DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

REPLY TO
ATTENTION OF

18 FEB '11

CECW-P

MEMORANDUM FOR MAJOR SUBORDINATE COMMANDS

SUBJECT: Civil Works Program - National Pilot Program: Initial Pilot Study Selection

CORE,

1. Reference memorandum dated 3 February 2011, subject: Civil Works Program - Pilot Study Implementation. The Pilot Program is intended to validate concepts of a new pre-authorization (planning) study paradigm that shortens the timeframe for completion of a planning study, while maintaining the quality and integrity of the analyses. The purpose of this memorandum is to announce the selection of the initial pilot studies for the National Pilot Program.

2. In the referenced memorandum input on three potential pilot studies was requested: Central Everglades, FL; Jordan Creek (Springfield), MO; and Sutter Basin, CA. The intent was to select two pilot studies on 10 February 2011 from these three studies unless more suitable studies were brought forward prior to 8 February 2011. Additional pilot studies will be selected from the nominations due by 23 February 2011.

3. No additional pilot studies were proposed by the close of business 7 February 2011 due date, so the selection panel proceeded with the three potential pilot studies outlined in the 3 February 2011 memorandum. The selected pilot studies are Jordan Creek (Springfield), MO and Sutter Basin, CA. Central Everglades, FL will remain under consideration for future selection as a pilot study.

- Jordan Creek (Springfield), MO has available Federal and non-Federal funds necessary to complete the study. The Feasibility Scoping Meeting (FSM) is currently scheduled for March 2011, and strong engagement and support of the sponsor, as well as existing vertical team engagement makes this project ideal for initial selection. Southwestern Division supports the study for inclusion as a pilot.

- Sutter Basin, CA is in the FY 2011 and 2012 President's Budget at an adequate level to complete the study. While the FSM for the study has been held, information discovered during planning has resulted in integration and consideration of new data and an expanded study area. The study has the strong support of South Pacific Division and the study sponsor for inclusion in the National Pilot Program.

4. Congratulations to these project delivery teams on their selection as the first representatives of the National Pilot Program. The National Pilot Program studies will proceed with vertical team coordination, a kick-off webinar, and pilot project activity scoping, including refinement and

communication of expectations, development of the path forward, and further definition of outcomes and indicators of success. The webinar will provide additional information and direction on the pilot program and will be held prior to 28 February 2011. Pilot Program project delivery teams will be contacted no later than 18 February 2011 to coordinate dates for the scoping meetings. The scoping meeting will be the official start of the National Pilot Program and will be held in early to mid-March.

5. We look forward to receipt of your additional nominations and appreciate your responsiveness and commitment to this important Civil Works initiative.

FOR THE COMMANDER:

Encls Thanks for Your Support!

WILLIAM T. GRISOLI
Major General, USA
Deputy Commanding General
for Civil and Emergency Operations

DISTRIBUTION:

COMMANDERS:
Great Lakes and Ohio River Division, CELRD
Mississippi Valley Division, CEMVD
North Atlantic Division, CENAD
Northwestern Division, CENWD
Pacific Ocean Division, CEPOD
South Atlantic Division, CESAD
South Pacific Division, CESPD
Southwestern Division, CESWD

CF:
OASA(CW), Doug Lamont
CHIEF, CECC-A
CHIEF, CECW-I
CHIEF, CECW-CO
CHIEF, CECW-CE
CHIEF, CECW-HS
CHIEF, CEMP-CR
DIRECTOR, IWR

Sutter Basin, California
Pilot Feasibility Study

Progress Document #1:
Without Project & Alternative Development
DRAFT

US Army Corps
of Engineers

Sacramento District

Version: 07 March 2013

Progress Document Purpose:

This is a summary document of the progress and process of the Sutter Basin Pilot Feasibility Study up to the development of a Refined Array of Alternatives.

A subsequent progress document will summarize the work and process of the Sutter Basin Pilot Feasibility Study to a Draft Array of Alternatives to a Tentatively Selected Plan.

Sutter Basin Pilot Feasibility Study

Progress #1 Document: Without Project and Alternative Development

Table of Contents

1.0 INTRODUCTION.....1

1.1 Purpose and Need for the Project and Report 1

1.2 Study Authority.....2

1.3 Study Sponsors.....2

1.4 Location and Description of the Study Area.....2

1.5 Related Projects and Studies 4

1.6 Planning Strategy 6

2.0 PROBLEM IDENIFICATION.....8

2.1 National Objective.....8

2.2 Public Involvement 8

2.3 Problems, Opportunities, Objectives, and Constraints.....10

2.4 Existing Conditions.....12

2.5 Future Without-Project Condition.....20

3.0 MEASURES AND CONCEPTUAL ALTERNATIVES.....25

3.1 Plan Formulation Process.....25

3.2 Management Measures.....26

3.3 Conceptual Alternatives 30

4.0 CONCEPTUAL DESIGN.....35

4.1 Levee Design.....35

4.2 Cost Estimates.....37

4.3 With Project Floodplains.....39

4.4 Economic Benefits 39

5.0 ALTERNATIVE REFINEMENT 39
5.1 VE Study/Charette Evaluation Criteria 40
5.2 VE Study/Charette Alternative Evaluation 42
5.3 VE Study/Charette Results 55

6.0 COMPARISON OF REFINED ALTERNATIVES 58
6.1 REFINED ARRAY ALTERNATIVES 58

7.0 NEXT STEPS 60

8.0 REFERENCES 61

Tables

1: Pilot Study Phases and Associated Decision Points
2: Design Flows and Regulated Flows
3: Probability of Geotechnical Failure by Median Hydrologic Annual Exceedance Probability
4: Damageable Property ($1,000's) Sutter Basin Feasibility Study Area
5: Summary of Measures Considered
6: Themes and Conceptual Alternatives
7: Economic Comparison
8: Refined Array of Alternatives

Plates

Study Information:

1: Watershed Map
2: Study Area Map
3: Sacramento River Flood Control Project

Conceptual Alternatives:

4: Conceptual Alternative 1.1
5: Conceptual Alternative 2.1
6: Conceptual Alternative 2.2

7: Conceptual Alternative 2.3

8: Conceptual Alternative 2.4

9: Conceptual Alternative 2.5

10: Conceptual Alternative 3.1

11: Conceptual Alternative 3.2

12: Conceptual Alternative 4.1

Refined Array of Alternatives:

13: Minimal Fix-in-Place plus Non-Structural Alternative

14: Yuba City Ring Levee Alternative

15: Little "J" Levee Alternative

16: Fix In Place Feather River, Thermalito to Star Bend Alternative

17: Fix In Place Feather River, Sutter Bypass, and Wadsworth Canal Alternative

Design:

X: Design Templates

Appendices

A: Public Scoping Meeting Summary

B: Value Engineering Study/Planning Charette Report

Sutter Basin Pilot Feasibility Study
Progress #1 Document:
Without Project and Alternative Development

1.0 INTRODUCTION

1.1 PURPOSE AND NEED FOR THE STUDY AND DOCUMENT

A high risk of flooding from levee failure threatens the public safety of approximately 80,000 people, as well as property and critical infrastructure throughout the Sutter Basin study area. Past flooding has caused loss of life and extensive economic damages. Recent geotechnical analysis and evaluation of historical performance during past floods indicate the project levees do not meet U.S. Army Corps of Engineers (USACE) levee design standards, authorized level of performance, and are at risk of breach failure at stages less than overtopping of the levees. Within the study area, as throughout the Sacramento Valley, floodplain and native habitats have been lost or degraded. Federally listed species and other special status species that are dependent on floodplain habitats have declined. Opportunities exist to restore land formerly converted by mining or agriculture to more natural habitats through Ecosystem Restoration (ER) in conjunction with flood risk management (FRM). There are also opportunities to provide outdoor recreational features on FRM and ER project lands. The purpose of the Sutter Basin Feasibility Study is to address FRM in conjunction with ER and recreation.

This document summarizes progress to the determination of the refined array of alternatives on the Sutter Basin Pilot Study. This array of alternatives will be considered in greater detail as the study progresses toward selection of the Tentatively Selected Plan. The information presented in this document will be incorporated into the draft Feasibility Study and Environmental Impact Statement/ Environmental Impact Report (EIS/EIR), which will integrate plan formulation with documentation of environmental effects. The Feasibility Study/EIS/EIR will serve to satisfy documentation requirements of ER 200-2-2 as well as the National Environmental Policy Act (NEPA) of 1969, as amended, and the requirements of the California Environmental Quality Act (CEQA).

1.2 STUDY AUTHORITY

The authority for the U.S. Army Corps of Engineers (USACE) to study FRM and related water resources problems in the Sacramento River Basin, including the study area in Sutter and Butte Counties, is provided in the Flood Control Act of 1962 (Public Law 87-874). A portion of the authorization reads as follows:

"The Secretary of the Army is hereby authorized and directed to cause surveys for flood control and allied purposes…to be made under the direction of the Chief of Engineers, in drainage areas of the United States…, which include the following named localities: Sacramento River Basin and streams in northern California, draining into the Pacific Ocean for the purpose of developing,

where feasible, multi-purpose water resource projects, particularly those which would be eligible under the provision of title III of Public Law 85-500."

The authority for including ecosystem restoration as a study objective or purpose in association with FRM is found in numerous Federal laws and executive orders establishing National policy for and Federal interest in the protection, restoration, conservation and management of environmental resources. These provisions endorse Federal efforts to advance environmental goals, and a number of these general statements declare it national policy that full consideration is given to the opportunities which projects afford to ecological resources. Recent water resources authorizations have specifically or programmatically enhanced opportunities for Corps involvement in addressing objectives related to the restoration of ecological resources and ecosystem management.

The legislative basis for Federal participation in recreation development is found in the Flood Control Act of 1944, as amended, the Federal Water Project Recreation Act of 1965 (Public Law 89-72), and the Water Resources Development Act of 1986 (Public Law 99-662). These give broad authority to include recreation as a project purpose. Present policy limits exercise of these authorities as defined in ER 1105-2-100, Planning Guidance.

1.3 STUDY SPONSORS

The non-Federal project sponsors include the State of California Central Valley Flood Protection Board (CVFPB) and the Sutter Butte Flood Control Agency (SBFCA). SBFCA is a joint powers agency formed in September 2007 by Sutter and Butte Counties, the cities of Biggs, Yuba City, Gridley, Live Oak, and levee districts 1 and 9 to finance and construct regional levee improvement projects.

1.4 LOCATION AND DESCRIPTION OF THE STUDY AREA

The study area is located in Sutter and Butte Counties California and is roughly bounded by the Feather River, Sutter Bypass, Wadsworth Canal, Sutter Buttes, and Cherokee Canal. The study area covers approximately 300 square miles and is approximately 43 miles long and 9 miles wide. The study area includes the communities of Yuba City, Live Oak, Gridley, Biggs, and Sutter with a total population of approximately 80,000. Yuba City is the largest community in the study area, with a population of approximately 65,000. A map of the watershed is included as Plate 1 and a map of the study area is included as Plate 2.

The study area is essentially encircled by project levees of the Sacramento River Flood Control Project (Plate 3) and high ground of the Sutter Buttes. In 1917, the Federal government authorized the Sacramento River Flood Control Project (See Plate 3), which adopted a system of locally built levees as Federal levees, and constructed additional levees, bypasses, overflow weirs, and pumping facilities. Although the Sacramento River Flood Control Project levees were often constructed of poor foundation materials such as river dredge soils that would not meet today's engineering standards, the levees are relied upon today to provide FRM for numerous communities.

The primary sources of flooding within the study area are the Butte Basin, Sutter Bypass, Feather River, Cherokee Canal, Wadsworth Canal, and local interior drainage. Flood depths and

frequency vary throughout the study area. Probability of flooding within the study area is primarily related to the stage of floodwaters within the river channels and the geotechnical probability of levee failure at or below flood stage.

The Butte Basin is a natural overflow and flood storage area north west of the Sutter Buttes and east of the Sacramento River. The basin provides approximately 1 million acre-feet of transitory storage at flood stage (DWR, 2010). Excess floodwaters from the Sacramento River enter Butte Basin via overbank areas along the river and through the Moulton and Colusa weirs. Butte Creek and its tributaries, including Cherokee Canal, also flow into the Butte Basin. Outflow from the Butte Basin is regulated by hydraulic conditions of Butte Slough and floodplain topography at the upstream entrance to the Sutter Bypass. In order to maintain the flood storage capabilities within Butte Basin, California has included regulation of the overflow area in Title 23 of the California Code of Regulations. In general these standards require approval from the board for any encroachments that could reduce or impede flood flows or would reclaim any of the floodplain within the Butte Basin (DWR, 2010).

