current land use patterns, soil types from U.S. Soil Conservation Service (SCS) and Corps criteria for material specifications. Borrow sites would be on land that are the least environmentally damaging and would be obtained from willing sellers. The data from land use maps and SCS has not been field verified, therefore to ensure that sufficient borrow material would be available for construction the Corps looked at all locations within the 20 mile radius for 20 times the needed material. This would allow for sites that do not meet specifications or are not available for extraction of material.

The evacuation limits on the borrow sites would provide a minimum buffer of 50 feet from the edge of the borrow site boundary. From this setback, the slope from existing grade down to the bottom of the excavation would be no steeper than 3H:1V. Excavation depths from the borrow sites would be determined on a basis of the suitable material and local groundwater conditions. The borrow sites would be stripped of top material and excavated to appropriate depths. Once material is extracted, borrow sites would be returned to their existing use whenever possible, or these lands could be used to mitigate for project impacts, if appropriate.

Table 4-2: Alternative 5 – Construction Sequence and Duration.

Construction Sequence[1]	Construction Duration
Yolo Bypass	1 year
DWSC West Levee	3 years
DWSC East Levee	3 years
Port North	2 years
Port South	1 year
South Cross Levee	2 years
Sacramento River North Levee	2 years
Sacramento River South Levee	4 years
Sacramento Bypass Training Levee	1 year

[1] Construction is sequenced to address the worst reaches first

- Summary of Feasibility Design Approach
    - Recommended Plan to be Refined and Optimized During PED
    - Comply with HQUSACE, SPK, and State Levee Design Criteria
    - Improve a Legacy Levee System, While Maintaining Existing Features (Environmental, Cultural, Etc.)
    - Provide Level of Risk Reduction to Flood Protection System that is Supportable by the USACE (HQ, SPD, SPK)
    - Redundant, Robust, and Resilient Plan
    - Plan that is Constructible, Operable, and Maintainable

- Constructability
    - ½ Levee Degrade accomplishes or provides the following:
        - Provide Adequate Width For Anticipated Cutoff Wall Construction Methods
        - Prevent Fracturing of Levee Embankment
        - Public and Worker Safety During Construction
    - L/S Toe Access accomplishes or provides the following:
        - Construction Traffic Access Route
        - Construction of L/S Toe Retaining Wall
        - Reestablish a minimum 2H:1V Side Slopes
        - Levee Raise
        - Public and Worker Safety During Construction

The following table (4-3) compares construction criteria for the construction of an ideal levee (new levee) with the construction criteria utilized for the existing levees to address redundancy, robustness, and resiliency.

Table 4-3: Redundancy, Robustness, Resiliency.

Ideal Levee Construction	Existing Levees in Study Area
Homogenous Engineered Embankment	Partially Zoned and Partially Non-Engineered Embankment
3H:1V Slopes	2H:1V Slopes
Cutoff Wall	Cutoff Wall
15/20-Foot Access	0/10-Foot Access
Full Vegetation Removal	Vegetation Variance

4.3 Environmental Effects and Mitigation Measures

The effects to the environment have been considered throughout the planning phase of the project and opportunities have been evaluated to reduce effects to resources within the project area. A vegetation variance will be sought for the Sacramento River reach of the project, which will allow vegetation to stay on the lower one third of the waterside levee slope. The waterside vegetation on the Sacramento River is valuable SRA habitat for many State and Federally listed fish species. Section 7 consultation has been initiated with USFWS and NMFS. Table 4-4 describes the impacts estimated for the TSP and the proposed mitigation to compensate for these effects. However, during the PED phase of the project opportunities will be considered to choose a design that will minimize effects to listed species, where feasible.

Table 4-4: Environmental Impacts of and Proposed Mitigation/Compensation for the West Sacramento GRR[1].

Habitat Type	Potential Impacts	Duration of Impact	Mitigation/Compensation (Acres/Linear Feet)	Cost
GGS Upland and Aquatic	18 and 20 Acres 38 total	Single Construction Season	Restore 38 Acres	$1,760,000
GGS Upland and Aquatic	36 total	Permanent	36 Acres	$1,700,000
Riparian	65 Acres	Permanent	130 Acres	$7,200,000
Grasslands	204 Acres	Single Construction Season	Restore 204 Acres	$1,632,000
Shaded Riverine Aquatic Habitat (ESA Fish Species)	60,000 Linear Feet (21 acres)	Single Construction Season (Different Levee Reaches)	60,000 Linear Feet Self Mitigating with on-site planting[2]	*Costs will be included as part of Construction*
Elderberry Shrubs	350 Shrubs	Permanent	40 Acres	$7,680,000
Oak Woodland	13 Acres	Permanent	26 Acres	$1,170,000
Total				$21,142,000

Notes:
[1] Assumes variance from USACE's vegetation guidance is granted for Sacramento River.
[2] The SRA habitat being impacted would be minimal due to the assumed approval of a vegetation variance. Trees providing SRA will be left in place and the sites will be planted with an approved planting pallet that provides additional SRA habitat once established. Repairs using the Sacramento Back Protection Project repair are considered self mitigating and all cost should be included in the construction cost. If additional mitigation is required by NMFS or USFWS, the cost is estimated to be $144 per linear foot.

4.4 REAL ESTATE REQUIREMENTS

The Real Estate Appendix discusses in detail, by reach, the real estate interests to support the construction, operation, and maintenance of the TSP. The real estate interests include the estates, number of ownerships, and estimated land values. The baseline cost estimates include a gross appraisal and the Federal and non-Federal costs associated with acquiring the lands for the project. The non-Federal administrative costs include right of way planning and management, securing rights of entry for Engineering and Environmental Studies, surveying existing roadways for plats and legal descriptions, right of way field staking, appraisal services, independent appraisal review, acquisition services, relocation assistance, title and escrow support, and condemnation support. The Federal administrative costs include feasibility report and design level estimated costs associated with the areas and estates that are required for the construction, operation and maintenance for the project. Several of the measures included in the plans increase the footprint of the flood control system: constructing a setback levee, widening levees on the land side as a result of construction of an adjacent levee, flattening of the waterside and/or landside slopes, and constructing seepage berms. In addition, permanent maintenance roads along the landside toe for the new levees or at the ends of new seepage berms, new utility corridors, and relocated drainage canal easements increase the real estate footprint of the project as well.

Other land requirements for the project include temporary borrow areas, permanent ditch/irrigation and drainage facility relocations, temporary construction areas, temporary staging areas, and permanent mitigation sites. The non-Federal sponsor will acquire adjacent land for relocation of infrastructure from the flood control corridor and planned improvements outside the flood control corridor, with appropriate easements provided to utility owners upon completion of the work. To meet its project footprint needs, the non-Federal Sponsor must acquire fee title to fish and wildlife mitigation lands, permanent easements for levees, walls, and other permanent structures, flowage areas, waterway improvements, spoil and borrow areas required for future maintenance work, and right-of-way relocation of public highways and public utilities. Permits or temporary easements for excavated material or borrow areas are required during construction.

Finally, the plan requires relocations of many government and public owned utilities (City, County, etc.) in the study area. Other relocations include residential and nonresidential structures to accommodate the expanded project footprint along the Sacramento River North and South levee and South Cross levee.

Table 4-5: Real Estate Costs for the TSP.

MII Account[1]	Category	Costs
01 – Lands and Damages		
	Non-Federal Administrative Costs	$12,545,000
	Non-Federal Lands	$167,831,000
	Non-Federal Relocation Payment Assistance (PL 91-646)	$1,435,500
	Subtotal Non Fed Lands and Damages	**$181,811,500**
	Federal Administrative Costs	$4,825,000
	Subtotal Federal and Non-Federal Lands and Damages	**$186,636,500**
02 – Utility/Facility Relocations		
	Utility Relocation Costs	$41,910,000
	Sub Total Relocations	**$41,910,000**
	Total Real Estate Costs (01 and 02 Accounts)	**$228,546,500**

Notes: [1]MII is the software program and associated format used by USACE in developing cost estimates. Costs are divided into various categories identified as "accounts." Detailed cost estimates are presented in Appendix C, Attachment D, Cost Engineering.

4.5 OPERATIONS, MAINTENANCE, AND REPLACEMENT CONSIDERATIONS

The Standard Operation and Maintenance Manual, Sacramento River Flood Control Project, approved April 1948, will be supplemented for the work completed in the project area. New operations and maintenance manuals will be required for work completed along the Sacramento River South levee and the South Cross levee.

4.5.1 Agencies and Organizations

The State of California would have management responsibilities for the proposed project features. The State of California has sub-agreements with WSAFCA, RD 900, and RD 537 to operate and maintain the levee system.

(1) West Sacramento Area Flood Control Agency (WSAFCA)

WSAFCA would be responsible for maintenance access and inspection, roads and rights-of-way, replacement canals and associated drainage and irrigation structures, and habitat creation sites for these and the remaining portions of the project. In addition, WSAFCA would be responsible for all necessary land acquisitions and easements to construct the project features. However, once these project features are completed, most of the land or land management responsibility would be conveyed by WSAFCA to the other management entities described below. WSAFCA would use memoranda of agreement, land ownership transfers, or management endowments, and contracts to transfer land management responsibility to the appropriate public agency or nonprofit land management organization. At the end of the project construction period, all project lands would be in public ownership and/or would be under the permanent control of a natural resource conservation entity.