The Sutter Bypass is a leveed flood control structure approximately three quarters of a mile wide, bordered on each side by levees. The bypass is an integral feature of the Sacramento River Flood Control Project's flood bypass system. The Sutter Bypass conveys flood waters from the Butte Basin, Sacramento River, and Feather River to the confluence of the Sacramento River and Yolo Bypass at Fremont Weir. Additional flood flows from the Sacramento River enter the Sutter Bypass through Tisdale Bypass. The lower portion of the Sutter Bypass also conveys the Feather River. Within this reach the Feather River is separated from the main conveyance of the bypass by a low levee. This design maintains higher velocities and sediment transport capacity within the Feather River during low flow events while utilizing the large conveyance of the Sutter Bypass during larger events. The Sutter Bypass also receives minor natural flow and agricultural return flow from Reclamation District 1660 to the west and from Wadsworth Canal and DWR pumping plants 1, 2, and 3 to the east. The Sutter Bypass includes four hydrologic reaches determined on tributary inflows; Butte Slough to Wadsworth Canal, Wadsworth Canal to Tisdale Bypass, Tisdale Bypass to Feather River, Feather River to Sacramento River.

The Feather River is a major tributary to the Sacramento River, merging with the Sutter Bypass upstream from the Sacramento River and Fremont Weir. The Yuba and Bear Rivers are major tributaries to the Feather River. Two major flood management reservoirs are located within the Feather River watershed: Oroville on the Feather River and New Bullards Bar on the Yuba River. The Feather River is described by four hydrologic reaches based on significant inflows; Thermalito to Honcut Creek, Honcut Creek to Yuba River, Yuba River to Bear River, and Bear River to Sutter Bypass.

The Cherokee Canal is a tributary to Butte Creek and the Butte Basin. The leveed canal was constructed between 1959 and 1960 by USACE. The canal drainage area is 94 square miles and varies in elevation from 70 feet to 2200 feet. The drainage area is bounded by the Feather River watershed to the east and southeast, Butte Creek and its tributaries to the north and west, and by Wadsworth Canal drainage to the south.

The Wadsworth Canal is a leveed tributary to the Sutter Bypass near the town of Sutter. The canal conveys flow from the East and West interceptor canals to the Sutter Bypass. The East and

West interceptor canals collect runoff from canals and shallow floodplain runoff into the Wadsworth Canal.

1.5 RELATED PROJECTS AND STUDIES

1.5.1 Advance Work by Local Interests in Study Area

Sections 104 and 3041 of WRDAs 1986 and 2007, respectively, provide authorization for non-Federal sponsors to receive credit for the cost of local advanced work to be applied to the required local contribution for the project. Section 104 authorizes credit for local work accomplished prior to authorization of the project provided that the Assistant Secretary of the Army for Civil Works has approved the proposed work prior to initiation of construction. Section 3041 authorizes credit for local work accomplished prior to the date of the Project Partnership Agreement for the project; credit to be provided in accordance with the provisions of Section 221 of the Flood Control Act of 1970. Section 221, as modified by Section 2003 of WRDA 2007, requires that the local work be performed after project authorization and after an In-Kind Memorandum Of Understanding is executed.

Under Section 408 (33 USC 408), temporary or permanent alteration, occupation, or use of any public works, including levees, for any purpose is allowable only with the permission of the Secretary of the Army. Under the terms of 33 USC 408, any proposed levee modification requires a determination by the Secretary that the proposed alteration, permanent occupation, or use of a Federal project will not be injurious to the public interest and will not impair the usefulness of the levee. The authority to make this determination and approve modifications to Federal works under 33 USC 408 has been delegated to the Chief of Engineers, USACE.

1.5.1.1 Feather River West Levee Project

SBFCA is proposing a levee improvement project along the Feather River west levee under the California Department of Water Resources (DWR) Early Implementation Program (EIP). EIPs are for flood control construction projects that rehabilitate, reconstruct, replace, improve, or add to the facilities of the State Plan of Flood Control. DWR provides bond funds to cost share for early implementation of state-federal flood control system modifications This two phase project proposes to construct levee improvements between the Thermalito Afterbay and the Feather River/Sutter Bypass confluence. Primary deficiencies of the levee include through-seepage, underseepage, and embankment instability. A Phase I Pre-Design Formulation Report was completed in August of 2011 and the 60% design was completed by March 2012. An EIS/EIR is being prepared for the project as part of a Section 408 application to obtain permission from USACE to alter project levees. The Draft EIS/EIR was released to the public in Spring 2012. This local project will be evaluated as one of the alternatives in the Pilot Study, and could potentially be considered for Section 221 crediting.

1.5.1.2 Star Bend Setback Levee Project

Construction of 3,400 feet of setback levee was recently completed within the study area under the DWR Early Implementation Program. The purpose of the setback levee was to address through-seepage, underseepage, and flow constriction issues. A request for approval under 33 USC Section 408 was granted and an application for consideration of Section 104 credit was

approved in 2009. This project and the request for Section 104 credit will be evaluated in the Pilot Study1.5.1.3 Lower Feather River Corridor Management Plan.

The purpose of the Lower Feather River Corridor Management Plan (CMP) by the Department of Water Resources is to develop a integrated strategy and long-term vision for managing the river corridor between the Yuba River and the Sutter Bypass in a way that facilitates and promotes economic sustainability and compatibility in future land uses, flood protection system management, maintenance of flood control facilities, and the restoration and enhancement of ecosystem functions and habitats.

1.5.1.4 Yuba River Basin, California, Marysville Ring Levee EngineeringDocumentation Report.

The Yuba River Basin Flood Risk Management Project, authorized by WRDA 99 Section 101(a) (10) and WRDA 07 Section 3041, is currently under reevaluation in the Yuba Basin General Reevaluation Report. During the project reevaluation it was determined that the Marysville Ring Levee was separable and common to all alternatives under consideration. The project team determined that the Marysville Ring Levee should proceed to implementation under the WRDA 99 authorization, as amended.

1.5.2 Systemwide Studies

1.5.2.1 Central Valley Flood Protection Plan

As required by State of California Senate Bill (SB) 5, the State has initiated the Central Valley Flood Protection Plan (CVFPP). The purpose of the CVFPP is to guide California's participation (and influence federal and local participation) in managing flood risk along the Sacramento and San Joaquin River systems. The CVFPP will require a 200-year level of flood risk management (1/200 annual exceedance probability) for urban and urbanizing areas by the year 2025, and no new development would be permitted if this target is not met. An urban area is defined as a developed area in which there are 10,000 residents or more. An urbanizing area is defined as a developed area or an area outside a developed area that is planned or anticipated to have 10,000 residents or more within the next 10 years.

The CVFPP proposes an initial systemwide investment approach for sustainable, integrated flood management in areas currently protected by facilities of the State Plan of Flood Control (SPFC). This investment approach includes system and regional elements, some of which are located in the Sutter Pilot study area. These elements, including the Feather River West Levee Project, are being considered as part of the Pilot Study effort. The draft 2012 CVFPP was released for public review in January 2012 and must be adopted by the CVFPB by July 1, 2012. The CVFPP will be updated every five years.

1.5.2.2 Central Valley Integrated Flood Management Study

The Central Valley Integrated Flood Management Study (CVIFMS) is a continuation of the Sacramento and San Joaquin River Basins Comprehensive Study. The Comprehensive Study was initiated by USACE and The Reclamation Board of the State of California in 1998 and authorized in the 1998 Energy and Water Development Appropriations Act, Public Law 105-62. The U.S. House of Representatives Report 105-190, which accompanied the 1998 act, directed

USACE to conduct a comprehensive assessment of the flood management system for the Sacramento and San Joaquin River Basins. CVIFMS is the federal complement to the State CVFPP. Through CVIFMS, the State and USACE are pursuing a common and shared approach to flood risk management in the Central Valley. The Project Management Plan for CVIFMS was completed in 2011 and the study has received limited funding to date.

1.5.2.3 Sacramento Bank Protection Project

A USACE continuing construction project to address bank erosion and protection within the Sacramento River Flood Control Project.

1.5.2.4 Central Valley Hydrologic Study (CFHS)

The Department of Water Resources and the U.S. Army Corps of Engineers (USACE Sacramento District) have partnered in the development of the Central Valley Hydrology Study (CVHS). CVHS is a comprehensive assessment of stream flow frequencies and magnitudes in the Sacramento and San Joaquin river basins. The goal of the hydrologic analysis is to estimate peak flows and hydrographs for various annual exceedence probabilities to describe flood hazard throughout the basins.

1.5.2.5 Central Valley Floodplain Evaluation and Delineation Program (CVFED) DWR study of floodplains in the central valley.

1.5.2.5 Sacramento San Joaquin Comprehensive Study

"Sacramento River and San Joaquin River Basins Comprehensive Study, California. In response to the devastating floods of 1997, Congress directed the Corps of Engineers to conduct a comprehensive assessment of the entire flood control system within the existing study authorizations of the Sacramento River Watershed Management Plan (authorized by the Flood Control Act of 1962) and the San Joaquin River and Tributaries authority (authorized by 1964 Resolution of the House Committee on Public Works). The Comprehensive Study was initiated in 1998. The results were a post-flood assessment and system-wide hydrologic/hydraulic model that included extensive public involvement and planning for flood damage reduction and ecosystem restoration purposes.

1.6 PLANNING STRATEGY

1.6.1 Pilot Study Background

The Sutter Basin Feasibility Study was selected for inclusion in the National Pilot Program in February 2011. The pilot initiative provides an opportunity to test principles that have been outlined in the USACE *Recommendations for Transforming the Current Pre-Authorization Study Process* (January 2011), which was drafted by a workgroup of planning and policy experts from USACE and the Office of the Assistant Secretary of the Army for Civil Works referred to as the 17+1 Team.

This new process requires heavy involvement as well as input and decisions from the Vertical Team at multiple points throughout the study. The new process focuses on early decision

making and the reduction of unnecessary detail. Instead of following the traditional USACE planning milestones, the pilot study is divided into four phases, each with a key decision point and associated In-Progress Reviews (IPRs). Table 1 summarizes the four pilot study phases and associated decision points.

Table 1. Pilot Study Phases and Associated Decision Points

Pilot Study Phase	Decision Point
Scoping Phase	Decision Point 1 – Federal Interest Determination
Analysis Phase	Decision Point 2 – Tentatively Selected Plan and Draft Report
Review Phase	Decision Point 3 – Civil Works Review Board
Confirmation Phase	Decision Point 4 – Chief's Report

Based on the pilot program principles, the Sutter Basin Feasibility Pilot Study strategy focuses on utilizing an appropriate level of detail based on the decisions being made at each stage of the study. This strategy includes qualitative analysis that will be increasingly detailed at each Decision Point or IPR and early elimination of alternatives with little probability of implementation.

Decision Point 1 for the Sutter Basin Pilot Study was held in August 2011. The Decision Point 1 panel members reached consensus that there was a Federal Interest in continuing the study toward Decision Point 2, which will focus on Vertical Team agreement on the Tentatively Selected Plan. This document summarizes the increasingly detailed analysis that has been completed to date and concludes with the array of alternatives that will be evaluated in further detail as the team progresses toward selection of the Tentatively Selected Plan to be confirmed by the Vertical Team at Decision Point 2. Since the information presented in this document will be incorporated into the draft Feasibility Study/EIS/EIR, the format and content is designed to comply with the target length of 100 pages or less specified in the memorandum from MG Walsh issued on 8 Feb 2012.

1.6.2 Level of Detail

The Pilot Study utilizes five classes to describe the analysis level of detail and potential uncertainty. Results presented in this memorandum are based on a class 4 level of detail. The five classes are described in Table 1 of EM 1110-2-1302 Civil Works Cost Engineering. The table is based on ASTM E 2516-06, Standard Classification for Cost Estimate Classification System. The purpose of the classification system is to improve communication among all the stakeholders involved with preparing, evaluating, and using cost estimates (ASTM, 2011). Class definitions, as they relate to the Pilot Study, are described below.

Class 5 is least accurate and is the minimum required for assessing rough order of magnitude. The level of project definition is 0% to 2% of a complete definition. The expected cost accuracy (+/-) is 4 to 20 times the accuracy of the best (Class 1) estimate.

Class 4 is minimum required for Reconnaissance/905b Reports and alternative analysis in feasibility studies. The level of project definition is 1% to 15% of a complete definition. The expected cost accuracy (+/-) is 3 to 12 times the accuracy of the best (Class 1) estimate.

Class 3 is the minimum required for the feasibility NED Plan and Feasibility Sponsor Preferred Plan. The level of project definition is 10% to 40% of a complete definition. The expected cost accuracy (+/-) is 2 to 6 times the accuracy of the best (Class 1) estimate.

Class 2 is minimum required for Planning, Engineering, and Design up to 90% Plans and Specifications. The level of project definition is 30% to 70% of a complete definition. The expected cost accuracy (+/-) is 1 to 3 times the accuracy of the best (Class 1) estimate.

Class 1 is minimum required for Planning, Engineering, and Design 100 % Plans and Specifications and the Independent Government Estimate. The level of project definition is 50% to 100% of a complete definition. This is considered the most accurate estimate. It does not imply that all unknowns and risk are eliminated.

2.0 PROBLEM IDENTIFICATION

2.1 NATIONAL OBJECTIVE

The National or Federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation. The National 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 risk 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 risk 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.