(2) RDs 900 and 537 and Maintenance Area 4

The mission of RD 900, RD 537 and the State of California Maintenance Area 4 (MA-4) are to operate and maintain their respective flood control levees that surround the North Basin and Southport and the internal drainage system that collects and discharges agricultural and urban stormwater runoff from the Basins. The lands acquired by WSAFCA and the State for constructing the flood control facilities included

in the TSP would be conveyed to RD 900, RD537, or the State either through flood control easements or in fee title.

By agreement with WSAFCA and the State, RD 900, RD 537, and MA-4 would operate and maintain the constructed facilities in accordance with the operation and maintenance requirements of the SRFCP. Typical flood control and drainage canal operation and maintenance activities would include mowing established grasslands along levee slopes, berms, and access areas; managing drainage canal bank vegetation, including noxious and invasive weeds; periodically removing sediment from the drainage canal; and maintaining and repairing levee and canal patrol roads. These efforts would be carried out under a long-term management agreement between WSAFCA and the State, RD 900, RD 537, and MA-4.

(3) Flood Fighting

An imminent threat of unusual flooding must exist for the Corps to assist in a flood fight. The threat must be established by National Weather Service forecasts or by Corps determinations of unusual flooding from adverse conditions. A written request from the governor of the State of California for Corps assistance is required.

Flood fights for the project area would be conducted by the California Department of Water Resources, Division of Flood Management, the Sacramento District, and the local responsible maintaining agencies, RD 900, RD 537 and State of California MA 4.

When water levels reach a predetermined height, mobile patrols will be assigned to those areas for observation. Patrols will look for wave wash, boils, seepage, cracks, or sloughing and threats of overtopping. These conditions will be reported to the emergency operations center for the State of California located in Sacramento and materials and resources allocated as appropriate.

4.5.2 Monitoring and Adaptive Management

Overall, after implementation of mitigation components, the mitigation sites would be monitored throughout the year for 3–10 years depending on the type of habitat and as developed in negotiation with the appropriate resource agencies. WSAFCA would be responsible for providing success monitoring in their increment (Southport Setback Levee) and the Corps would be responsible for providing success monitoring in the remainder of the project. Success monitoring, as required by the appropriate resource agencies, would be conducted by a qualified ecologist, botanist, or biologist. The monitor would be objective and independent from the installation contractor responsible for maintenance of the site. A monitoring and adaptive management plan would be developed during the PED phase of the project in coordination with the USFWS and NOAA Fisheries

All habitat types and mitigation sites would receive quantitative and qualitative monitoring. Quantitative monitoring for endangered species mitigation would be performed in accordance with USFWS and NMFS guidelines for the applicable species. Qualitative monitoring would provide an opportunity to document general plant health, overall plant community composition, hydrologic conditions, damage to the site, infestation of weeds, signs of excessive herbivory, signs of wildlife use, erosion problems, and signs of human disturbance and vandalism. These criteria would be assessed and noted for use in adaptive management of the mitigation sites, but they would not be used to determine project success. In addition, a complete list of all wildlife species encountered would be compiled for each mitigation site during each monitoring visit. Particular attention would be given to looking for evidence of giant garter snake, valley elderberry longhorn beetle exit holes, and Swainson's hawk.

WSAFCA would prepare an annual report in conjunction with the resource managers that would be submitted to the Corps, the USFWS, DFG, and the Central Valley RWQCB by December 31 of each year

during the success monitoring period, or until the agencies have verified that final success criteria have been met. The report would assess the attainment of or progress toward meeting the success criteria for the mitigation sites.

O&M Costs. The Sacramento District developed operation, maintenance, repair, replacement and rehabilitation (OMRR&R) costs associated with the project features. The costs were developed with input from one of the local maintaining agencies (LMA). Specifically, conversations between the District and Reclamation District 900 staff resulted in a mutual understanding of the increased efforts and impact on costs. Some of the OMRR&R costs were developed quantitatively, however, many of the costs were developed using qualitative judgment to determine the increase in cost beyond what is currently included in the existing O&M Manual. The estimated increase in OMRR&R costs is estimated at $106,000 per year.

4.6 SAFETY ASSURANCE REVIEW

Section 2035 of WRDA 2007, Pub. L. No. 110-114, § 2035, 121 Stat. 1041, 1091-1092 (2007), requires that flood damage reduction projects be reviewed by independent experts where appropriate to ensure public health, safety, and welfare. A safety assurance review is necessary if any of the following factors are applicable:

- The failure of the project would pose a significant threat to human life;
- The project involves the use of innovative materials or techniques;
- The project design lacks redundancy; or
- The project has a unique construction sequencing or a reduced or overlapping design construction schedule.

Safety assurance reviews must include participation by independent experts selected from among individuals who are distinguished experts in engineering, hydrology, or other appropriate disciplines, and who have not been involved in the design of the project, have no conflict of interest, and do not carry out or advocate for or against Federal water resources projects. The purpose of a review is to provide information on the adequacy, appropriateness, and acceptability of the design and construction activities so as to assure public health, safety, and welfare. The reviews should focus on whether the assumptions made for the hazards remain valid as additional knowledge is gained and the state of the art evolves. In addition, the review panel should advise whether project features adequately address redundancy, robustness, and resiliency and that the findings during construction reflect the assumptions made during design. Additional reviews should be completed periodically, on a regular schedule, until construction activities are completed.

Because failure of the proposed levee improvements around the Sacramento area would pose a significant threat to human life, independent review of the design and construction activities based on the Safety Assurance Review standards referenced above will be required. Similar to what was done for the West Sacramento Levee Improvement Program a three-member Board of Senior Consultants will be assembled. Board members will include recognized experts in flood control projects and levee design issues with expertise in disciplines such as geotechnical engineering, hydraulics and hydrology. The Board of Senior Consultants will provide independent reviews of engineering design and construction activities at crucial points in the West Sacramento project design process.

4.7 RESIDUAL RISK

The recommended plan would substantially lessen the probability of an uncontrolled flood in the study area due to levee failure. After implementation of the TSP, West Sacramento will, however, have a remaining risk of flooding due to the chance of overtopping from a flood event that exceeds the design event. Depending on the size of the flood eventthe flooding depth in the majority of West Sacramento could be greater than 3 feet above ground elevation, with some areas having flood depths up to 23 feet. Shallower depths are expected to be adjacent to and possibly intermingled with the extreme depths. This is severe and deep floodplain flooding. The duration of the flooding is likely to be a few weeks after the water levels in the river have receded. Large amounts of pumping would be needed to remove flood waters from the basins. The average expected residential and public displacement times are 18 months. Residential evacuees could total up to 48,000 citizens. During a large flood, residents of the affected area either self-evacuate or are assisted. During the flood and in its immediate aftermath, many of these displaced residents would have to stay at shelters. Rivers can rise from low flow levels to damaging floods within one to three days. The average annual residual damages in West Sacramento are presently estimated to be $31,400,000 per year. Following is a discussion of further actions being taken to address residual risk.

4.7.1 Levee Superiority

The concept of “superiority” was introduced as a USACE levee design profile consideration by ETL 1110-2-299 in 1986. It essentially seeks to mitigate the life-safety consequences of exceeding a project’s capacity by identifying an initial overtopping reach at an acceptable location, and assuring that reach is resilient to the effects of overtopping flow. This would provide for a relatively predictable overtopping scenario with less catastrophic effects that would enable enhanced flood evacuation and response planning. Due to the disastrous effects that would likely result from an uncontrolled overtopping of one of its levees, The West Sacramento area is a location where “superiority” should be provided. However, establishing a location that would initially overtop with some certainty would require lowering the levee in that location, or raising the levee everywhere else. Lowering a levee reach would obviously increase flood risk in West Sacramento.

According to ETL 1110-2-299, “Overtopping of Flood Control Levees and Floodwalls,” two design types can be used to control initial overtopping. The first is the use of different levee heights relative to the design water surface from reach to reach to force overtopping in a desired location. The second design uses notches, openings, or weirs in the structure. The inverts for these features are at or above a design water surface elevation but below the neighboring top of levee. Examples are railroad or road openings and rock weirs.

For this study, the second option (the use of the bypasses and weirs as described in ETL 1110-2-299) was mostly applied. There is one weir on the Sacramento River in the project area that diverts high flows from the Sacramento River into the Yolo Bypass. The Sacramento Weir is a designed flood relief structure in the system. The levees in the project area have not been designed for overtopping but there are incidental low areas that will likely overtop first.

4.7.2 Local Sponsor Actions

According to the City of West Sacramento website, flood protection is the number one priority for the City of West Sacramento. The City has three mechanisms to complete the local funding share of the flood improvement program.

Two voter approved measures passed in 2008. Measure U continued a one-fourth cent portion (capital allocation) of an existing one-half cent sales tax for an additional twenty years. Measure V provided guidelines for the use of the one-fourth cent of sales tax proceeds. A portion of the proceeds is dedicated to funding flood protection measures.

WSAFCA Assessment Fee - In July of 2007 West Sacramento voters passed the Proposition 218 ballot measure to form a new assessment district by the West Sacramento Area Flood Control Agency. The assessment will finance the local share of flood risk management projects, such as the WSLIP and West Sacramento projects, and ongoing operations and maintenance. The City Council for West Sacramento reaffirmed its General Plan policy of achieving a minimum of 200 year protection for the City by adopting Ordinance 07-11 in May 2007.

The City Council also established an in-lieu fee on future development to provide additional resources for levee improvements. Before issuance of a building permit, new development either demonstrate that a 200-year level of flood protection has been achieved by construction of flood risk management or other mitigation measures, or by making a payment to the city of an in-lieu fee. The in-lieu fee is used to fund levee improvements.

4.7.3 Senate Bill 5

The California State Senate, in 2007, approved Senate Bill 5. There are various components included in Senate Bill 5. One element is the identification of the 100- and 200-year floodplains in the Sacramento and San Joaquin valleys. One additional feature establishes a standard for urban areas to have a 200-year level of protection, as defined by State of California's methodologies. Even though it is not specifically stated, the intent of these features is to provide a higher level of flood protection for urban areas than for nonurban areas, thereby giving superiority to urban areas. The CVFPP was completed in 2012 and established urban (200-year) and non-urban (100-year) standard levels of protection.

4.7.4 Post-Flood Reoccupation of West Sacramento

The levees surrounding the basin vary from approximately 10 feet tall to approximately 25 feet tall. A levee failure anywhere in either the North Basin or Southport basin would likely inundate the entire basin. Conditions in the basins, if this were to occur, would be very similar to conditions in New Orleans after Hurricane Katrina.

With 48,000 people living in the two basins, considerable infrastructure is required to support this population. Key infrastructure within the basin includes power transmission lines, water supply lines, sewage lines, interior drainage canals and pump stations, phone lines, roadways, etc. In addition to the infrastructure flooding in the event of a levee failure, the dwellings of the 48,000 residents and commercial structures would be inundated, in many cases with up to 23 feet of depth of flooding.

In the event of significant flooding of the basins, numerous actions would have to be completed prior to reoccupation of the basin. Probably the most significant action would be reestablishment of interior drainage infrastructure. Interior drainage for the North Basin is accomplished with five pump stations; there are eight pump stations in Southport. These pump stations would be inundated should a levee failure occur. Because of this, these pumps would not be available to dewater the basin during and immediately after the levee failure. Additionally, because the pump motors would likely be inundated for a considerable amount of time, the motors would have to either require a considerable amount of work, or would have to be completely replaced in order to restore interior drainage capability. Additionally, power to the pump stations will likely have been interrupted. In this case, generating capacity would have to be provided to operate the pumps until the power grid was reestablished. Due

to these circumstances, the basin will likely be under water for a considerable period of time, most likely multiple months.

After the basin has been dewatered, considerable additional work will be necessary prior to reoccupation of the basin. Water supply infrastructure, wastewater transport facilities, and power supply infrastructure will have been inundated for a considerable period of time. Once the water is removed, repair must be done to these facilities, including cleaning and disinfecting, prior to the facilities being usable. Roadways may be usable some time after dewatering; however, considerable repair of these roadways would likely be necessary. Other infrastructure, such as phone lines and fiber optic lines, may need to be completely replaced after a flood.

Dwellings will be uninhabitable for some time after a flood. In many cases, the homes will be completely submerged. For these cases, houses will have to be completely removed and a new structure built. Buildings damaged by flooding can become contaminated with mold and fungi if they do not dry out quickly enough; these molds and fungi can pose serious health risks. When a house can be salvaged, building materials inside of the structure that could harbor mold and fungi would have to be removed, including sheet rock and insulation. Because of the limited number of contractors available to do this type of work rebuilding or repairing homes could take years.

4.8 FLOOD WARNING AND EVACUATION PLANS

4.8.1 Flood Warning System

With much of the area within the 100-year flood plain, the City of West Sacramento has developed a comprehensive flood warning system and evacuation plan. The City of West Sacramento utilizes stream gauges in the Sacramento River to determine the Flood Warning and Alert stages.

4.8.2 Evacuation Plan

The City monitors weather conditions and stream levels to determine the level of severity and evacuation triggers of potential flood events. The City monitors the gauge on the Sacramento River at the I Street Bridge. The levels of emergency evacuation identified by the City ranging from less severe to most severe include: Watch Stage, Warning Stage, Full Alert Stage, Emergency Stage, General Evacuation Stage, and Flooding Stage. The triggers for the various stages and the resultant actions are presented below and in Table 4-6.

Stage 1 – Watch Stage

The Sacramento River is at normal height but is expected to rise due to weather conditions and/or dam releases. Action: Monitor changes in the weather and river levels.

Stage 2 – Warning Stage

Sacramento River level reaches 23.0 ft. at the I Street Bridge. Action: The City's Emergency Operations Center (EOC) will open with minimal staff and continue to monitor the weather and river levels.

Stage 3 – Full Alert Stage

Sacramento River level reaches 25.7 ft. at the I Street Bridge and expected to rise due to weather conditions and/or dam releases. Action: The EOC will be fully staffed and emergency operations will commence on a 24-hour basis. Preparations for voluntary evacuation notice begin.

Stage 4 - Emergency Stage

Sacramento River level reaches 26.7 ft. at the I Street Bridge and the water levels are expected to rise due to weather conditions and/or dam releases. Action: Start evacuation of citizens that have special care needs and special care facilities. Notice of voluntary evacuation would be issued. There is a low probability of widespread flooding because the water level is still well below the top of the levees. Notification at this time will give citizens plenty of time to evacuate to an area that is not expected to flood.

Stage 5 – General Evacuation Stage

Sacramento River level reaches 29.7 ft. at the I Street Bridge and the water levels are expected to rise due to weather conditions and/or dam releases. Action: Evacuation of all citizens in the immediate threatened areas begins and then proceeds outward as river level rises. The water level is projected to be about 2 (two) foot from the top of the levees.

Stage 6 – Flooding; Levee Overtopping or Break

Sacramento River level reaches or exceeds 31.7 ft. at the I Street Bridge and the water levels are expected to rise due to weather conditions and/or dam releases. Action: Citizens who have not previously left their homes/business by this time will be directed to immediately evacuate as the danger level is very high.

Table 4-6: Emergency Activation Triggers.

Location	Watch Stage	Warning Stage	Full Alert Stage	Emergency Stage	General Evacuation Stage	Flooding
I Street on Sacramento River	River is expected to rise due to weather conditions and/or dam releases.	River level reaches 23.0 ft. at the I Street Bridge.	River level reaches 25.7 ft. at the I Street Bridge and expected to rise due to weather conditions and/or dam releases.	River level reaches 26.7 ft. at the I Street Bridge and expected to rise due to weather conditions and/or dam releases.	River level reaches 29.7 ft. at the I Street Bridge and expected to rise due to weather conditions and/or dam releases.	River level reaches or exceeds 31.7 ft. at the I Street Bridge and expected to rise due to weather conditions and/or dam releases.

4.8.3 Public Alert and Warning

One of the major methods of warning the public of an emergency situation is the Emergency Alert System (EAS) which is designed exclusively for the rapid notification of an emergency situation. Activation is utilized when an anticipated or existent emergency poses an immediate threat to life or property. The City is also a partner in a regional Reverse 911 Community Notification System which is capable of rapid notification to a specific geographic area or selected population by telephone.

Information provided to the public will include, but be not limited to the following:

- Description of the emergency.
- Identify the specific area involved.
- Provide instructions to people living in the area directly involved, such as, evacuation routes, cautions, relocation assembly areas and shelter locations.

There could also be public address announcements from helicopters, vehicles driving in the area or door to door notification if circumstances allow.

4.8.4 Shelter Locations

Shelter locations have been established by the City to provide shelter, food, emergency first aid, disaster welfare information, and bulk distribution of emergency relief items in the event of an evacuation. Eight schools have been identified as shelters; five schools in the North Basin and three schools in Southport. Rally points have been identified as pickup sites for residents without transportation. Emergency housing will be established at the Yolo County Fairgrounds in Woodland.

4.8.5 Hypothetical Flood Depth and Evacuation Maps

Hypothetical flood depth and rescue and evacuation area maps have been developed by the City of West Sacramento for two hypothetical levee failure locations, one in the North Basin and one in Southport as part of the Flood Emergency Evacuation Plan. The hypothetical flood depth maps depict both the maximum flood depths and the elapsed time from levee failure until an area is inundated with floodwaters to a depth of 1 foot for the two levee failure locations on the levees surrounding West Sacramento. Depending on the levee failure location the elapsed time to get to 1 foot flood depths can range from 2 to 22 hours.

In Southport a levee failure on the Sacramento River levee just downstream of the Barge Canal would cause flood water to reach a depth of 1 foot in the Linden Road vicinity and residential area within 6 hours. Flood water would reach a depth of 1 foot on the northern section of Jefferson Avenue within 6 hours. Jefferson Avenue is the main evacuation route for Southport; a depth of one foot is regarded as impassable from the standpoint of vehicular traffic. There are only four ways to exit Southport: the north and south ends of Jefferson Boulevard, River Road to the south, and Lake Washington/Harbor Boulevard to the north. A majority of the Southport area would be isolated from the primary evacuation route within 8 hours. Maximum flood depths in a large portion of Southport could be greater than 9 feet; some areas of Southport could reach 23 feet. The elapsed time from the breach till when water spilled over the South Cross Levee, inundating virtually all of Southport, would be 30 hours.

Emergency evacuation routes have been established to provide egress from the City in an emergency. Evacuation areas and evacuation routes for West Sacramento have been established for two different levee breach locations; one in the North Basin and one in the South Basin. Evacuation route inundation times are color coded on the various levee breach location maps and vary depending on the location of the levee breach. Figure 4-3 shows the inundation times, flood depths, and evacuation routes for the South Basin.