2.2 PUBLIC INVOLVEMENT

Public input has been received through coordination with the sponsors, coordination with other agencies, and through public workshops. As part of the NEPA and CEQA process, USACE, the CVFPB, and SBFCA have reached out to government agencies and the public to solicit input on the study. A Notice of Intent and a Notice of Preparation for the Environmental Impact Statement/Environmental Impact Report (EIS/EIR) were published on May 20, 2011. Public scoping meetings were held in Yuba City and Gridley on June 27 and June 28, 2011. The

meetings provided the public and agencies an opportunity to learn about the study and provide input as to what components of the project are important to them, as well as what environmental resources should considered in formulation of plans and in impact analyses. A public scoping meeting summary is included in Appendix A.

The list below summarizes the views expressed in oral and written comments received during the four scoping meetings and in response to the Notice of Intent and Notice of Preparation. These represent the areas of interest or concern to the public and stakeholders in the study area:

Keep landowners apprised of associated activities occurring on their lands.

Keep the feasibility study on schedule so the State will be able to release early implementation program funding for the Feather River West Levee Project.

Coordinate with the State Department of Water Resources' Lower Feather River Corridor Management Project so that duplicative efforts pertaining to environmental studies are avoided.

Consider levee setbacks in the study area.

Consider a perimeter levee around Yuba City or a "J" levee on the south and west sides.

Project lead agencies must obtain appropriate water quality/discharge permits including those related to dewatering, discharge, sewer, and construction and land disturbance.

The area being studied is located in the planning area of the Yuba/Sutter Habitat Conservation Plan/Natural Community Conservation Plan (HCP/HCCP); therefore please provide the Sutter County Community Services Director's office with all future notices regarding this project.

Project teams need to review the current effective Flood Insurance Rate Maps for all counties and cities in the study area. Please note that these cities and counties are participants in the National Flood Insurance Program and the minimum, basic NFIP floodplain management building requirements are described in 44 Code of Federal Regulations (CFR) §§59–65.

General requests for more detailed information about the boundaries of each project and the relationship between the two projects.

A request to memorialize, in some way, the unreported deaths in 1955 caused by a levee break at Shanghai Bend.

The California State Lands Commission (CSLC) requests that as the Project proceeds, SBFCA submits additional information (e.g., detailed maps) to enable CSLC staff to determine if any components of the Project will require a lease or permit. CLSC additionally requests to be placed on any future distribution mailing list for the Project. A thorough project description should be included in the EIS/EIR in order to facilitate meaningful environmental review of potential impacts, mitigation measures, and alternatives.

The project's EIS/EIR should carefully consider issues and mitigation alternatives in order to formulate a more comprehensive and sustainable approach to flood management in the Sutter/Butte region. These include growth inducing impacts, downstream flood impacts, impacts under climate change, and evaluation of a broad range of alternatives.

Feather River Air Quality Management District (AQMD): Recommends discussing potential air quality and climate change impacts for both projects. The EIS/EIR should include a discussion of greenhouse gas emissions and climate change impacts. The project should submit a Fugitive Dust Control Plan to the Feather River AQMD prior to beginning work.

The California Department of Fish and Game (CDFG) would like to emphasize the critical importance of coordination with CDFG during the California Environmental Quality Act (CEQA) and regulatory processes.

- The Native American Heritage Commission (NAHC) recommends adequately assessing and mitigating project impacts related impacts to cultural resources.

2.3 PROBLEMS, OPPORTUNTIES, OBJECTIVES, AND CONSTRAINTS

Following inclusion of the Sutter Basin Feasibility Study in the National Pilot Program, the PDT and non-Federal sponsors participated in a study risk workshop with several members of the Vertical Team during which the following problem, opportunity, objective, and constraint statements were developed and refined.

2.3.1 Problems

A high risk of flooding from levee failure threatens the public safety of approximately 80,000 people, as well as property and critical infrastructure throughout the study area.
Flooding has caused loss of life and extensive economic damages. A levee failure in 1955 resulted in unexpected rapid flooding of Yuba City and caused $327 million in damages (2011 dollars) and 37 recorded fatalities. Additionally, there have been three levee breaches adjacent to the study area since 1986. The adjacent levees are of similar design and age as those within the Sutter Basin Feasibility study area and the failures occurred prior to overtopping. . Recent geotechnical analysis and evaluation of historical performance during past floods indicate the project levees do not meet USACE levee design standards and are at risk of breach failure at stages less than overtopping. This is evidenced by historical boils and heavy seepage at stages less than authorized design flows. Almost every location within the study area is afforded some flood risk reduction by these levees. . The risk of unexpected levee failure coupled with the consequence of deep flooding presents a continued threat to public safety, property, and critical infrastructure.

Existing levees have isolated the floodplains from waterways, which has eliminated channel capacity and significant floodplain habitats for native species, including federally listed species and other special status species. Conversion of high value habitats to other land uses has reduced the abundance, distribution and diversity of native species. Historically, lands subject to regular flooding or occasional overflow covered about one-third of the Sacramento Valley in 1880, or about 1 million acres. Within the study area, as throughout the Sacramento Valley, floodplain and native habitats have been lost or degraded. Federally listed species and other special status species that are dependent on floodplain habitats have declined.

2.3.2 Opportunities

There are FRM structural and non-structural opportunities to decrease known flood risks within the study area.

Direct and indirect conversion of land and water resources due to mining and agriculture has degraded ecosystems, reducing the quantity and quality of high value habitat. These factors

contributed to a number of species being listed as threatened, endangered or extirpated. Land formerly converted by mining or agriculture can be restored to more natural habitats in conjunction with FRM.

There is an opportunity to provide outdoor recreational features on FRM and ER project lands. The levees within the study area effectively cut off public access to waterways and associated recreation amenities. Facilities can be included at recommended flood risk management and ecosystem restoration features to provide public access and use and improved outdoor recreation experiences.

2.3.3 Objectives

The problems and opportunities identified for 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 include the following:

- Reduce the risk to life, health, and public safety due to flooding.
- Reduce the risk of property damage due to flooding.
- Reduce the risk of damage to critical infrastructure due to flooding.
- Encourage wise use of the floodplain.
- In conjunction with FRM, restore floodplain connectivity and associated dynamic riverine processes.
- In conjunction with FRM, restore aquatic, wetland, riparian, and terrestrial habitats for special status and other native species.
- In conjunction with FRM and ER, improve the public's access to and use of outdoor recreational opportunities in the study area.

2.3.4 Additional Non-Federal Sponsor Objective

The CVFPP will require a 200-year level of flood risk management (1/200 annual exceedance probability) for urban and urbanizing areas by the year 2025, and no new development would be permitted if this target is not met. Based on this requirement, the following non-Federal sponsor objective has been included:

- Reduce the probability of flooding to urban and urbanizing areas to less than 1/200 annual exceedance probability.

2.3. 5 Constraints

A constraint is a restriction that limits the extent of the planning process. It is a statement of things the alternative plans should avoid. Constraints are designed to avoid undesirable changes between future with and without-project conditions. The planning constraints include:

- Minimize significant adverse impacts to the human environment.

- Comply with applicable Federal laws, regulations, and policies such as the National Environmental Policy Act, Endangered Species Act, Fish and Wildlife Coordination Act, Clean Water Act, Clean Air Act, and the National Historic Preservation Act.

2.4 EXISTING CONDITIONS

Existing conditions are those at the time the study is conducted and form the basis for extrapolation to other conditions. Existing conditions within the study area are discussed below.

2.4.1 Flow Frequency Estimates

A tabulation of the regulated peak flows at select locations and reaches within the study area is shown in Table 2. These estimates are based on unsteady hydraulic model output and may be revised at the TSP selection phase.

Table 2. Design Flows and Regulated Flows

Stream and Reach	Design Flow (cfs)	Regulated Peak Flows (cfs)						
		50% ACE	10% ACE	4% ACE	2% ACE	1% ACE	0.5% ACE	0.2% ACE
Sacramento River								
Colusa to Tisdale Weir	66000	44,000	48,000	50,000	53,000	55,000	59,000	68,000
Tisdale Weir to Sutter Bypass	30000	28,000	30,000	31,000	32,000	34,000	36,000	41,000
Feather River								
Oroville to Honcut Creek	210,000	60,000	100,000	150,000	150,000	150,000	174,000	327,000
Honcut Creek to Yuba River	210,000	49,000	106,000	156,000	146,000	151,000	195,000	311,000
Yuba River to Bear River	300,000	71,000	192,000	253,000	279,000	287,000	356,000	501,000
Bear River to Sutter Bypass	320,000	81,000	207,000	276,000	302,000	314,000	380,000	500,000
Sutter Bypass								
Meridian to Wadsworth Canal	150,000	57,000	102,000	126,000	155,000	184,000	228,000	327,000
Wadsworth Canal to Tisdale Weir	155,000	59,000	103,000	127,000	156,000	185,000	229,000	250,000
Tisdale Weir to Feather River	180,000	70,000	114,000	139,000	161,000	194,000	231,000	258,000
Feather River to Sacramento River	380,000	145,000	276,000	392,000	435,000	493,000	585,000	726,000
Wadsworth Canal								
East - West Interceptor to Sutter Bypass	1,500	750	1,900	2,550	3,050	3,550	4,050	4,720
Cherokee Canal								
Nelson Shipee Road to Western Canal	8,500							
Western Canal to Afton Road	11,500	6,000	10,300	12,100	13,200	14,300	15,200	16,300
Afton Road to Gridley-Colusa Road	12,500							

Peak Regulated flows obtained from HEC-RAS Model for the Sutter Basin Feasibility Study (August 2011 version).
Design Flows obtained from USACE file drawing 50-10-3334, Levee Channel Profiles, 15 March 1957
Note: Peak flow is the highest of the Sacramento or Shanghai Bend storm centering peak flows
Note: Wadsworth and Cherokee Canal are unregulated streams
Note: Peak flows for 0.5% and 0.2% ACE include effects from levee overtopping and may be reduced from their possible maximums.

Table 2 is subject to update by Peterson-Brustad Inc after new flood routings are complete. Flow frequency estimates for the Feather River and Sutter Bypass are based on analysis described in the Sacramento and San Joaquin River Basins Comprehensive Study and Yuba River Basin Feasibility Study documentation. Flow Frequency curves and hydrographs of unregulated flow were developed for the 50% (1/2) to 0.2% (1/500) annual chance Exceedance probability (ACE) frequencies. Regional synthetic hydrology presented in these studies represents the best available data for the large flood sources (Sutter Bypass and Feather River) of

the Sutter Basin Feasibility Study. These hydrologic analyses have also been used as the foundation for several other feasibility studies in the region, such as the American River Common Features and Yuba River Basin studies. DWR and USACE are in the process of developing new hydrologic frequency estimates. However, the results will not be available until late 2012. Therefore, this study utilizes the results from the San Joaquin River Basins Comprehensive Study hydrologic analysis.

Synthetic hydrology of the Sacramento and San Joaquin River Basins Comprehensive Study was based on transformation of unregulated hydrologic conditions to regulated conditions. This was accomplished by developing balanced unregulated hydrographs based upon historically patterned storm events. Balanced hydrographs have the same annual exceedance frequency for all flood durations. For example a 10% (1/10) ACE hydrograph contains the 10% (1/10) ACE 1-day flow, 10% (1/10) ACE 3-day average flow, 10% (1/10) ACE 5-day average flow etc. These balanced hydrographs were then transformed to regulated hydrographs using an HEC-5 reservoir operations model of the system. The HEC-5 model, also developed and calibrated for the Sacramento and San Joaquin River Basins Comprehensive Study, simulates reservoir operations and produces regulated hydrographs. The comprehensive study transferred the hydrographs from the HEC-5 model at 'handoff' points and modeled in more hydraulic detail using UNET. The portion of the UNET model downstream of Sacramento River at Colusa and Butte Slough near Meridian was replaced by an HEC-RAS unsteady model developed for this study (see hydraulics section). Hydrographs at Sacramento River at Colusa and Butte Slough near Meridian were obtained from the UNET model. All other hydrograph boundary conditions were obtained from the HEC-5 model.

The Sacramento and San Joaquin River Basins Comprehensive Study hydrology utilized a storm centering approach to evaluate possible hydrologic scenarios. A storm centering is a storm positioned (centered) over a watershed to produce flow rates or stages of specific frequencies at the specified runoff location or gage. Multiple storm centering scenarios are possible due to the diverse spectrum of floods that can occur from different combinations of concurrent storms on tributaries, orographic influences, and other factors that influence regional rainfall runoff events. The Sacramento and San Joaquin River Basins Comprehensive Study evaluated a suite of storm centerings and selected the centering that produced the largest stage or flow rate at a given location. For the smaller geographic area of the Sutter Basin Feasibility study area, the Sacramento and San Joaquin River Basins Comprehensive Study results were reviewed and narrowed to two possible centerings. The Sacramento storm centering predominantly applies to the Sacramento River and the Sutter Bypass, while the Shanghai Bend storm centering predominantly applies to the Feather and Yuba Rivers.

Flow frequency of the Cherokee Canal was estimated by detailed methods using gage records on the Cherokee Canal and contributing streams. Frequency curves and hydrographs of unregulated flow were developed for the 50% (1/2) ACE to 0.5% (1/200) ACE events.

Flow frequency of Wadsworth Canal was estimated by detailed methods using gage records. Frequency curves and hydrographs of unregulated flow were developed for the 50% (1/2) ACE to 0.5% (1/200) ACE events.