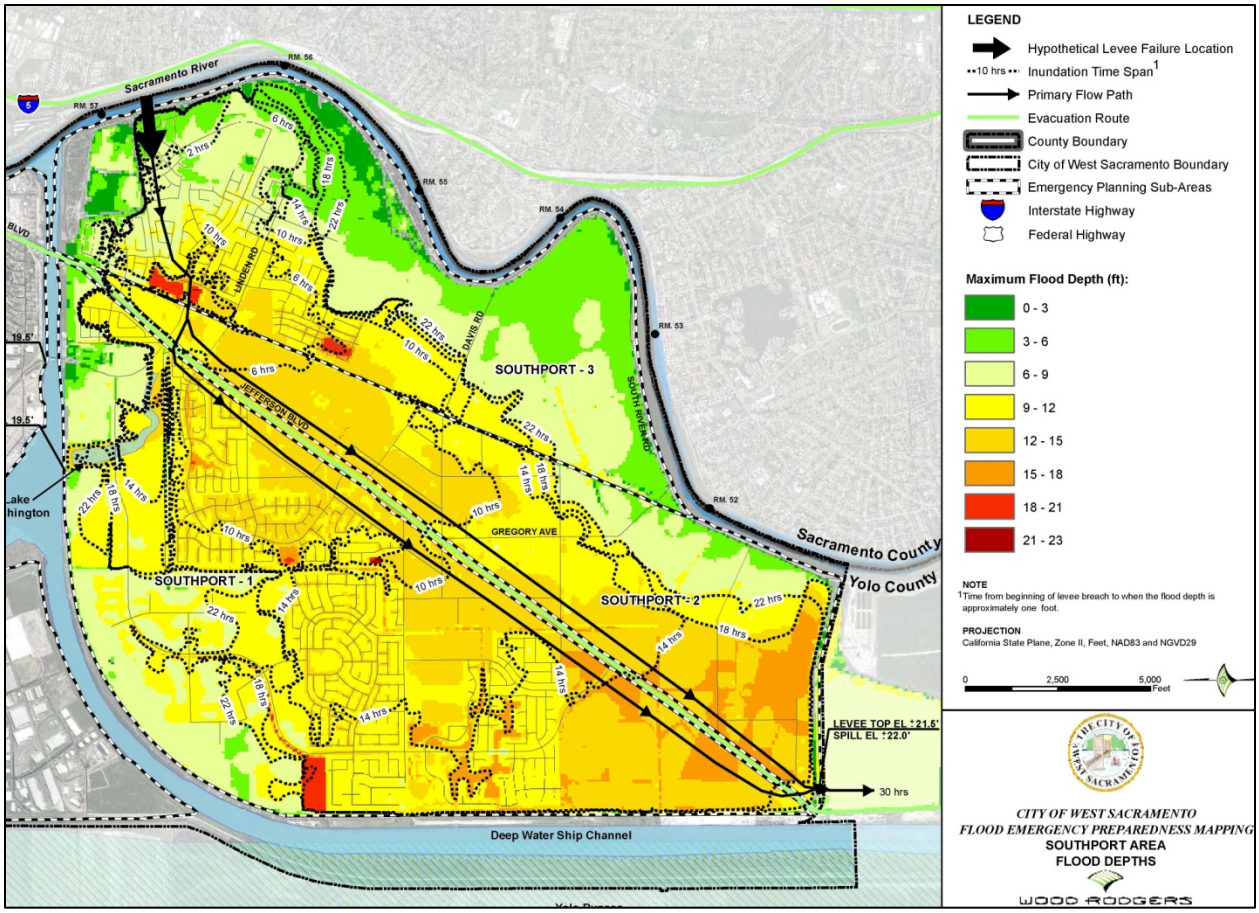

Figure 4-3: Inundation times, flood depths, and evacuation routes for the South Basin.

In the North Basin a levee failure on the Sacramento River levee near Bryte Park would inundate a large portion of the Bryte and Broderick neighborhoods to a depth of 1 foot within 6 hours. Sacramento Avenue, an evacuation route, would be inundated to a depth of 1 foot within 6 hours. A major portion of the North Basin would have less than 12 hours to evacuate. Maximum flood depths in a large portion of the North Basin would be greater than 3 feet. Some area in the western portion of North Basin could have flood depths of 12 feet or greater. The elapsed time from the breach till when water spilled over into the Deep Water Ship Channel, inundating virtually all of the North Basin, would be 24 hours. Figure 4-4 shows the inundation times, flood depths, and evacuation routes for the North Basin.

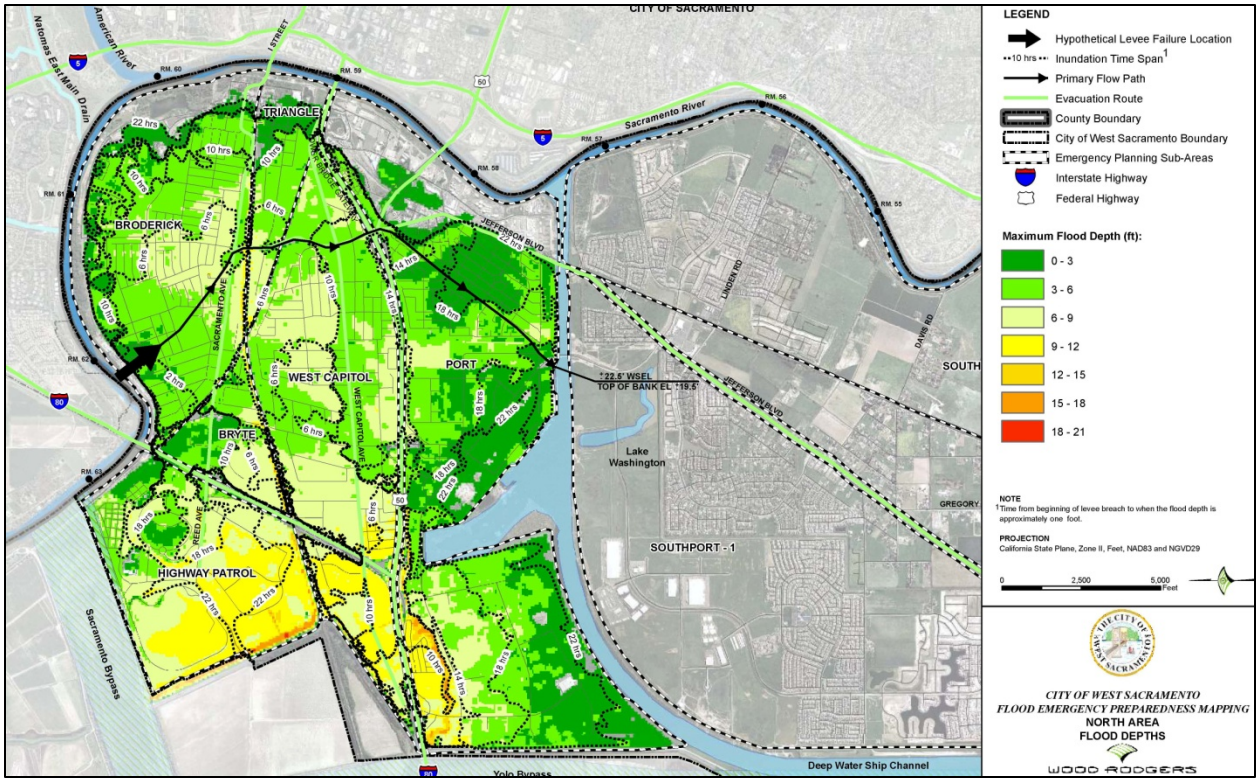

Figure 4-4: Inundation times, flood depths, and evacuation routes for the North Basin.

As depicted in the maps above there are limited evacuation routes available for the citizens of West Sacramento. In addition, the evacuation routes that are available lead to areas that could potentially also be inundated. The populations of the North Basin and Southport are approximately 30,000 and 18,000, respectively. The potential rapid inundation time and the limited evacuation routes associated for a flood event for both the North Basin and Southport raise serious life safety concerns.

4.9 HYDRAULIC IMPACT EVALUATION

Hydraulic impacts of West Sacramento GRR alternatives were evaluated using the same process the Hydrologic Engineering Center (HEC) developed in evaluating system-wide hydraulic impacts of proposed modifications to the levees of the Sacramento River Flood Control Project (SRFCP). The process utilized risk analysis methods that followed USACE policy as outlined in ER 1105-2-101.

The purpose of this evaluation was to determine if any of the alternatives could cause potential system-wide impacts. Using the model HEC created for the Sacramento River Flood Control Project (SRFCP) levees, new plans were created for each of the following three scenarios:

- Future without-project baseline condition
- Alternative 1: Fix in place
- Alternative 2: Fix in place with Sacramento Bypass widening

Alternatives 3, 4 & 5 were not analyzed. Alternatives 3&4 include a portion of alternatives 1 & 2 plus a closure structure along the DWSC. A DWSC closure structure will not impact the water surface elevations within the SRFCP. Alternative 5 includes portions of Alternative 1 with a 4.25 mile setback

levee on the Sacramento River south of the Deep Water Ship Channel sector gates; based on the 408 applicant's model results, there is a slight increase in stage downstream of the setback at the Pocket (0.13 foot and 0.17 foot rise for the 100-year and 200-year, respectively).

Potential impacts are identified from FDA model results when an increase in the annual exceedance probability (AEP) and a reduction in conditional non-exceedance probability (CNP, also referred to as 'assurance') occur at locations throughout the system when compared to the hydraulic baseline condition. The median AEP is computed directly from the inflow discharge-exceedance probability, the inflow-outflow and stage-discharge relationships that are defined at each index location. The expected AEP incorporates uncertainty in these relationships. Typically, an increase in water surface elevation without a change in the levee height will result in an increase in AEP and a reduction in CNP, which indicates an increase in the level of risk.

The following changes in AEP and CNP were identified based on comparison of the two alternatives and the future without project baseline condition:

- There was no significant change in median AEP
- There was no significant change in expected AEP (rounded at three significant figures)

There are small changes in the CNP/assurance, mostly in the thousandths place. For additional information, see the Hydraulics Appendix or The Systems Risk Technical Memorandum (USACE, May 2013).

4.10 ENVIRONMENTAL SUMMARY

The Sacramento District published a notice of intent (NOI) to prepare the West Sacramento GRR EIS in the Federal Register (Vol. 74, No. 133) on July 14, 2009. A series of public scoping meetings were held in July 2009 to present information to the public and to receive public comments on the scope of the EIS. There is no mandated time limit to receive written comments in response to the NOI under NEPA. Appendix B contains the NOI and the one comment letter received in 2009.

The draft Feasibility Study and EIS/EIR will be circulated for a 45 day public review period to Federal, State, and local agencies, organizations, and individuals who have an interest in the project. A notice of availability of the draft EIS/EIR will be published in the Federal Register when the document is released for public review. Public workshops will be held during the review period to provide additional opportunities for comments on the draft document. All comments received during the public review period will be considered and incorporated into the final EIS/EIR, as appropriate. A comment and response appendix will be included with the final document.

A biological assessment has been prepared and consultation was initiated with the resource agencies in June 2014. ESA Section 7 consultation has been on-going as part of the West Sacramento Project. A biological opinion (B.O.) has not been issued by USFWS or NMFS at this time. However, prior to release of the Final EIS a B.O. will be required.

This project is being coordinated with USFWS under the Fish and Wildlife Coordination Act (the Fish and Wildlife Coordination Act Report (CAR) and a draft CAR is included as Appendix B5. Mitigation recommended in the CAR is included in Table 4-9 which displays the potential effects and mitigation proposed for the TSP. This mitigation reflects what is currently in the biological assessment and has been coordinated with USFWS, NMFS, and the California Department of Fish and Wildlife (CDFW).

Table 4-7: Summary of Environmental Effects and Mitigation Measures.

Potential Effects	Mitigation Measure	Effects with Mitigation
Land Use		
Acquisition of properties for flood control easements along the Sacramento River. Conversion of agricultural lands to floodway or easements.	Federal Relocation Act compliance. Farmland Protection Policy Act.	Less than significant with mitigation.
Hydrology and Hydraulics		
No effect.	Not applicable.	Not applicable.
Water Quality		
Potential impacts include increased turbidity during bank protection construction, runoff of exposed soils, and cement, slurry, or fuel spills during construction.	Preparation of a Stormwater Pollution Protection Plan, Spill Prevention Control and Countermeasures Plan, and a Bentonite Slurry Spill Contingency Plan. Implementation of BMPs listed in Section 3.5.6 of the EIS.	Less than significant with mitigation.
Vegetation and Wildlife		
Construction of levee improvements and vegetation removal would result in significant loss of vegetation and wildlife habitat on the landside of the Sacramento River levees.	When possible, compensation would be planted on planting berms, within rock, or on other lands within West Sacramento- including the setback area. A hydraulic evaluation will be conducted to determine whether mitigation could occur in the Sacramento Bypass. Additional mitigation may be constructed at mitigation banks.	Significant.
Fisheries		
Indirect effects to fish habitat from the removal of vegetation from the levee slopes. Direct effects from the placement of rock at bank protection sites, causing an increase in turbidity and a loss of soft bank.	Vegetation variance would allow waterside vegetation to remain on the Sacramento River except where some trees would be removed in order to place bank protection. Bank protection sites would be revegetated following construction. BMPs would be implemented to address turbidity,	Less than significant with mitigation.

Potential Effects	**Mitigation Measure**	**Effects with Mitigation**
	and are discussed in Section 3.7.7 of the EIS.	
Special Status Species		
Direct effects to GGS, fish species, and Swainson's Hawks during construction. Indirect effects due to loss of habitat. Vegetation variance for the waterside levee slopes would reduce the effects to endangered fish species.	Replace habitat for species either on-site or in close proximity to lost habitat and purchase credits at mitigation banks if necessary. Implement BMPs discussed in Section 3.7.7 of the EIS during construction to prevent mortality.	Less than significant with mitigation
Cultural Resources		
Adverse effects to historic properties from construction of levee improvements and the setback levee.	Preparation and implementation of a Programmatic Agreement, Historic Properties Management Plan, and Historic Properties Treatment Plans.	Significant.
Transportation and Circulation		
Increased traffic on public roadways.	Preparation of a Traffic Control and Road Management Plan and other BMPs listed in Section 3.10.7 of the EIS.	Less than significant with mitigation.
Air Quality		
Emissions of criteria pollutants from construction equipment, haul trucks, and barges.	Implementation of SMAQMD's Basic Construction Emission Control Practices and other BMPs, as listed in Section 3.11.7 of the EIS.	Less than significant with mitigation.
Climate Change		
Increased greenhouse gas emissions from construction equipment, haul trucks, and barges.	Implementation of SMAQMD's Basic Construction Emission Control Practices and other BMPs, as listed in Section 3.12.7of the EIS.	Less than significant with mitigation.
Noise		
Increased noise in proximity to sensitive receptors due to construction activities.	Coordination with local residents, compliance with noise ordinances, and other BMPs, as listed in Section	Less than significant with mitigation.

Potential Effects	Mitigation Measure	Effects with Mitigation
	3.13.7of the EIS.	
Recreation		
Temporary closure of recreation facilities along the Sacramento River and DWSC during construction, including bike paths, walking trails, and boat launches. Possible closure of the Sacramento Bypass during portions of hunting season.	Notification and coordination with recreation users and bike groups. Flaggers, signage, detours, and fencing to notify and control recreation access and traffic around construction sites.	Less than significant.
Visual Resources		
Vegetation loss and construction activities would disrupt the existing visual conditions along the Sacramento River.	Trees would be planted after construction is completed on planting berms and within bank protection; however there would still be a temporal loss of vegetation. Disturbed areas would be reseeded with native grasses.	Significant.
Public Utilities and Services		
Temporary disruptions to utility services possible, particularly during relocation of utilities that penetrate the levee.	Notification of potential interruptions would be provided to the appropriate agencies and to landowners.	Less than significant.
Hazardous, Toxic, and Radiological Wastes		
No effect from construction activities. HTRW sites encountered would be removed and properly disposed of prior to construction.	Borrow material would be tested prior to use to ensure that no contaminated soils are used for this project.	Less than significant with mitigation.
Socioeconomics, Population, and Environmental Justice		
Disruption to residents alongside construction sites from traffic, noise, and dust. Acquisition of properties for flood control easements.	Federal Relocation Act compliance.	Less than significant.

4.11 EXECUTIVE ORDER 11988

Executive Order 11988 requires Federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of natural flood plains and to

avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities."

The Water Resources Council Floodplain Management Guidelines for implementation of EO 11988, as referenced in the Corps' ER 1165-2-26, require an eight-step process that agencies should carry out as part of their decision-making on projects that have potential impacts to or within the floodplain. The eight steps reflect the decision-making process required in Section 2(a) of the Order. The eight steps and responses to them are summarized below.

1. Determine if the proposed action is in the base flood plain.

The proposed project involves improving levees located in the base 1% (1/100) ACE floodplain but would improve the current level of protection for the lands behind the levees to the goal of 0.5% 1/200 ACE protection.

2. If the action is in the base flood plain, identify and evaluate practicable alternatives to the action or to location of the action in the base flood plain.

Strengthening of the existing system of levees is the only practicable alternative and the first increment to address flood risk management within the West Sacramento project area. This is also the conclusion reached earlier by the U.S. Army Corps of Engineers in the evaluation of the WSAFCA levee improvement projects for which Section 408 permission was granted as supported by the NEPA documentation summarized in the Environmental Appendix.

Additionally, it should be noted that previously West Sacramento has not been mapped in the base floodplain, and land use planning decisions have been based on studies demonstrating protection from the base flood. Only the conclusions of recent studies (as described in Chapter 1) based on evolving levee standards now necessitate improvements to continue maintaining protection above the base floodplain.

Detailed analyses were performed for the project-level alternatives and have found the proposed action to be the only practicable alternative that achieves the objectives of the project. Construction of the proposed project will remove thousands of commercial, institutional, and residential structures, transportation facilities, and approximately 48,000 residents out of the base floodplain.

3. If the action must be in the flood plain, advise the general public in the affected area and obtain their views and comments.

Public involvement activities undertaken are described in Chapter 7, Consultation and Coordination of the EIS/EIR. Notices required under NEPA and CEQA have been mailed to affected property owners throughout the WSLIP environmental review process, soliciting input on the content of the environmental document and noticing various public meetings. Additionally, notices have also been posted in the local newspaper, West Sacramento News – Ledger and the City of West Sacramento website announcing various public meetings. Public comments received on the NOI/NOP were considered and addressed, where appropriate in the DEIS/DEIR; public comments received on the DEIS/DEIR were addressed in the FEIS/FEIR; and public comments received on the FEIS and FEIR will be addressed in the record of decision (ROD).

4. Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial flood plain values. Where actions proposed to be located outside the base flood plain will affect the base flood plain, impacts resulting from these actions should also be identified.

Potential impacts associated with the West Sacramento Project are identified in Chapter 4, "Environmental Consequences and Mitigation Measures," of the EIS/EIR.

Construction of in-place levee improvements and vegetation removal would result in significant loss of vegetation and wildlife habitat along the Sacramento River levees. Setting back the levee would reduce the need to remove vegetation on the Sacramento River south.