Hydrologic analysis of the Sutter Basin interior area was done by approximate methods using a conceptual level HEC-HMS model. Approximate methods were deemed suitable because the feasibility study is not evaluating FRM projects to address flooding at the existing interior drainage pump locations. Model parameters were based on comparison to measured runoff volumes at the three DWR pumping plants during the February 1983 and March 1986 storm events. It was determined that approximately 24 days are required to pump the volume of a significant flood out of the basin, therefore a 30-day storm duration has been used to produce runoff estimates..

2.4.2 Hydraulics

Hydraulic analyses were performed using one-dimensional and two-dimensional models.. Channel stages were estimated using a system wide HEC-RAS one-dimensional unsteady flow model. Floodplain stages were estimated using a FLO-2D two-dimensional floodplain model of the study area. HEC-RAS models were developed for two levee overtopping scenarios: Scenario A – infinitely tall levee with no breach and Scenario B – existing levee heights with simulated levee breach. FLO-2D was used to model overland flow from each simulated levee breach in Scenario B. Water surface profiles and levee breach inundation maps were developed for hydrologic events ranging from 50% (1/2) to 0.2% (1/500) ACE median hydrologic events. All models and stage data are relative to the NAVD88 vertical datum.

Water surface profiles for Sutter Bypass, Feather River, and Wadsworth Canal were estimated using a system wide HEC-RAS model. Profiles were computed for two hydrologic storm centerings (see hydrology section for description of storm centering). The final profile is the higher of the two possible storm centering profiles. Model geometry was based on topographic and bathymetric mapping collected for the Sacramento and San Joaquin River Basins Comprehensive Study (1997-1999). Manning's roughness values were based on unsteady model calibration and verification of the 1997 and 2006 flood events.

Water surface profiles of Cherokee Canal were estimated using a HEC-RAS model. Water surface profiles were computed for a single storm centered above Highway 162. Model geometry was based on topographic and bathymetric mapping provided by DWR.

Levee breach simulations were independently performed for thirteen spatially distributed levee breaches throughout the study area. Breach locations were placed at representative locations based on levee geotechnical characteristics and floodplain inundation characteristics. Eight breaches were simulated on the Feather River from Thermalito to Sutter Bypass. Two breaches were simulated on the Sutter Bypass between Wadsworth Canal and Feather River. Two breaches were simulated on Cherokee Canal with one upstream and one downstream of the Union Pacific Railroad. A single breach was simulated on Wadsworth Canal. All breach simulations assume remaining levee reaches would be overtopped without failure.

For each hydrologic frequency event, floodplain inundation maps were developed for the thirteen spatially distributed levee breaches throughout the study area. The inundation maps were conditional (assumed a levee breach). The hydrologic frequency of the inundation map is not the frequency of inundation. Inundation frequency estimates have to account for performance of the levee (probability of the breach). The inundation frequency is computed in the economic flood damage analysis using the geotechnical performance curves.

Floodplains for existing conditions were estimated by including areas impacted by a breach of any levee that had less than 90% reliability for the given flood. Floodplain depth maps that combine the probability of the conditional floodplain inundation into a single ACE event were not developed. The probability of flooding from each source is based on the hydrologic frequency, stage-discharge relationship and the geotechnical performance. The combination of these parameters is done in the FDA economic model. The FDA economic model does not have the capability to display the geographic variability of flood risk on a map because it aggregates the results at index locations.

2.4.3 Geotechnical Levee Performance

Geotechnical conditions of the existing levees within the study area were evaluated to assess the probability of unsatisfactory performance/reliability (levee fragility curve) over a range of flood events. Risk and uncertainty based methods were utilized in accordance with ETL 1110-2-556, ETL 1110-2-561, and accepted guidance for planning studies.

Data gathered by USACE and the State of California's Urban Levee Evaluations (ULE) Program were utilized. The State's ULE Program performed a comprehensive geotechnical investigation suitable for feasibility studies between 2007 and 2012. ULE subsurface explorations have been conducted at approximately 1,000 foot intervals throughout the entire study area excluding Cherokee Canal. The inventory was augmented with nine additional explorations conducted for this study along the east levee of Cherokee Canal performed by the Corps. The explorations include Cone Penetration Tests (CPT), auger borings with standard penetrations tests, and sonic borings. Geophysical data including helicopter electromagnetic surveys (HEM) were performed as well as data gathering on past performance and as-built conditions.

The ULE evaluation subdivided the levee segments within the study area into 50 reaches, based on expected geotechnical performance. For the Pilot Study, the ULE reaches were adopted as subreaches and grouped into 12 larger reaches with similar characteristics for the economic analysis. An additional reach for Cherokee Canal was also evaluated, resulting in a total of 13 reaches.

An evaluation was performed for each reach using methods described in ETL 1110-2-556 (Risk-Based Analysis in Geotechnical Engineering for Support of Planning Studies) and consistent with applicable guidance on underseepage described in ETL 1110-2-569 (Design Guidance for Underseepage).

For each of the 12 reaches, a levee fragility curve was prepared for the existing levee conditions. These curves included probability of failure for the following modes:

- Underseepage
- Landside Slope Stability
- Judgment (Erosion, Animal Burrow, Penetrations)

An evaluation of through-seepage was not conducted at this time. Through-seepage is estimated to be a minor factor and will be included during evaluation of the selected alternative. The

probability of geotechnical levee failure for each location is provided in Table 3. The table is based on the stage estimates for a median hydrologic event.

Table 3. Probability of Geotechnical Failure by Median Hydrologic Annual Chance Exceedance (ACE)

	Probability of Geotechnical Failure by Median Hydrologic ACE						
	50% (1/2)	10% (1/10)	4% (1/25)	50% (1/50)	1% (1/100)	0.5% (1/200)	0.2% (1/500)
Feather River							
Hamilton Bend LM0.51	0.00-0.00	0.05-0.11	0.22-0.45	0.22-0.45	0.22-0.45	0.40-0.63	0.89-1.00
MA 16-LM0.90	0.00 -0.00	0.00-0.03	0.05-0.32	0.14-0.42	0.13-0.41	0.35-0.61	0.94-1.00
LD9-LM0.52	0.00-0.00	0.09-0.19	0.26-0.35	0.30-0.41	0.31-0.42	0.49-0.63	0.88-1.00
LD1-LM9.31	0.01-0.02	0.02-0.02	0.06-0.11	0.09-0.15	0.11-0.16	0.19-0.25	0.39-1.00
LD1-LM3.99	0.00-0.00	0.12-0.17	0.21-0.27	0.25-0.30	0.26-0.32	0.35-0.40	0.46-1.00
MA3-LM4.92	0.00-0.00	0.29-0.35	0.38-0.44	0.41-0.46	0.44-0.49	0.49-0.54	0.57-0.60
Sutter Bypass							
SBE-LM6.2	0.19-0.24	0.31-0.39	0.40-0.47	0.46-0.53	0.52-0.59	0.60-0.65	0.65-1.00
SBE-LM11.9	0.19-0.24	0.31-0.39	0.41-0.49	0.46-0.53	0.51-0.58	0.58-0.64	0.64-1.00
Wadsworth Canal							
WCE-LM0.84	0.02-0.05	0.08-0.14	0.14-0.39	0.35-0.60	0.56-0.76	0.78-1.00	0.89-1.00
Cherokee Canal							
CCE-LM9.5	0.08-0.19	0.22-0.32	0.27-1.00	0.30-1.00	0.33-1.00	1.00-1.00	1.00-1.00

2.4.4 Flood Damages

Existing condition damages were estimated using results from the hydrologic, hydraulic, and geotechnical analysis described above. For this preliminary screening phase, Expected Annual Damages (EAD) were estimated for Yuba City using the HEC-FDA software program and graphical probability-stage curves. Total damages for the remaining study area were estimated based on the ratio of total damageable property between the unknown area and the Yuba City area. Yuba City contains approximately 70% of the total damageable property within the study area.

An economic inventory was assembled following standard USACE methods. For the study area, a base geographic information system (GIS) inventory with parcel attribute data was provided by the local sponsor for both Sutter and Butte counties. Building attribute data were used to determine land use and valuation of structures and contents. Detailed GIS data were unavailable for all multifamily and commercial properties. These data were estimated using available digitized footprints and aerial imagery. Field visits were conducted to collect and validate the base inventory data.

Parcels with structures were categorized by land use and grouped into the following categories:

Residential – Includes all parcels represented by a single unit such as detached single-family homes and parcels with more than one unit such as apartment complexes, condominiums, and multiplex units. Each parcel may have multiple structures.

- *Commercial* – Includes retail, service stations, office buildings, restaurants, and shopping centers.

- *Industrial* – Includes warehouses, light and heavy manufacturing facilities, and food and agricultural processing facilities.

- *Public* – Includes both public and semi-public uses such as post office, fire dept, hospitals, government buildings, schools, and churches.

The value of damageable structures was estimated based on depreciated replacement values. The depreciated replacement value of a structure was determined by multiplying the structures square footage by the cost per square foot and a remaining-value ratio. Values for cost per square foot were obtained from the Marshall and Swift Valuation Service based on land use, building type, construction class, and quality. The remaining-value ratio was based on the factors such as condition of the structure and the year the structure was built.

The value of damageable building contents was estimated as a percentage of depreciated structure value based on associated land use. Content percentages were based on the expert elicitation findings used in the *American River Watershed Common Features Natomas Basin Post-Authorization Change Report and Interim General Reevaluation Report* (USACE, 2010).

The total value of damageable property (structures and contents) within the Sutter Basin study area is estimated at $7.1billion. Table 4 displays the total value of damageable property by category.

Table 4. Damageable Property ($1,000's)

Stutter Basin Feasibility Study Area EIA	Structure Value ($1,000's)	Content Value ($1,000's)	Total Value ($1,000's)	Percent of Total
Biggs	54,757	23,560	78,318	1%
Gridley	278,501	133,560	412,061	6%
Live Oak	250,603	105,118	355,721	5%
Yuba City	3,327,010	1,636,411	4,963,421	77%
Rural-Butte	160,829	66,573	227,401	4%
Rural-Sutter	302,114	132,396	434,510	7%
TOTAL	$4,373,815	$2,097,617	$7,118,575	100%

Agricultural damage analysis is currently being completed. Agricultural crop and equipment values are estimated to be approximately 10% of the value of the total urban damageable property ($647 million). Future analysis will include an assessment of production costs of crops grown within the project area and the inventory of crops expected to be flooded.

2.4.5 Environmental

Existing and future without-project conditions have been developed for the study area and are described in the draft *Sutter Basin Feasibility Study Environmental Without-Project Conditions Report* (ICF International, 2011). This report will be the basis for the "Affected Environment" and "No Action Alternative" sections of the Sutter Pilot Feasibility Study/EIS/EIR. Following is a brief summary of existing environmental conditions based on the report.

The study area is located within the northern portion of California's Central Valley. The Sacramento Valley is a semi-arid region with an annual rainfall of approximately eighteen inches. There are two distinct annual seasons, a hot dry summer and a cool wet winter. Approximately eighty percent of the annual rainfall occurs in between October to March.

Sutter County is primarily rural, with extensive agricultural areas and a low population density. The county is one of California's major agricultural counties and its traditional job base is agriculture. Eighty-six percent of Sutter County's lands are dedicated to agriculture; uses include field and row crops, orchards, rice, livestock grazing, dry farming, and timber according to the Sutter County General Plan, dated 2010. Nearly two thirds of the county's residents live in the incorporated cities of Live Oak and Yuba City. The California Department of Finance provides population data estimates and projections for cities and counties throughout California. Based on these estimates, the population of Sutter County increased from 78,930 to 99,154 between April 2000 and January 2010. For that same timeframe, the population within the incorporated cities of Live Oak and Yuba City grew from 6,229 to 8,791 and 36,758 to 65,372, respectively.

Butte County occupies the northern portion of the study area and includes the small communities of Gridley and Biggs. Agricultural lands dominate the landscape of the county. Agriculture is a major employment sector in Butte County. According to the California Department of Finance, between April 2000 and January 2010, the population of Butte County increased from 203,171 to 221,768. For that same timeframe, the population of the incorporated City of Gridley rose from 5,408 to 6,454. The population within the City of Biggs declined from 1,793 to 1,787.

Due to agricultural development and urbanization little historic native habitat remains within the Basin. According to some estimates, riparian forests in the Central Valley have declined by as much as 89 percent from the time of the Gold Rush. The study area is largely agricultural with about 80 percent of the area in farmland (orchards and rice fields), 10 percent in urban and developed lands, and about 10 percent in natural areas. Most remaining natural wetland areas that do exist are protected and are in State (Department of Fish and Game (CDFG)) or Federal (United States Fish and Wildlife Service (USFWS)) ownership. Most of the remaining land is used for agriculture and does not contain native vegetation. Existing rice fields however do provide valuable waterfowl habitat and habitat for the federally-listed threatened giant garter snake (GGS).

The project levees are covered primarily with grasses and forbs with widely scattered trees. While the levees are relatively free of woody vegetation compared to other levees within the

Sacramento region, the levees have been determined based on a periodic inspection in 2010 to be in noncompliance with ETL-1110-2-571, *Engineering and Design: Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures* (USACE, 2009). Efforts are underway to determine how to bring the levees into compliance while preserving where feasible vegetation. Obtaining a variance and/or incorporating design measures to retain vegetation are strategies being considered.

Along the Feather River within the designated floodway, significant habitats of riparian woodlands and grasslands occur. A wide band of riparian vegetation up to a mile in width extends from the river to the project levees. Most reaches of levees on the Feather River are set back some distance from the river channel allowing for a significant riparian corridor. This is unlike the Sacramento River where below Colusa the levees tightly constrain the river. Riparian habitat types include willow riparian, cottonwood riparian, and Great Valley mixed riparian.. Riparian habitats in general provide shelter, nesting, and foraging habitat for countless wildlife species in the Central Valley including numerous species of migratory birds protected via the federal Migratory Bird Treaty Act 1973.

Significant areas of native riparian vegetation along the Feather River are within the California Department of Fish and Game Feather River Wildlife Management Area and the Audubon Society's Bobelaine Sanctuary. Both areas include typical valley riparian species interspersed with freshwater marshes. The riparian tree species include large Fremont cottonwood trees along with sycamore, black walnut, Oregon ash, and valley oak. The understory vegetation consists of box elder, willow, wild rose, blackberry, wild grape, and poison oak.

A number of Federal and State listed species are known to occur or potentially occur in the study area. Many of these species are located within the riparian areas along the Feather River. Federally listed species identified by the USFWS as potentially occurring in the study area include the valley elderberry longhorn beetle, giant garter snake, vernal pool fairy shrimp, California tiger salamander, Central Valley steelhead, Central Valley spring-run Chinook salmon, and the green sturgeon. State listed species include the bank swallow, Swanson's hawk, western yellow-billed cuckoo, greater sandhill crane, and giant garter snake.

The Feather River and other rivers in the general area provide spawning, rearing, and migratory habitat for a diverse assemblage of native and nonnative fish species. Native species present in these streams can be separated into anadromous (species that spawn in fresh water after migrating as adults from marine habitat) and resident species. Native anadromous species include two runs of Chinook salmon, steelhead, green and white sturgeon, Pacific lamprey, and river lamprey. Native resident species include Sacramento pikeminnow, Sacramento splittail, Sacramento sucker, hardhead, California roach, and rainbow trout. Nonnative anadromous and resident species are also present. Chinook salmon, steelhead, green sturgeon, Pacific lamprey, and Sacramento splittail have experienced declines in abundance as a result of natural and human-related factors.

The elderberry shrub, present within the riparian zone and near project levees, is the sole host plant to the federally-listed threatened valley elderberry longhorn beetle. Elderberry shrubs are a common component of riparian forests and adjacent uplands throughout California's Central Valley. The GGS, a state and federally threatened species, also has potential habitat along the

existing levees. Typically inhabiting marshes, sloughs, ponds, small lakes, and low gradient streams, GGS also heavily utilize agricultural wetlands such as irrigation and drainage canals, rice fields, and the adjacent uplands. These two listed species and the Swanson's hawk are considered the most likely species to be potentially adversely affected by levee construction activities. In some locations, elderberry shrubs and Swanson hawks can occur in the riparian habitat in close proximity to the levees and GGS aquatic habitat occurs in canals and ditches located near the toe of levees. Additional information regarding habitat conditions is included in the *Environmental Constraints Analysis for the Feather River West Levee Project* (ICF International, 2011), which was prepared to identify sensitive habitat areas along the west levee of the Feather River.

The Sutter National Wildlife Refuge operated by the USFWS is located within and along the Sutter Bypass consists of about 3,000 acres along about 20 miles of riparian channels on both sides of the interior of the bypass. Within the Sutter Bypass, riparian and emergent marsh vegetation is limited to narrow bands of woody vegetation near the low flow streams waterward of the project levees. Cottonwood and willow are the most common riparian tree species. During periods of high flow when the bypass is flooded, the bypass provides seasonal winter wetland habitat for migratory waterfowl. Segments of drainage ditches that are located landward of the Sutter Bypass and parallel the levee toe support areas of emergent marsh and the State and Federally-listed threatened GGS.

Various recreation activities are actively pursued along the banks of the Feather River. Fishing and boating are the major recreational activities. There are a number of County and city parks along the river. CDFG operates several areas within the Feather River Wildlife Area that are managed primarily for wildlife but offer recreation opportunities, including hunting, fishing, bird watching, and nature study. During the NEPA scoping period for the study, a concern was expressed regarding lack of river access for recreation. Use of levee top for hiking and biking is restricted because the public is not allowed to use most of the levee tops for recreation.

The study area is located in a federally designated nonattainment area for PM10 (particulate matter equal or less than 10 microns in diameter) under the Clean Air Act. Construction generated emissions of dust and diesel particulate matter is an air quality health concern.

2.5 FUTURE WITHOUT PROJECT CONDITION

The future without-project condition is the most likely condition expected to exist in the future in the absence of a proposed water resources project and constitutes the benchmark against which alternatives are evaluated. These forecasts of future conditions are from the base year (year when a project is expected to be operational) to the end of the period of analysis (50 years). Future without-project conditions for this study are projected assuming a base year of 2020 and a 50 year period of analysis out to year 2070. Current economics efforts do not include a future without project condition with future development estimates. It is scoped to do these calculations after the TSP selection as more detailed analysis is warranted. Some discussions on possible approaches follow.

Circumstances regarding flood risk may influence community development and population growth. One such circumstance is through imposition of development restrictions if target levels of flood protection are not in place. As stated in Section 1.5.2, the CVFPP will require a 200-year level of flood risk management (0.5% (1/200) ACE) for urban and urbanizing areas by the year 2025, and no new development would be permitted if this target is not met. As an interim measure under SB 5, no new development would be permitted if adequate progress is not being made toward this goal by 2015.

These measures apply to the study area and therefore may result in development restrictions if the required conditions are not met, which in turn may negatively influence community build-out as prescribed in the general plans, and similarly may negatively influence population growth projections. Therefore, two future growth scenarios have been described to bracket the potential circumstances of full growth and limited growth. Although these scenarios are highly speculative, the California Department of Finance assisted by providing unpublished data to support the potential population changes based on these scenarios. The scenarios are presented below.

2.5.1 Full-Growth Scenario

The following conditions apply to the full-growth scenario:

- The communities of Yuba City and Live Oak as well as surrounding areas within Sutter County are currently mapped by the Federal Emergency Management Agency (FEMA) as Zone X. It is anticipated that FEMA will issue updated floodplain maps for the portion of the study area within Sutter County by 2013. Updated FEMA Flood Insurance Rate Maps for the portion of the study area within Butte County became effective on January 6, 2011. The communities of Biggs and Gridley as well as surrounding areas within Butte County are mapped as FEMA Zone X. Under the full-growth scenario, current officially adopted FEMA maps would remain in place; no new FEMA restrictions.
- No SB 5 restrictions would be triggered; 200-year protection would be met via non-Federal actions area wide or over large planning areas.
- Current municipal general plans would be built out and continue beyond those plans to 2070; planned community development would continue as described in the general plans.
- Population growth would continue as described under current municipal general plans and would continue beyond those plans to 2070.

2.5.2 Limited-Growth Scenario

The following conditions apply to the limited-growth scenario:

- Current officially adopted FEMA maps would remain in place; no new FEMA restrictions.
- SB 5 restrictions would be triggered; 200-year protection would be met on a per parcel basis or over small, discrete planning areas.
- Current municipal general plans would not be built out beyond 2025; limited community development would continue but would be shifted from urbanized areas, under SB 5

restrictions, to non-urbanized areas.

- Population growth would continue but would be restricted according to community development.

2.5.3 Population

2.5.3.1 Full-Growth Scenario

According to California Department of Finance (2007c), "California's population is projected to reach almost 60 million people by 2050, adding over 25 million since the 2000 decennial census." In this time frame, Sutter County is expected to more than triple in size and experience the state's largest population increase (+255%). In 2050, the total population of Sutter County is expected to reach 282,894 (California Department of Finance 2007a), and the total population of Butte County is expected to reach 441,596 (California Department of Finance 2007b).

Specific population and other long-term projection data related to socioeconomics are not yet available for 2070; however, California Department of Finance prepared unofficial 2070 population estimates for Sutter and Butte Counties for this project. It is estimated that the population of Butte County will be 512,095 and the population of Sutter County will be 341,216. These projections are based on very preliminary analysis of migration and fertility trends, which will change. Also, it is important to note that 60-year projections are subject to an enormous amount of potential external changes that could render these values completely inaccurate (Schwarm pers. comm.). Based on these projections, the population in the study area would continue to increase, and it can be assumed that employment, income, and the demand for housing would also increase between 2011 and 2070.

2.5.3.1 Limited-Growth Scenario

The California Department of Finance prepared unofficial population estimates for Sutter and Butte Counties under the limited-growth scenario (Schwarm pers. comm.). It is estimated that the population of Butte County will be 438,676 and the population of Sutter County will be 301,516. As described above, these projections are based on very preliminary analysis of migration and fertility trends, which will change. Butte County is assumed to be slightly more affected by SB 5 and the provisions associated with it than Sutter County. Also, it is important to note that 60-year projections are subject to an enormous amount of potential external changes that could render these values completely inaccurate. However, under the limited-growth scenario, the population of both counties would be significantly less than it would be under the full-growth scenario.

2.5.4 Land Use

2.5.4.1 Full-Growth Scenario

It is anticipated that build out of Sutter County's General Plan will be achieved by the year 2070. Development rates in 2070 are expected to coincide with population growth over the next 60 years. The county's land use goals include maintaining adequate land use supply and preserving

agricultural heritage and natural resources. It is anticipated that in 2070 the primary land use will be agriculture in the unincorporated county. The main areas of growth will be in the Yuba City and Live Oak spheres of influence, rural planned communities, employment corridors, and industrial/commercial use. By 2070 the majority of the land use in unincorporated Butte County in the study area would remain in agriculture. It is likely that the 2030 build out numbers projected in the Butte County General Plan 2030 would be realized. While it could be assumed that the build out numbers for 2030 would be realized earlier, the county does not have a history of reaching planned build out numbers.

2.5.4.2 Limited-Growth Scenario

Under a limited-growth scenario in 2070, the estimated population of Sutter and Butte Counties will be approximately 13% smaller than the population numbers under a full-growth scenario. It is anticipated that there will be continued growth in cities and counties in the study area between 2025 (the year in which the CVFPP will require limitations on new development in urban and urbanizing areas) and 2070. Growth has been the trend within the study area and is anticipated, planned for, and encouraged in the municipal general plans. As this trend continues into the future, it will broaden the economic base. It is probable that because new development will be restricted in urbanized areas, existing smaller cities (such as Gridley, Biggs, and Live Oak) and unincorporated towns will grow and new communities will come into existence in areas with populations presently below 10,000. This will increase suburban growth, with the city spreading outward through low-density and auto-dependent development on rural and often unincorporated lands. As a result of new populations moving to currently undeveloped areas, there is the potential for cities and counties to change land use designations to accommodate the shift in population, despite the current emphasis on preserving agricultural lands for economic and recreational benefits.

The potential effects of the limited-growth scenario on land use in all jurisdictions in the study area could include conversion of important farmland to non-agricultural uses. Because housing in urban and urbanizing areas will be fully occupied and development limited after 2025, new housing will likely be driven to rural areas. This may ultimately require lands that are designated for agriculture, recreation, or open space to be converted to uses that support the development of housing. Land may also be converted to accommodate commercial districts that support the developing suburban communities. Furthermore, temporary zoning conflicts associated with suburban development are likely to occur.

In both Sutter and Butte Counties, it is likely that the dominant land use in 2070 under a limited-growth scenario will continue to be agriculture. This is because of the foreseeable demand for the area's agricultural commodities. Agriculture represents the economic base for both counties, and the preservation of open space and agricultural lands is highly regarded in the region.

2.5.5 Additional Assumptions

Additional assumptions regarding the future without-project condition are listed below:

- For purposes of evaluating the transfer of flood risk, the future without-project condition will assume the levees do not fail due to geotechnical conditions since their original design was not based on failure assumptions.

- Ongoing levee maintenance will result in no change to geotechnical conditions and levee performance curves.

- Oroville and New Bullards Bar reservoirs on the Feather and Yuba River Systems will continue to be operated using the existing rule curves.

- Vegetation and topographic conditions within the channel are expected to remain the same as existing conditions.

- Remaining natural areas are not expected to substantially decline in acreage and value over the period of analysis.

- Future urban development is expected to occur within agricultural lands rather than natural areas based on current adopted general plans.

- Since refinements, additions, and deletions of elements associated with the Systemwide Investment Approach presented in the 2012 CVFPP are anticipated, these elements will not be included in the future without-project condition.