When possible, compensation would be planted on planting berms, within rock, or within West Sacramento. Mitigation credits for riparian, SRA, oak woodlands, and wetlands would be purchased at a mitigation bank. A hydraulic evaluation will be conducted to determine whether mitigation could occur between the existing levee and the setback levee.

The Tentatively Selected Plan includes construction of a setback levee along the Sacramento River in Southport which would reconnect about 60 acres of the floodplain to seasonal inundation. Improvements to the levee systems would not affect the base floodplain.

5. If the action is likely to induce development in the base flood plain, determine if a practicable non-flood plain alternative for the development exists.

Strengthening of the existing system of levees, including setback levees, is the only practicable alternative and first increment to address flood risk management within the West Sacramento project area. This is also the conclusion reached earlier by the U.S. Army Corps of Engineers in the evaluation of the WSAFCA levee improvement projects for which Section 408 permission was granted as supported by the NEPA documentation as summarized in Environmental Appendix.

Within the West Sacramento area, population growth and urban development are driven by local, regional, and national economic conditions. Local land use decisions within the incorporated area are within the jurisdiction of Yolo County and the City of West Sacramento. The City of West Sacramento has adopted a general plan, consistent with state law, which provides an overall framework for growth and development within the project area.

The West Sacramento General plan provides for continued growth and development in the West Sacramento study area. This future growth was planned with the assumption that the area will have adequate flood protection. The West Sacramento General Plan was adopted in 1990 and readopted with amendments in 2004.

The floodplain for the West Sacramento North Basin is approximately 90 percent developed. There are plans for various infill projects and development of the Bridge District, a former industrial area located between the Tower and US Highway 50 Bridges. The Bridge District will include commercial and residential development.

The South Basin (Southport) of West Sacramento is comprised of a total of approximately 7,000 acres, and is approximately 50 percent developed. The City of West Sacramento, based on the understanding that the City was outside the 1% (1/100) ACE floodplain, has developed plans for future development in Southport. The Southport Framework Plan includes creating four pedestrian – oriented villages. Each village contains its own community services, shops schools, parks and residential neighborhood. The villages will be connected through a roadway system as well as pedestrian/bike trails. Various densities of residential development, ranging from rural estates to high density are planned. Some areas of the southern portion of Southport will remain agricultural. Residential and

commercial development has occurred in the northern and central portion of the basin. Several other portions of Southport have undergone initial development in the form of horizontal construction, including laying out utilities, such as water and sewer lines. The Sacramento Area Council of Governments in 2007 predicted that the population of West Sacramento would increase by 64% from 2007 to 2030, with a population of 73,500 in 2030.

Regional infrastructure planning reflects these growth plans. In December 2004, The Sacramento Area Council of Governments (SACOG), representing the Counties of El Dorado, Placer, Sacramento, Sutter, Yolo, and Yuba and their 22 constituent cities, adopted the "Preferred Blueprint Scenario" to guide land use and transportation choices over the next 50 years as the region's population grows from its current population of 2 million to include more than 3.8 million people. The Blueprint project was initiated in 2002 to study future land use patterns and their potential effects on the region's transportation system, air quality, housing, open space, and other resources.

The study found that continuing the recent practice of building large-lot, low-density housing would consume another 660 square miles of undeveloped land. Residents would face longer commutes, more vehicle trips, dirtier air, and a growing disconnect between where they live and where they work.

Through a series of Blueprint workshops at the neighborhood, city, county, and regional level, more than 5,000 residents, elected officials, business leaders, and environmental interests helped craft an alternative vision that integrates smart growth concepts such as higher-density, mixed-use developments and reinvestment in existing developed areas. The Preferred Blueprint Scenario assumes certain levels and locations of both "reinvestment" (i.e., additional development on already-built parcels) and greenfield development (i.e., large-scale development on vacant land), both of which are present in the West Sacramento area that would be protected by the project. An analysis of this scenario showed that following smart growth principles would shorten future commute times, reduce traffic congestion, lessen dependence on automobiles, and provide for housing choices that more closely align with the needs of an aging population. The Preferred Blueprint Scenario has become part of SACOG's long-range transportation plan for the six-county region. It also will serve as a framework to guide local government in growth and transportation planning through 2050.

Using the above information, combined with an evaluation of residual flood damage, it was concluded that there is substantial evidence that the recommended plan as a whole would accommodate anticipated growth in the project area in a manner that would be consistent with adopted local and regional growth management plans and with the state's emerging approach to the State Plan of Flood Control as reflected in the Central Valley Flood Protection Plan. Thus, the project, while accommodating planned regional growth, is not growth inducing itself and is compliant with EO 11988.

6. As part of the planning process under the Principles and Guidelines, determine viable methods to minimize any adverse impacts of the action including any likely induced development for which there is no practicable alternative and methods to restore and preserve the natural and beneficial flood plain values. This should include reevaluation of the "no action" alternative.

There is no practicable alternative other than the strengthening of the existing system of levees to reduce flood risk to existing residents in the West Sacramento area.

Construction of in-place levee improvements and vegetation removal would result in significant loss of vegetation and wildlife habitat along the Sacramento River levees. Setting back the levee would reduce the need to remove vegetation on the Sacramento River south.

When possible, compensation would be planted on planting berms, within rock, or within West Sacramento. Mitigation credits for riparian, SRA, oak woodlands, and wetlands would be purchased at a

mitigation bank. A hydraulic evaluation will be conducted to determine whether mitigation could occur between the existing levee and the setback levee.

The Tentatively Selected Plan includes construction of a setback levee along the Sacramento River in Southport which would reconnect about 60 acres of the floodplain to seasonal inundation.

7. If the final determination is made that no practicable alternative exists to locating the action in the flood plain, advise the general public in the affected area of the findings.

See response to Item 3, above.

8. Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order.

The objective of the project is to reduce the risks associated with flooding to public health, safety, and property in West Sacramento. The project is responsive to the EO 11988 objective of "avoidance, to the extent possible, of long- and short-term adverse impacts associated with the occupancy and modification of the base flood plain and the avoidance of direct and indirect support of development in the base flood plain wherever there is a practicable alternative" because it would not in and of itself induce additional development in the floodplain, would reduce the hazard and risk associated with floods thereby minimizing the impacts of floods on human safety, health, and welfare. The tentatively selected plan, with the Southport Setback Levee, would improve the natural and beneficial values of the base floodplain in the setback area.

4.12 PLAN ECONOMICS AND COST SHARING

The project first cost, estimated on the basis of October 2013 price levels, amounts to $1,612,767,000. Table 4-8 displays the project first cost by MCACES account.

Table 4-8: Estimated Costs of Tentatively Selected Plan[1] ($1,000).

MCACES Account[2]	Description	Total First Cost
01	Lands and Damages[3]	286,462
02	Relocations[4]	21,808
06	Fish and Wildlife	18,105
11	Levees and Floodwalls	1,034,413
18	Cultural Resource Compliance Contingency[5]	$8,006
30	Planning, Engineering, Design[6]	152,655
31	Construction Management[7]	$91,318
	Total First Cost[8]	**1,612,767**

Notes:
[1]Based on October 2013 price levels, 3.5% interest rate, and a 50-year period of analysis.
[2]Micro Computer-Aided Cost Engineering System (MCACES) is the software program and associated format used by USACE in developing cost estimates. Costs are divided into various categories identified as "accounts." Detailed costs estimates are presented in Appendix C, Attachment D, Cost Engineering.
[3]Real Estate land costs, which include no damages.
[4]Relocations include relocating affected utilities and irrigation ditches.
[5]Contingency costs for cultural resource compliance is specifically for data recovery as needed.
[6]12 percent of 02, 11, and 18 accounts.
[7]8.5 percent of 02, 11, and 18 accounts.
[8] Numbers reported may be slightly different than those presented in the appendices due to rounding.

A summary of the cost sharing responsibilities is presented in Table 4-9.

Table 4-9: Summary of Cost Sharing Responsibilities for the TSP[1] ($1,000s - working level estimates).

Item	Federal[2]	Non-Federal	Total
Lands and Damages[3]	0	286,462	286,462
Relocations	0	21,808	21,808
Fish and Wildlife Facilities	18,105	0	18,105
Levees and Floodwalls	1,034,413	0	1,034,413
Pumping Plants	0	0	0
Subtotal	**1,052,518**	**308,270**	**1,360,788**
PED[4]	152,655	0	152,655
Construction Management	91,318	0	91,318
Subtotal	**1,296,491**	**308,270**	**1,604,761**
Minimum 35% Share	0	561,666	
Total Required Cash	-253,396	253,396	
Cultural Resource Preservation[5]	8,006		
Total	1,051,101	561,666	1,612,767
Cost Sharing (%)	65	35	100

Notes:
[1] Based on October 2013 price levels, 3.5% interest rate, and a 50-year period of analysis.
[2] Federal Project First Costs are based on 65% of the NED Plan of $ 1,612,676.
[3] Lands, Easements, Rights of Way, Relocations and Disposal Areas.
[4] Planning, Engineering, and Design.
[5] Cost is only for data recovery or cultural resources mitigation.

4.13 VIEWS OF NON-FEDERAL SPONSORS AND OTHER AGENCIES

The State of California and WSAFCA have expressed the desire for implementing the project and sponsoring project construction in accordance with the items of local cooperation that are set forth in the recommendations chapter of this report. Throughout development of this GRR, there has been significant coordination with the State of California and WSAFCA. The financial analysis indicates that the non-Federal sponsors are financially capable of participating in the selected plan.