- Quantitative estimates of flood damage related to climate change will not be made. However, a sensitivity analysis to changes in hydrologic frequency will be conducted. Evaluating the impact of climate change on local flood extremes would require lengthy and complex analysis. For example, evaluation of global climate models would be necessary to estimate changes in extreme rainfall amounts and temperature as well as seasonal changes to snowpack. Hydrologic modeling would be necessary to compute runoff from the basins hydrologic characteristics, precipitation amounts, precipitation temperature, and snowmelt excess. Reservoir modeling would be necessary to evaluate flood control operations based on downstream control points. DWR is developing a new methodology for estimating the impacts of climate change on flood hydrology (DWR, 2011). The study will evaluate climate change impacts on extreme events based on estimated changes to local extremes. The results of this complex analysis will not be available within the schedule of this study.

- Section 104 of WRDA 86 allows for the plan formulation analysis to exclude work conducted by the sponsor from the without project condition, thereby allowing the work to potentially be incorporated in to the recommended plan, if it is found to be in the Federal interest. Since the application for consideration of Section 104 credit for the completed Star Bend setback levee was approved in 2009, this project will not be considered part of the future without-project condition.

- Per direction from the Vertical Team at In-Progress Review #1, the Feather River West Levee Project <u>will not</u> be considered part of the future without-project condition (assumes no contract prior to the Chief's Report for the pilot study).

3.0 MEASURES AND CONCEPTUAL ALTERNATIVES

3.1 PLAN FORMULATION PROCESS

The plan formulation process develops and evaluates alternative plans to address the needs and desires of society as expressed in specific planning objectives. Accordingly, the TSP best satisfies the objectives as well as the Federal interest. Consistent with the Federal Water Resources Council's Principles and Guidelines (P&G) and the Planning Guidance Notebook (ER 1105-2-100), the procedure is broken down as follows:

- Establish specific planning objectives.
- Determine the nature and extent of issues to be addressed and identify the most important issues raised by the proposed action.
- Engage Federal and State resource agencies in the formulation process.
- Define constraints and criteria for formulating an implementable plan.
- Identify management measures to address the planning objectives. Retain those measures that are effective and produce NED benefits at less cost than other measures.
- Develop alternatives from the measures to meet or address the planning objectives and criteria.
- Compare alternatives in terms of economic cost and benefit, and identify the alternative that reasonabily maximizes net NED benefits if applicable.
- Identify the LPP.
- Reconcile differences between the NED plan and the LPP to develop a TSP that retains Federal interest. The overall TSP must continue to be economically feasible, and any deviation from the NED must be justified and must be approved by the ASA (CW). Any significant deviation from the NED may be a local sponsor responsibility and the local sponsor may be required to pay for entire project costs beyond what was identified in the NED Plan.

3.2 MANAGEMENT MEASURES

A broad array of management measures was developed based on information from existing reports and studies, as well as public input and professional judgment. The measures included the following categories: FRM structural, ER with FRM structural component, FRM non-structural, and recreational. These measures were presented at the Sutter Basin Pilot Study

Critical Thinking Charette held at the Sacramento District on July 18-19, 2011. The charette was attended by the PDT and non-Federal sponsors, along with several members of the Vertical Team and the National Pilot Program 17+1 Team. The measures were presented in an interactive format utilizing GIS and Google Earth. The team reviewed each measure, identified additional measures, and then evaluated the measures based on study objectives, study constraints, and Water Resources Council Principles and Guidelines (P&G) criteria. A group decision was made as to whether each measure should be retained or dropped from further consideration. Table 5 provides a description of the measures evaluated at the charette and indicates whether each one was retained or dropped and the reason(s) for dropping. Of the total 46 measures that were evaluated, 32 were retained.

Table 5. Summary of Measures Considered

ID	Measure	Measure Description	Retained	Dropped	Primary Reason(s) for Dropping Measure
S1	Biggs Ring Levee	Construct ring levee around highly developed area of Biggs.	X		
S2	Gridley Ring Levee	Construct ring levee around highly developed area of Gridley.	X		
S3	Live Oak Ring Levee	Construct ring levee around highly developed area of Live Oak.	X		
S4	Yuba City Ring Levee	Construct ring levee around highly developed area of Yuba City.	X		
S5	Fix-In-Place Feather River West Levee from Thermalito to Shanghai Bend	Fix in Place Feather River West Levee from Thermalito to Shanghai Bend.	X		
S6	Southern Portion of J-Levee	Construct Southern Portion of J-Levee. This measure would prevent potential levee failures on Sutter Bypass or Feather River downstream of Shanghai bend from backing up into Yuba City. However, if a failure occurred upstream of Shanghai, the measure would increase flood depths in Yuba City by ponding behind the J- levee.	X		
S7	Fix-in-Place Feather River West Levee from Shanghai Bend to Sutter Bypass; plus Wadsworth Canal East Levee; plus Sutter Bypass East Levee	Fix in Place existing Feather River west levee from Shanghai Bend to Sutter Bypass, Sutter Bypass East levee, and Wadsworth Canal Levee.	X		
S8	Butte Bypass	Construct a 1400 foot wide bypass from Feather River to Butte Basin.		X	This measure was dropped from further consideration because it would need to be combined with Sutter Bypass increase in capacity and additional easements. This measure would also require a fix-in-place levee. Additional engineering requirements along Feather River and Sutter Bypass and/or ring levee would be needed before this measure would be effective.

S9	Sutter Bypass Setback Levee	Construct a 500 foot setback levee along Sutter Bypass.	X		This measure would utilize the existing DWR pumping stations.
S10	Northern Feather River Setback Levee	Construct a 5.3 mile long setback levee.	X		
S11	Sutter Bypass and Feather River Confluence Setback Levee	Construct 2.1 mile long setback levee near Feather River and Sutter Bypass confluence.	X		
S12	Star Bend Setback Levee	Construct a 0.8 mile long setback levee at Star Bend.	X		
S13	Oroville DFG Wildlife Management Area – Degrade Land Surface and Restore Wetlands	Measure consists of degrading land surface and restoring wetlands. However, current ground surface is not hydraulically efficient and measure may only result in a small stage reduction.	X		
S14	Nelson Slough Sediment Removal at Sutter Bypass and Feather River Confluence	Measure consists of removal of sediment upstream from Nelson Slough rock weir.		X	This measure was dropped from further consideration because it would provide minor hydraulic benefit. The benefits would be temporary because this area would continue to have sediment deposition. This measure would result in high operations and maintenance costs, along with potential increased costs related to HTRW concerns.
S15	Southern Relief Structure	Construct relief structure in the levee at the south end of the Basin. If a levee were to fail upstream this downstream gate or fuse plug type feature would be used to convey floodwaters back the Feather River and Sutter Bypass channel In a levee breach scenario this may reduce peak stages in the southern portion resulting in less structures being flooded in the Yuba City area.	X		
S16	Modify Fremont Weir	Modify Fremont Weir to reduce stages in the study area.		X	This measure would not reduce the water surface elevations enough to reduce seepage under and through the levees nor address the stability issues.
S17	Reoperation of Oroville Dam & Reservoir (Feather River)	This measure seeks to offset approximately 100,000 acre-feet of water supply for flood control storage space in Oroville Reservoir.		X	This measure was dropped from further consideration because fixes to the existing levee would still be required. This measure provides limited benefits downstream. Other listed measures would provide more efficient means to achieve performance.
S18	Increased flood storage in Shasta and Black Butte Reservoirs upstream of Sutter Bypass	This measure seeks to offset approximately 1,460,000 acre-feet of water supply in Shasta Reservoir and 674,000 acre-feet in Black Butte Reservoir for flood control storage space.		X	Based on the Sacramento San Joaquin Comprehensive Study results, this measure was found to have almost no impact on flood stages in the study area.

S19	Authorized Marysville Reservoir (South Yuba River)	Marysville Reservoir is a USACE authorized project that has not been constructed. Marysville Reservoir would be located on the Yuba River just upstream of the City of Marysville and downstream from New Bullards Bar and Englebright dams.		X	This measure is considered cost-infeasible due to deep foundation problems.
S20	Feather River Dredging	This measure consists of dredging the Feather River from Oroville to the mouth of Sacramento River.		X	This measure was dropped from further consideration because it does not fix the under seepage problem occurring within the existing levee. This measure also results in high costs of ongoing operation and maintenance and land acquisition. In addition, there are environmental concerns with mercury and heavy metals.
S21	Modify pumps along Sutter Bypass	This measure seeks to reduce or eliminate flooding due to ponding of excess flood waters in the southwestern portion of the study area.		X	This measure was dropped from further consideration because it does not fit within the study objectives. The study objectives do not focus on interior drainage.
S22	Cherokee Canal Sediment Removal	This measure would remove sediment that may have accumulated in the Cherokee Canal.		X	This measure was dropped from further consideration because canal maintenance is the responsibility of another party. There are other ongoing efforts to address sediment removal in the Cherokee Canal.
S23	Sunset Weir Modification	This measure would modify a hydraulic structure in the Feather River that is used to divert water into an irrigation canal.	X		
S24	Gilsizer Cross Levee with flap gates	This measure would involve constructing a new levee across the Sutter Basin from Star Bend on the Feather River to Pumping Plant #2 on the Sutter Bypass. The areas to the north and south of the new levee would have different residual flood probability.	X		
S25	Wadsworth Canal Tributary Drainage	This measure would involve increasing the capacity of the Wadsworth Canal to accommodate additional runoff.	X		
S26	Managed overtopping (levee superiority) on Feather River and Sutter Bypass.	This measure would increase the resilience of the existing levee system by providing designated overtopping locations similar to spillways.	X		
S27	Improve upstream fish passage in Sutter Bypass. (Remove fish passage barriers). Dependent on S9	This measure would identify and remove fish passage barriers in the Sutter Bypass. This measure is dependent on measure S9.	X		
S28	Sutter Bypass Sediment Removal	This measure would remove sediment that may have accumulated in the Sutter Bypass.		X	This measure was dropped from further consideration because it is considered maintenance. Maintenance is the responsibility of another party.

S29	Vegetation Management in Sutter Bypass	This measure would manage vegetation that affects stages within the Sutter Bypass.		X	This measure was dropped from further consideration because it is considered maintenance. Maintenance is the responsibility of another party.
S30	Vegetation Management in Lower Feather River	This measure would manage vegetation that affects stages within the Lower Feather River.		X	This measure was dropped from further consideration because it is considered maintenance. Maintenance is the responsibility of another party.
S31	Vegetation Management in Upper Feather River	This measure would manage vegetation that affects stages within the Upper Feather River.		X	This measure was dropped from further consideration because it is considered maintenance. Maintenance is the responsibility of another party.
NS1	Relocate structures and critical infrastructure in floodplain.	This measure would include relocation of structures and critical infrastructure in floodplains.	X		
NS2	Floodproof at isolated locations.	Residential structures and other buildings would be evaluated for potential damages during flood events from water entering the structure. Floodproofing techniques would be selected on a case-by-case basis.	X		
NS3	Elevate structures and transportation infrastructure	This measure would include elevating structures, railroads, and highways.	X		
NS4	Establish flood-resistant housing	This measure would include construction of flood-resistant housing.	X		
NS5	Secure large floatable objects	Objects that might be mobilized and strike people during a flood event would be removed, relocated, or secured.	X		
NS6	Flood-warning system	This measure would involve developing, establishing, and implementing a system for warning the public about potential flood events.	X		
NS7	Evacuation plan	This measure involves coordination with local entities to establish and implement a plan for evacuation during a flood event.	X		
NS8	Construct ring levees at isolated locations	This measure would involve construction of ring levees around structures that are subject to damage from flood waters.	X		
NS9	Floodfight pre-staging equipment and supply area	This measure includes establishing designated sites within the study area for pre-staging floodfighting equipment and supplies.	X		
R1	Multi-Use Trails	Establish an interconnected multiuse trail system.	X		
R2	Bicycle Trails	Connect bike trails to a larger trail system, with a focus on Class 1 trails.	X		
R3	Equestrian Trails	Equestrian trails are designed for horses and their riders. They are typically separated from bike and pedestrian trails.	X		
R4	Day Use Area	Day use areas are staging or access points to recreation spaces that have	X		

		their own specific uses.			
R5	River Access	River access facilities allow the public to directly engage the water safely at controlled locations.	X		
R6	Scenic Overlook	This measure consists of wildlife viewing platforms and/or boardwalks on levees or flood risk management lands for bird watchers and wildlife enthusiasts separate from main trails.	X		
R7	Recreational parkway	This measure compliments the multi-use trail measure by preserving natural areas and wildlife habitat along the trail system.	X		

3.3 CONCEPTUAL ALTERNATIVES

Following the initial screening of measures, the team identified four themes (strategies) for plan formulation. The themes included the following: 1) Consequence Management Focused on Public Safety, 2) Urban FRM Focus, 3) Maximize Existing System with FRM Focus, and 4) Ecosystem Restoration Focus.

These themes were used to assist the team in establishing a preliminary array of conceptual alternatives by grouping measures according to the primary focus of each theme. Measures listed under each conceptual alternative were designated as either required measures or optional measures that could be incrementally added to the alternative. Based on the measures grouped under each theme, the team identified a total of nine conceptual alternatives. Aside from Alternative 1.1, all alternatives are comprised primarily of new levees or strengthening of existing levees. A matrix with the array of conceptual alternatives and measures associated with each of these alternatives is also included in Table 6. The nine conceptual alternatives are described below by theme. In addition to the nine conceptual alternatives, the No Action Alternative is described below.

Table 6. Themes and Conceptual Alternatives

ID	Management Measure	Theme 1: Consequence Management Focused on Public Safety	Alternative 1.1: Nonstructural	Theme 2: Urban FRM Focus	Alternative 2.1: Ring Levees	Alternative 2.2: Big J	Alternative 2.3: Little J	Alternative 2.4: Minimal Fix in Place	Alternative 2.5: Fix in Place Thermalito to Star Bend	Theme 3: Maximize Existing System with FRM Emphasis	Alternative 3.1: Fix in Place w/o Raising	Alternative 3.2: Fix in Place w/o Raising including Modest Setbacks	Theme 4: Ecosystem Emphasis	Alternative 4.1: Setbacks with Ecosystem Restoration
S1	Biggs Ring Levee			*	X									
S2	Gridley Ring Levee			*	X									
S3	Live Oak Ring Levee			*	X									
S4	Yuba City Ring Levee			*	X									
S5	Fix-In-Place Feather River West Levee from Thermalito to Shanghai Bend			*		X	X	X SBFCA segment 4 and 5 only (Sunset Weir to Shanghai Bend)	X	*	X May include sub reaches	X	*	X
S6	Southern Portion of J-Levee			*			X							
S7	Fix-in-Place Feather River West Levee from Shanghai Bend to Sutter Bypass; plus Wadsworth Canal East Levee; plus Sutter Bypass East Levee			* South to Star Bend only		X Feather River North of Star bend and Shanghai Bend north of Gilsizer slough		X Shanghai Bend to Star Bend	X Shanghai Bend to Star Bend	*	X May include sub reaches	X	* w/o Sutter Bypass fix in place	X w/o Sutter Bypass fix in place
S9	Sutter Bypass Setback Levee									*		O	*	X

S10	Northern Feather River Setback Levee			*						*		O	*	X
S11	Sutter Bypass and Feather River Confluence Setback Levee									*		X	*	X
S12	Star Bend Setback Levee			*		X			X	*	X	X	*	X
S13	Oroville DFG Wildlife Management Area – Degrade Land Surface and Restore Wetlands					O	O				O	O	*	X
S15	Southern Relief Structure	*	O	*						*	O	O	*	X
S23	Sunset Weir Modification			*		O	O	O		*	O	O	*	X
S24	Gilsizer Cross Levee with flap gates	*		*		X								
S25	Wadsworth Canal Tributary Drainage			*		O	O			*	O	O		
S26	Managed overtopping (levee superiority) on Feather River and Sutter Bypass.			*		O	O	O		*	O	O		
S27	Improve upstream fish passage in Sutter Bypass. (Remove fish passage barriers). Dependent on S9												*	X
NS1	Relocate structures and critical infrastructure in floodplain.	*	O	*	O	O	O	O	O	*	O	O	*	O
NS2	Floodproof at isolated locations.	*	O	*	O	O	O	O	O	*	O	O	*	O
NS3	Elevate structures and transportation infrastructure	*	O	*	O	O	O	O	O	*	O	O	*	O
NS4	Establish flood-resistant housing	*	O	*	O	O	O	O	O	*	O	O	*	O

NS5	Secure large floatable objects	*	O	*	O	O	O	O	O	*	O	O	*	O
NS6	Flood-warning system	*	X	*	X	X	X	X	X	*	X	X	*	X
NS7	Evacuation plan	*	X	*	X	X	X	X	X	*	X	X	*	X
NS8	Construct ring levees at isolated locations	*	O	*	O	O	O	O	O	*	O	O	*	O
NS9	Floodfight pre-staging equipment and supply area	*	X	*	X	X	X	X	X	*	X	X	*	X
R1	Multi-Use Trails	*	O	*	O	O	O	O	O	*	O	O	*	O
R2	Bicycle Trails	*	O	*	O	O	O	O	O	*	O	O	*	O
R3	Equestrian Trails	*	O	*	O	O	O	O	O	*	O	O	*	O
R4	Day Use Area	*	O	*	O	O	O	O	O	*	O	O	*	O
R5	River Access	*	O	*	O	O	O	O	O	*	O	O	*	O
R6	Scenic Overlook	*	O	*	O	O	O	O	O	*	O	O	*	O
R7	Recreational parkway	*	O	*	O	O	O	O	O	*	O	O	*	O

*: Included in theme
X: Included in alternative
O: Optional to alternative

3.3.1 Consequence Management Focused on Public Safety

3.3.1.1 Alternative 1.1: Nonstructural

At a minimum, the team determined that this alternative will include a flood warning system and evacuation plan. Optional measures include relocation of structures and critical infrastructure in the floodplain, floodproofing at isolated locations, elevating structures and transportation infrastructure, establishing flood-resistant housing, securing large floatable objects, constructing ring levees at isolated locations, and incorporating a southern relief structure. A map of this alternative is included as Plate 4. Only those measures with site specific locations are shown on Plate 4 and the plates for the other alternatives.

3.3.2 Urban FRM Focus

3.3.2.1 Alternative 2.1: Ring Levees

A map of this alternative including estimated residual floodplains is provided as Plate 5. This alternative consists of ring levees around the communities of Biggs, Gridley, Live Oak, and Yuba City. The heights of the Biggs, Gridley, and Live Oak ring levees were estimated based on the 0.2% (1/500) ACE levee breach inundation depths and an assumed additional height to provide 90% reliability. The height of the Yuba City ring levee was estimated based on the 0.5% (1/200) ACE levee breach floodplain and additional height to provide

90% reliability. The eastern flank of the Yuba City ring levee would utilize the existing Feather River levee. The existing levee would be strengthened in place to its existing authorized height with no raising and would meet current USACE design standards. The higher level of performance for the Biggs, Gridley, and Live Oak ring levees was utilized because the flood depths are relatively shallow and do not vary significantly between flood frequencies. Each ring levee was assumed to require a pump station to address interior drainage. The capacity of the pump station was based on the rational method.

3.3.2.2 Alternative 2.2: Big J

A map of this alternative including estimated residual floodplains is provided as Plate 6. This alternative includes strengthening the Feather River levees from Thermalito to Star Bend, constructing a new cross-levee from Star Bend to Gilsizer Slough, strengthening the Sutter Bypass levee from Gilsizer slough to Wadsworth canal, and strengthening the south levee of the Wadsworth canal. All fix in place levees would meet current USACE design standards and would be strengthened to the existing authorized height with no raising. The new levee reach was assumed to be a straight line profile from the Feather River levee to the Sutter Bypass levee. The levee footprint follows the approximate drainage divide to the two existing DWR pumping plants. Therefore, additional pumping plants would not be required. This alternative also includes the Star Bend setback levee.

3.3.2.3 Alternative 2.3: Little J

A map of this alternative including estimated residual floodplains is provided as Plate 7. This alternative includes strengthening in place Feather River levees from Thermalito to Shanghai Bend and constructing a new levee to the south and west of Yuba City. All fix in place levees would meet current USACE design standards and would be strengthened to the existing authorized height with no raising. The "J" levee was assumed to require a pump station to address interior drainage. The capacity of the pump station was based on the rational method.

3.3.2.4 Alternative 2.4: Minimal Fix-In-Place

A map of this alternative including estimated residual floodplains is provided as Plate 8. This alternative consists of strengthening in place the Feather River levees from Sunset Weir to Star Bend. All fix in place levees would meet current USACE design standards and would be strengthened to the existing authorized height with no raising.

3.3.2.5 Alternative 2.5: Fix-In-Place Thermalito to Star Bend

A map of this alternative including estimated residual floodplains is provided as Plate 9. This alternative consists of fixing in place Feather River levees from Thermalito to Star Bend and corresponds to phase 1 of the Feather River West Levee Project described in Section 1.4.1. The alternative also includes the Star Bend setback levee. All fix in place levees would meet current USACE design standards and would be strengthened to the existing authorized height with no raising.

3.3.3 Maximize Existing System with FRM Focus

3.3.3.1 Alternative 3.1: Fix-In-Place Without Raising

A map of this alternative including estimated residual floodplains is provided as Plate 10. This alternative consists of fixing in place the Feather River levees from Thermalito to the confluence with the Sutter Bypass and improving the east levees of the Sutter Bypass. . Levees along the south side of Wadsworth Canal would also be improved. The alternative also includes the Star Bend setback levee. All fix in place levees would meet current USACE design standards and would be strengthened to the existing authorized height with no raising.

3.3.3.2 Alternative 3.2: Primarily Fix-in-Place Including Modest Setbacks

A map of this alternative including estimated residual floodplains is provided as Plate 11. This alternative is similar to Alternative 3.1. However, in lieu of fixing in place the existing levees, new setback levees would be constructed at Northern Feather River and at the Sutter Bypass and Feather River confluence. The alternative also includes the Star Bend setback levee.

3.3.4 Ecosystem Restoration Focus

3.5.4.1 Alternative 4.1: Setbacks with Ecosystem Restoration

A map of this alternative including estimated residual floodplains is provided as Plate 12. This alternative is similar to Alternative 3.2. However, in lieu of improving the existing Sutter Bypass levee, a new setback levee would be constructed along the Sutter Bypass.

3.3.5 No Action Alternative

Under this alternative, the Federal government would take no action toward implementing a specific flood damage reduction plan. The study area would continue to be subject to risk of flooding and will rely on emergency responses to ensure the safety of local communities. Significant damage to property and potential loss of life could occur if the levees were to fail. Subsequent improvements to the levees would be done under emergency or post-failure conditions. Emergency costs associated with evacuation, flood fighting, fire and police, and government disruptions would occur. Transportation through the area could be severely hampered by a major flood, and critical infrastructure could be rendered nonfunctional for an extended period of time after a flood.

4.0 CONCEPTUAL DESIGN

Following the charette, each alternative was further developed at a class 4 level of detail based on civil design, hydrologic, hydraulic, geotechnical, and engineering considerations. Quantities, costs, and economic benefits were then estimated for each alternative.

4.1 LEVEE DESIGN

All levees within each alternative assume a design that meets current USACE standards for slopes (1V:3H waterside, 1:2H or 1V:3H landside existing or new slopes respectively), crest

width (20 ft), O&M access (10 ft existing minimum), and seepage and stability (0.5 exit gradient at the toe and 1.4 factor of safety for long term steady state stability). This includes both cases of new levees and modification of existing levees. The levees are considered to be capable of performance to the authorized design level for loading conditions. To achieve this performance, seepage control measures have been included in every alternative based on a parametric approach.

The parametric levee design approach utilized a suite of nine levee cross section (referred to as templates; refer to Plate X) that represent typical design configurations applicable to the study area. The parametric templates include:

- Stability Berm Element
- Stability Berm with Relief Wells Element
- Seepage Berm Element
- Gravel Stability Berm Element
- Waterside Soil-Bentonite Cutoff Wall Element
- Centerline Soil-Bentonite Slurry Cutoff Wall Element
- New Levee Element
- New Levee with Centerline Soil-Bentonite Cutoff Wall Element
- Levee Crest Widening Element

Not every possible seepage control or stability mitigation measure was included at this level of detail. Soil-bentonite cutoff walls are assumed at this level of design, though at subsequent design level, a seepage berm or some other measure (e.g. relief fells, etc.) may be required. This was done for simplicity, given the low level of information available, and because soil-bentonite walls have a lower impact to the environment.

A set of applicable templates was assigned to each reach based on a review of the conditions. Each template was then specified as a percentage of overall reach length. For example, a reach might include 20% soil bentonite slurry wall template and 90% levee crest widening template (note that the totals can be more than 100%, even for seepage control measures). The basic parameters that define each template were then specified based on an assessment of the existing performance of the levee within each reach.

Parametric templates were specified to meet current USACE geotechnical design requirements. Cutoff walls were typically specified for levee strengthening instead of seepage berms. For new levees, it is more cost effective to construct a cutoff wall than a seepage berm. In general, seepage berms and cutoff walls are roughly the same overall cost (considering real estate acquisition, and the increasing number of local contractors capable of cutoff wall construction), but seepage berms usually have a higher impact to the environment during construction

Proposed seepage control measures, including type (berm, cutoff wall, etc.), sizing (depth, width, etc.) and length (or percentage of length) were based on the existing condition report, and augmented by professional judgment and specific local knowledge, and/ or geological and soil maps.

The alignment of new levees was refined following the charette. Alignments were based on a review of aerial photography and topographic features. Geographic placement was based on minimizing impacts to existing structures, environmentally sensitive areas, and features expected to require costly mitigation or relocation. The objective was to maximize FRM benefits to existing structures while minimizing the length (cost) of the new levee.

Geotechnical design template parameters for seepage control measures were based on "expected" or median values. Judgment was used to estimate the minimum and maximum possible values, followed by an assumption of a median value. For instance, a ring levee far from the river was assumed to require a cutoff wall for some portion of the ring, and the lowest possible value that was expected based on engineering judgment was selected (for instance 25%). Next, the highest possible value was estimated (for instance 75%). The same approach was used for het depth of the cutoff wall. Finally, based on engineering experience the "expected" value was estimated to lie between these extreme values. Note that the median value was not necessarily a conservative value, nor was it the "mean" value.