4.14 POTENTIAL ADDITIONAL STUDIES

There are potential additional studies that could impact the West Sacramento project. The American River Common Features project is completing an "Interim General Reevaluation Report" which is addressing water resources in a specific area within the American River watershed authorization, rather than the entire area authorized by the study. Additional studies to address other water resource issues within the Sacramento and American River Watersheds, including measures that could improve the level of flood risk management FRM for West Sacramento, could be initiated based on Congressional direction. The plan presented in Chapter 3 as the Maximum Plan could be evaluated to determine if there was Federal interest.

5 - CHANGES TO WEST SACRAMENTO PROJECT

The chapter integrates the reevaluated West Sacramento Project with the other previously authorized and constructed portions of the project to describe proposed changes to the authorized West Sacramento Project. The economics, cost apportionment, cost allocation, crediting, fully funded cost estimate and implementation schedule must be determined for the integrated project to establish the changes.

5.1 CONSTRUCTED WEST SACRAMENTO PROJECT FEATURES

The West Sacramento Project features, as they have evolved through subsequent authorizations are presented in Table 5-1. Table 5-2 presents an economic summary of the authorized plan and Table 5-3 presents the cost apportionment for the authorized plan.

Table 5-1: Authorized and Constructed Project Features.

Sacramento Urban Area Levee Reconstruction Project
Construction of berms to improve stability and manage seepage at two relatively small sites along the right bank of the Sacramento River near the Lighthouse Marina Six miles of levee along the right bank of the Sacramento River extending from near the Barge Canal entrance downstream to near the South Cross levee. Construction began in November 1990 and was completed in 1992.
Sacramento Metropolitan Area, 1992 and 1999 Authorization (West Sacramento Project)
Raising and installing a slurry wall along 4.7 miles of the east bank of the Yolo Bypass levee from the Sacramento Bypass south to the Navigation Levee. Reconstructing and raising the levee along one mile of the south bank of the Sacramento Bypass, including backfill of a drainage ditch and placing riprap along the levee. Construction was completed in 2004.

5.2 FEATURES OF THE TENTATIVELY SELECTED PLAN

The principal features of the Tentatively Selected Plan are:

- Cutoff walls to address seepage remediation and stability problems, rock bank protection to address erosion problems, and levee raises to address overtopping issues along the Sacramento River North levee.
- Flood wall and levee raises with embankment fill to address overtopping concerns on the Port North levee.
- Cutoff walls and slope flattening to address seepage and stability concerns on the Yolo Bypass levee.
- Bank protection to address erosion concerns on the Sacramento Bypass training levee.
- Construct a sheet pile wall with embankment fill to plug gap in levee east of Stone Lock.

- Construct a setback levee with cutoff walls and/or seepage berms to address seepage remediation, rock bank protection to address erosion problems, and levee raise to address overtopping issues along the Sacramento River South levee.
- Cutoff walls or seepage berm to address seepage remediation and stability problems, and levee raise to address overtopping issues along the South Cross levee.
- Cutoff walls address seepage remediation and stability problems, and levee raise to address overtopping issues along the Deep Water Ship Channel East levee and the Port South levee.
- Cutoff walls or seepage berms to address seepage remediation and stability problems, and levee raise to address overtopping issues along the South Cross levee.
- Cutoff walls to address seepage remediation and stability problems, rock bank protection to address erosion problems, and levee raises to address overtopping issues along the Deep Water Ship Channel West levee.

5.3 ECONOMIC SUMMARY.

The estimated first costs, along with total annual costs, annual benefits, net economic benefits and the benefits-to-cost ratios are shown on the following table. These values are based on October 2013 price levels, an interest rate of 3.5% and a 50-year period of economic analysis, assuming initiation of Corps construction in FY 2011.

Table 5-2: Economic Analysis of the Tentatively Selected Plan ($1,000) .

MCACES ACCOUNT		Authorized West Sacramento Project[1]	Authorized West Sacramento Project[2]	Tentatively Selected Plan
01	Lands and Damages	1,800	2,387	286,462
02	Relocations	15	128	21,808
06	Fish and Wildlife Facilities	2,400	3,044	18,105
11	Levees and Floodwalls	10,200	28,394	1,034,413
13	Pumping Plants	-	-	-
18	Cultural Resources	131	-	8,006
	Subtotal	14,546	33,953	1,368,794
30	PED	1,665	10,690	152,655
31	Construction Management	1,132	2,034	91,318
	Subtotal First Cost	17,400	46,677	1,612,768
	Associated Cost	---	---	---
	Interest During Construction	1,600	4,195[3]	646,916
	Total First Cost	19,000	50,872	2,259,694
	Interest and Amortization	1,680	2,419	96,330
	OMRR&R	20	20[4]	106
	Total Annual Costs	1,700	2,439	96,436
	Flood Risk Management (Structure and Contents)	9,800	9,800[5]	256,859
	Total Annual Benefits	9,800	9,800	256,859
Net Annual Benefits		8,100	7,361	160,423
Benefit to Cost Ratio		5.8	4.0	2.7

1.Authorized Cost from 1992 Sacramento Metropolitan Area Feasibility Report
2. Project Cost Estimate from SPK, June 2011
3. IDC was calculated based on a ratio of IDC to first costs from 1992 feasibility study
4. OMRR&R costs taken from 1992 feasibility study
5. Benefits have not been recalculated, benefits from 1992 feasibility study carried forward

5.4 CREDIT PROVISIONS

The TSP includes construction of a cutoff wall to strengthen approximately 500 feet of existing levee along the Sacramento River North levee in the vicinity of the I Street Bridge. One of the non-Federal sponsors, WSAFCA, requested credit consideration under Section 104 of the Water Resources Development Act of 1986 for this work to be applied toward the required non-Federal cost share of any future West Sacramento project. By memorandum dated 9 September 2008, ASA(CW) approved the request for credit consideration.

Further advance work that is eligible for credit includes WSAFCA design and construction of the Southport Setback levee Early Implementation Project (EIP) which provides flood risk management benefits to the people and property of West Sacramento in advance of the Federal project. The sponsor's intent is to seek Section 221 credit to be applied to the non-Federal cost share of the West Sacramento project. A Section 221 Memorandum of Understanding will be executed in advance of local construction as required by Engineering Regulation 1165-2-208: Water Resources Policies and Authorities, In Kind Contribution Provision of Section 221 of the Flood Control Act of 1970, as amended (2012). Section 221 provides that credit will be afforded only if ASA(CW) determines that a material or service provided as an in-kind contribution by a non-Federal sponsor is integral to the project. To be integral to the project, the material or service must be part of the work that the Federal Government would otherwise have undertaken for construction of what is ultimately determined to be the Federal project. During the PED phase an Integral Determination Report will be prepared prior to the execution of the PPA. Section 104 and 221 credit will be accorded only in accordance with the provisions of the PPA.

Table 5-3: Authorized Plan Cost Apportionment

ESTIMATE OF FIRST COSTS ($000)[1]				
ACT	**ITEM**	**FEDERAL**	**NON-FEDERAL**	**TOTAL**
1	Lands and Damages	180	2,207	2,387
2	Relocations	-	128	128
6	Fish and Wildlife Facilities	3,044	0	3,044
11	Levees and Floodwalls	28,394	0	28,394
18	Cultural Resources	0	0	0
30	PED	10,685	5	10,690
31	Construction Management	2,032	2	2,034
	Subtotal First Cost	**44,335**	**2,342**	**46,667**
	Non-Federal Cash Contribution	-9,327	9,327	0
	Total First Cost	35,008	11,669	46,677

[1] Project Cost Estimate from SPK, June 2011

5.5 COST APPORTIONMENT

Cost apportionment for the existing authorized West Sacramento project, the TSP, and the Total West Sacramento Recommended Plan is shown in accordance with the authorized percentages.

Table 5-4: Cost Apportionment ($000).

Existing Authorized West Sacramento Project[1]	Federal	Non-Federal	Total
Lands and Damages	180	2,207	2,387
Relocations	0	128	128
Fish and Wildlife Facilities	3,044	0	3,044
Levees and Floodwalls	28,394	0	28,394
Pumping Plants	0	0	0
Subtotal	**31,618**	**2,335**	**33,953**
PED	10,685	5	10,690
Construction Management	2,032	2	2,034
Subtotal	**44,335**	**2,342**	**46,677**
Minimum 25% Share	0	11,669	-
Total Required Cash	-9,327	9,327	-
Cultural Resource Preservation	0	0	0
Total	35,008	11,669	46,677
Cost Sharing (%)	75	25	100
TSP[2]			
Lands and Damages	0	286,462	286,462
Relocations	0	21,808	21,808
Fish and Wildlife Facilities	18,105	0	18,105
Levees and Floodwalls	1,034,413	0	1,034,413
Pumping Plants	0	0	0
Subtotal	**1,052,518**	**308,270**	**1,360,788**
PED	152,655	0	152,655
Construction Management	91,318	0	91,318
Subtotal	**1,296,491**	**308,270**	**1,604,761**
Minimum 35% Share	0	561,666	
Total Required Cash	-253,396	253,396	
Cultural Resource Preservation	8,006		
Total	1,051,101	561,666	1,612,767
Cost Sharing (%)	65	35	100
Total West Sacramento Recommended Plan			
Lands and Damages	180	288,669	288,849
Relocations	0	21,936	21,936
Fish and Wildlife Facilities	21,149	0	21,149
Levees and Floodwalls	1,062,807	0	1,062,807
Pumping Plants	0	0	0
Subtotal	**1,084,136**	**310,605**	**1,394,741**
PED	163,340	5	163,345
Construction Management	93,350	2	93,352
Subtotal	**1,340,826**	**310,612**	**1,651,438**
Minimum Adjusted Share	0	573,335	

Total Required Cash	-262,723	262,723	
Cultural Resource Preservation	8,006	0	8,006
Total	1,086,109	573,335	1,659,444
Cost Sharing (%)	65	35	100

[1] Project Cost Estimate from SPK June 2011
[2]Based on October 2013 price levels, 3.5% interest rate, and a 50-year period of analysis.

5.6 COST ESTIMATE WITH CONSTRUCTED AND UNCONSTRUCTED PARTS OF THE TENTATIVELY SELECTED PLAN

With the WSLIP project, the sponsor has already started construction of part of the recommended plan. As described previously, the sponsor has made several requests for credit under Section 104. Table 5-5 below shows the estimated costs of the constructed and unconstructed portions of the recommended plan. The costs for the constructed portions reported in Table 5-5 are based on the cost estimates contained in Appendix G, Cost.

Table 5-5: Constructed and Unconstructed Parts of Tentatively Selected Plan ($1,000).

	Constructed (Non-Federal)[1]	Unconstructed[2]	
		Federal	Non-Federal
Lands and Damages	604	0	286,462
Relocations	0	0	21,808
Fish & Wildlife Facilities	0	18,105	0
Levees & Floodwalls	100	1,034,413	0
Pumping Plants	0	0	0
Subtotal	704	**1,052,518**	**308,270**
Preconstruction Engineering and Design	1,691	152,655	0
Construction Management	354	91,318	0
Subtotal	3,300	**1,296,491**	**308,270**
Minimum 35% Share	NA	0	561,666
5% Cash	NA	-80,238	80,238
Additional Required Cash	NA	-173,158	173,158
Total Required Cash	NA	-253,596	253,396
Cultural Resource Preservation	0	8,006	
Total	NA	1,051,101	561,666
Cost Sharing	NA	65	35

[1]Provided by WSAFCA
[2]Based on October 2013 price levels, 3.5% interest rate, and a 50-year period of analysis.

5.7 INSTITUTIONAL REQUIREMENTS

Table 5.6 shows a tentative implementation schedule.

Table 5-6. Implementation Schedule.

Item	Completion Date
Plans and Specifications for First Contract Complete	2016
PPA Signed	2016
Real Estate Acquisitions Completed for First Contract	2017
Advertise First Construction Contract	2017
Completion of All Construction	2034

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6 - PUBLIC INVOLVEMENT, REVIEW, AND CONSULTATION

6.1 PUBLIC INVOLVEMENT PROGRAM

To announce the start of the West Sacramento General Reevaluation Study, a notice of intent (NOI) to prepare the West Sacramento General Reevaluation Report (GRR) Environmental Impact Statement (EIS) was posted in the Federal Register (Vol. 74, No. 133) on July 14, 2009. The recipients were invited to comment on the results of the earlier completed reconnaissance study and to provide input to the feasibility study, including the scoping of the environmental issues that should be address throughout the study. The notice in 2009 announced a group of public workshops, where the public was given the opportunity to comment. A joint National Environmental Policy Act (NEPA)/California Environmental Quality Act (CEQA) public scoping meeting was held to brief interested parties on the West Sacramento General Reevaluation Report and obtain the views of agency representatives and the public on the scope and content of the EIS/EIR.

The meeting location, date, and times were as follows:

- July 21, West Sacramento City Hall, 1110 West Capitol Avenue, West Sacramento (3-5pm) and (6:30-8pm).

6.2 PUBLIC FEEDBACK

There were 4 people in all who attended the meetings. Comments were solicited through the use of court reporters at the meetings. Additionally, comments could be submitted through mail or electronic mail. Oral and written comments were made throughout the series of meetings by two State Agencies. The comments and the responses to them are summarized in the Public Involvement Section of the DEIS/EIR (Appendix I of the DEIS/EIR).

6.3 OTHER PUBLIC INVOLVEMENT

To help the community stay informed about current project activities, information is provided in a variety of ways:

- The Corps and the City of West Sacramento each maintain Web sites (http://www.spk.usace.army.mil and http://cityofwestsacramento.org/city/flood/default.asp, respectively) that contain public documents related to the GRR and the WSLIP. Additionally, the City of West Sacramento Web site contains public notices, project maps, schedule updates, news articles, WSAFCA Board of Directors meeting agendas and meeting summaries, and other project-related materials;
- GRR and WSLIP updates are provided at the monthly WSAFCA Board of Directors meetings, which typically occur on the second Thursday of each month. These meetings are held at the West Sacramento City Hall at 1100 West Capitol Avenue, West Sacramento, California, 95814 and begin at 10:30 a.m.; and
- WSAFCA has held several meetings with landowner groups and other interest groups during conceptual project design for Early Implementation Projects as part of the West Sacramento

Levee Improvement Program and will continue to meet with these groups to address concerns and interests.

- Additional public meetings will be conducted when the Draft Report is released for public review.

6.4 INSTITUTIONAL INVOLVEMENT

6.4.1 Study Team

During the reevaluation study, staff from the State of California and WSAFCA participated along with the Corps as members of the study team. They participated directly in the study effort and on the Executive Leadership Board.

6.4.2 Agency Participation

During the general reevaluation study, coordination with the USFWS was conducted in accordance with the Fish and Wildlife Coordination Act. USFWS has provided the Corps with a draft Coordination Act Report that includes their views on the selected plan. USFWS had no mitigation recommendations beyond those described through the Section 7 consultation. A biological assessment has been prepared and consultation was initiated with the resource agencies in June 2014. ESA Section 7 consultation has been on-going as part of the West Sacramento Project. A biological opinion (B.O.) has not been issued by USFWS or NMFS at this time.

- The project has been coordinated with National Marine Fisheries Service and the California Department of Fish and Game.
- These agencies have been participating through the Section 408 approval process, the Section 404 permitting process, and the NEPA/CEQA process.

6.5 ADDITIONAL REQUIRED COORDINATION

Additional required coordination will be summarized in the final report.

6.6 PUBLIC VIEWS AND RESPONSES

Public views and responses to comments on the draft report will be summarized in the final report.

6.7 IMPACT ON RECOMMENDATIONS

Any impacts on the recommendations due to public views will be summarized in the final report.

7 - Recommendations

This chapter describes the Items of Cooperation for a Structural Flood Damage Reduction (Single Purpose) Project that will be specifically authorized.

I recommend modifying the authorized West Sacramento Project to include the following:

In addition to the features included in the 1999 authorization, the selected plan includes the additional features to improve the plan for flood risk management to the entire West Sacramento project area. The principal features of this plan are:

- Slurry cutoff walls to address seepage remediation and stability problems, rock bank protection to address erosion problems, and levee raises to address overtopping issues along the Sacramento River North levee.
- Flood wall and levee raises with embankment fill to address overtopping concerns on the Port North levee.
- Slurry Cutoff walls and slope flattening to address seepage and stability concerns on the Yolo Bypass levee.
- Bank protection to address erosion concerns on the Sacramento Bypass training levee.
- Construct a sheet pile wall with embankment fill to plug gap in levee east of Stone Lock.
- Construct a setback levee with slurry cutoff walls and/or seepage berms to address seepage remediation, rock bank protection to address erosion problems, and levee raise to address overtopping issues along the Sacramento River South levee.
- Slurry cutoff walls or seepage berm to address seepage remediation and stability problems, and levee raise to address overtopping issues along the South Cross levee.
- Slurry cutoff walls address seepage remediation and stability problems, and levee raise to address overtopping issues along the Deep Water Ship Channel East levee and the Port South levee.
- Slurry cutoff walls or seepage berms to address seepage remediation and stability problems, and levee raise to address overtopping issues along the South Cross levee.
- Slurry cutoff walls to address seepage remediation and stability problems, rock bank protection to address erosion problems, and levee raises to address overtopping issues along the Deep Water Ship Channel West levee.

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The estimated first cost of these recommended improvements is $1,612,767,000. Adding the cost of these improvements to the West Sacramento project makes a total project first cost of $1,659,444,000. The estimated annual Operation and Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) cost is $106,000. The Federal portion of the estimated total first cost is $1,086,109,000. The total first cost of the West Sacramento project of $1,659,444,000 includes costs already incurred implementing previously authorized West Sacramento elements. Federal implementation of the recommended project would be subject to the non-Federal sponsor agreeing to comply with applicable Federal laws and policies, including but not limited to:

a. Provide a minimum of 35 percent, but not to exceed 50 percent of total project costs as further specified below:

    1. Provide 35 percent of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

    2. Provide, during construction, a contribution of funds equal to 5 percent of total project costs;

    3. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the project;

    4. Provide, during construction, any additional funds necessary to make its total contribution equal to at least 35 percent of total project costs;

b. Provide 100 percent of all costs for local betterments.

c. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;

d. Not less than once each year, inform affected interests of the extent of protection afforded by the project;

e. Agree to participate in and comply with applicable Federal flood plain management and flood insurance programs;

f. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal interest to agree to participate in and comply with applicable Federal floodplain management and floodplain insurance programs and to prepare a flood plain management plan within one year after the date of signing a project cooperation agreement, and to implement such plan not later than one year after completion of construction of the project;

g. Publicize flood plain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the project;

h. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the level of protection the project affords, hinder operation and maintenance of the project, or interfere with the project's proper function;

i. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those

necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

j. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

k. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

l. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

m. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

n. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c *et seq.*);

o. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

p. Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and

maintenance of the project;

q. Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and

r. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the sponsor, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

_____ _____

Date

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