The current authorized height was used for the design height of existing levees. An increase to the currently authorized levee design height was not considered due to possible adverse hydraulic impacts to floodplains outside of the study area. The design height of new levees was based on modeled floodplain water surface elevations and additional estimated height to provide 90% confidence The water surface elevation was based on a worst case breach of any levees outside the strengthened reaches identified in the alternative. As previously indicated, design of existing levees was assumed to provide performance to the authorized design elevation. No range of evaluations for different loading conditions was developed, because past protect experience indicates that any modification at all provides improvement of the project to the design elevation, leaving segments of high and low level of performance, which does not provide a systematic approach. An assessment of large relocations (road and canal/ditch crossings) was based on visual inspection of aerial imagery. Relocations were tabulated based on common characteristics such as road crossings, flood gates, bridges, and closure structures.

Real estate and structure relocations were developed for each alternative based on estimated rights-of-way. Acreage was calculated using the levee template parameters within each reach.

Additional features necessary to meet current USACE standards were tabulated by levee reach. Examples of additional features include utility penetrations, drainage culverts, and pipelines. The additional features were estimated from levee logs recently completed by DWR.

4.2 COST ESTIMATES

Cost estimates were completed for each alternative. Quantities for levee improvements were developed from the levee design templates and levee logs. Quantities for relocations, additional non-levee features, and real estate were developed primarily from assessment of aerial imagery.

A spreadsheet developed by URS Corporation was used to prepare cost estimates for the levee improvements and new levees. This spreadsheet estimates costs based on a parametric approach. The spreadsheet calculates the cost based on the design cross section templates and typical parameters within the reach (levee top width, height, etc.). The spreadsheet utilizes a database of

unit price data from public bid results and projects that URS worked on for DWR and other public agencies. Unit prices in the spreadsheet were reviewed and updated to reflect present costs. For each levee reach and selected design template, the design parameters and quantities provided by USACE civil and geotechnical engineers were utilized to generate the cost estimate.

Other major cost items including roads, railroads and canals crossing new levees, utility relocations, interior drainage, traffic control, Storm Water Pollution Prevention Plan and erosion control, cultural resources, and fish and wildlife mitigation, along with corresponding project costs for Planning, Engineering & Design (PED), and Construction Management were considered separately. The costs for work relative to obstructions and structures crossing levees (special items) and interior drainage (pump stations) were based on preliminary quantity take-offs, hydrological analysis, existing cost data for similar projects, and historic cost estimates for projects with similar work. A percentage of the construction costs was used to compute costs for the other major cost items.

Real estate land costs were estimated using the parametric spreadsheet described above. The spreadsheet multiplies the estimated footprint area by the percentage of land in four typical categories found within the study area. The four categories included agricultural, residential, commercial, and orchard. The percentage of land within each category was based on a review of the linear distribution in recent aerial photography. The approximate land costs of each category were based on a range of values (high and low) provided by the appraisal section. The costs included in the parametric spreadsheet were based on the average of the high and low values within each category.

Real estate administration costs required to acquire a portion of a parcel or entire parcel by the non Federal sponsor include securing rights of entry for engineering and environmental surveys, topographic mapping, surveying existing levee toes, surveying existing roadways for Plats and Legal Descriptions, right of way field staking, appraisal services, Independent Appraisal Review, acquisition services, relocation assistance program, title and escrow support, and condemnation support if needed. Report development and future land crediting activities are also federal administrative costs required as part of the cost estimate.

Real estate administration costs were estimated by multiplying the estimated number of parcels within the levee footprint by a typical administration cost. Administrative costs were estimated to be $85,000 per parcel for new levees and $60,000 per parcel for existing levees. Administrative costs were assumed be less for existing levees because they are likely to be within an existing right-of-way. The costs were estimated based on historical Corps projects. Actual values would vary significantly because each parcel is unique. Major factors affecting this cost include willing seller, no willing seller and potential condemnation. Relocation costs for displaced residents or businesses as addressed in P.L. 91-646 (Uniform Relocation Assistance and Real Property Acquisition Policies Act) are not included, but will be determined as the array is refined..

The total estimated cost for each alternative is the summation of the costs from the parametric spreadsheet output, the costs developed for special items and interior drainage, and the costs of the other major cost items (as a percentage of construction cost).

4.3 WITH PROJECT FLOODPLAINS

With project residual floodplains were estimated for each alternative. The floodplains were estimated assuming levee heights would be sufficient to provide 90% reliability for the design flood. The floodplains for the with project conditions were estimated using the modeled breaches under existing conditions. For the fix in place alternatives, this was accomplished by only including breaches in the unimproved levee reaches. For the Ring and J-Levee alternatives, the existing condition breach maps were modified to remove the portions on the land side of the ring and J-levee.

4.4 ECONOMIC BENEFITS

Economic benefits were estimated for each alternative. The first step was to estimate the maximum economic benefit of fixing all levees to their design height. For each alternative, the benefit was estimated by applying a ratio based on the without and with project floodplains. The intent of the use of these results is solely to screen out those preliminary alternatives that do not appear economically justified even in the most favorable benefit/cost ratio ranges. Table 7 provides an economic comparison of the alternatives.

Table 7. Economic Comparison

Alternative	Total First Cost ($Millions)		Estimated Annual Net Benefits ($Millions)		Estimated Benefit to Cost Ratio	
	Low	High	Low	High	Low	High
1.1 - Nonstructural	TBD	TBD	TBD	TBD	TBD	TBD
2.1 - Ring Levees						
Yuba City	313	671	-10	29	0.4	3.2
Gridley	95	204	-6	0	0.1	0.9
Live Oak	82	177	-5	0	0.1	0.9
Biggs	60	129	-5	-2	0.0	0.3
2.2 - Big J	703	1,506	-35	26	0.2	1.9
2.3 - Little J	560	1,201	-24	32	0.3	2.4
2.4 - Minimal Fix- in -Place	177	381	-8	9	0.3	2.3
2.5 - Fix in Place Thermalito to Star Bend	422	905	-17	29	0.3	2.7
3.1 - Fix in Place w/o Raising	737	1,579	-36	29	0.2	2.0
3.2 Primarily Fix in Place including modest setbacks	882	1,900	-48	22	0.2	1.6
4.1 Setbacks with Ecosystem Restoration	1,543	3,308	-100	-3	0.1	0.9

5.0 ALTERNATIVE REFINEMENT

A combined Value Engineering (VE) Study and Planning Charette was held from 31 October to 4 November 2011. The VE methodology was incorporated into the planning process at an early stage of the study to compare, refine, and optimize alternatives based on multiple criteria in order to ensure a robust array. This process also provided an opportunity to validate the array of preliminary alternatives and to ensure that significant alternatives had not been overlooked. The

VE Study/Charette was attended by the PDT and non-Federal sponsors, the SPK VE Officer and SPD VE Program Manager, the SPD Plan Formulation Lead, and representatives from the National Pilot Program 17+1 Team. The team reviewed initial alternative evaluation criteria and expanded these criteria based on input from the group. Following are the final criteria that were used to assess each alternative in combination with the conceptual level cost estimates for each alternative.

5.1 VE STUDY/CHARETTE EVALUATION CRITERIA

5.1.1 Life Safety

This criterion focuses on the potential for life safety risk including the potential for the loss of human life and immediate health impacts that result from flood conditions as well as to facilities such as medical—hospitals, critical care units, helipads for medical; concentrated overnight places– nursing homes, motels; administrative coordination and assistance facilities. It also includes an assessment of the ability to maintain evacuation routes such as road systems leaving major population centers during flood events. Levees with lower geotechnical performance (higher probability of failure prior to overtopping) were considered to have higher life safety risk due to unexpected failure. A qualitative assessment of life safety was also conducted during the VE study.

5.1.2 Flood Damage Benefits

This criterion focuses on flood damage benefits which account for the reduction of flood damages to property. Property includes, for example, buildings, economic assets, and loss of standing crops and livestock in agriculture. Each alternative was qualitatively rated based on the geographic distribution of damageable property and the estimated 1% (1/100), 0.5% (1/200), and 0.2% (1/500) ACE residual floodplains for the alternative.

5.1.3 Critical Infrastructure Impacts

This criterion focuses on the potential for impacts to critical infrastructure such as power plants; transportation– road, rail, and air; power– energy supply and distribution systems, including oil; communications– telecommunications network including; public health services– regional healthcare facilities; and water supply and treatment facilities.

5.1.4 Design Capacity Exceedance

Design capacity exceedance measures the remaining flood risks after project measures are constructed that are above and beyond those risks being addressed by the project. This criterion also considers the issue of levee superiority to manage residual risk of catastrophic failures and measures the consequences to life and property if a given alternative's design is exceeded.

5.1.5 Wise Use of Floodplain (Minimize Growth Inducement in Floodplain)

This criterion considers the characteristics of the alternative which could encourage or facilitate growth in the floodplain in an unwise manner. Each alternative was qualitatively rated based on the degree to which the alternative would discourage development in the most high risk areas of the floodplain.

5.1.6 Sustainability

This criterion is a measure of the extent to which future funds and effort will be required to sustain the project measures provided. It is defined as developing and protecting the constructed measures in a manner that enables people to meet current needs and provides that future generations can also meet future needs, from the joint perspective of environmental, economic and community objectives.

5.1.7 Ecosystem Functionality

Ecosystem functionality is a measure of the project's ability to maintain or enhance the natural environment to support a functioning ecosystem. This criterion includes an assessment of the opportunities for riparian and wetland habitat preservation and restoration as well as the efforts to minimize impacts to environmentally sensitive areas adjacent to floodplain such as the riparian forest, oak woodland, and giant garter snake habitats . The criterion also considers the restoration or preservation of natural riverine processes in the floodplain. A wider river channel would also contribute to improvements in fish habitat. Alternatives should restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities.

In order to assess ecosystem functionality associated with each of the alternatives, the team identified areas for potential ER, in conjunction with FRM, by reviewing aerial photography, coordinating with the local sponsor, and reviewing existing reports. Primary information sources included the draft *Sutter Basin Feasibility Study Environmental Without-Project Conditions Report* (ICF International 2011), *Pre-Design Formulation Report Sutter Butte Flood Control Agency Feather River West Levee Project* (HDR, MHM, URS, & Wood Rodgers, 2011), and *Sutter Basin Feasibility Study Restoration Opportunities, Measures, and Sponsors* (ICF International, 2010).

5.1.8 Environmental Impacts

This criterion focuses on the project's temporary and permanent impacts to the environment. It includes the preservation of the existing floodplain and avoiding adverse effects on air quality, water quality, and other resources. Land disturbance outside the existing levee footprint should be minimized. The criterion also considers the loss of farmland and impacts to existing structures.

In order to identify sensitive habitat and qualitatively assess potential environmental impacts associated with each of the alternatives, the team reviewed available information from various databases and existing reports. Primary information sources included the draft *Sutter Basin Feasibility Study Environmental Without-Project Conditions Report* (ICF International, 2011) and the *Environmental Constraints Analysis for the Feather River West Levee Project* (ICF International, 2011). The team also reviewed the *Environmental Site Assessment, Sutter Basin*

Pilot Study Preliminary Assessment of Alternatives report (USACE, 2011) to assess potential HTRW issues associated with each of the alternatives.

5.2 VE STUDY/CHARETTE ALTERNATIVE EVALUATION

During the VE Study/Charette, each preliminary alternative was qualitatively rated on a relative scale of 1 (worst) to 10 (best) based on the criteria presented in Section 2.2. A discussion of each alternative in relation to these criteria is provided below. The VE Study/Charette Report, which includes more details on the relative ratings of each alternative and the evaluation process, is included in Appendix B.

Since the measures to be included in the nonstructural alternative have not yet been well defined, this alternative was not evaluated during the combined VE Study/Charette. However, the team qualitatively evaluated the alternative following the VE Study/Charette. The results of this evaluation are discussed below. By policy, a primarily nonstructural alternative will be included in the final array.

5.2.1 Nonstructural Alternative

5.2.1.1 Cost

In order to assess flood damage benefits, the team needs to refine the nonstructural alternative and calculate the costs of the measures that would comprise the nonstructural alternative.

5.2.1.2 Life Safety

Risk of geotechnical levee failure and subsequent flooding in the surrounding area would remain. Subsequent improvements to the levee would be done under emergency or post-failure conditions.

5.2.1.3 Flood Damage Benefits

In order to assess flood damage benefits, the team needs to refine the nonstructural alternative and calculate the benefits of the measures that would comprise the nonstructural alternative.

5.2.1.4 Critical Infrastructure Impacts

At a minimum, measure NS6 (flood warning system) and measure NS7 (evacuation plan) will be included in this alternative. These measures would not address impacts to critical infrastructure. In order to assess critical infrastructure impacts, the team needs to refine the nonstructural alternative.

5.2.1.5 Design Capacity Exceedance

In order to assess design capacity exceedance, the team needs to determine what other measures would be included in the nonstructural alternative in addition to measure NS6 (flood warning system) and measure NS7 (evacuation plan).

5.2.1.6 Wise Use of Floodplain (Minimize Growth Inducement)

This alternative would likely limit growth of local communities and future regional growth.

5.2.1.7 Sustainability

In order to assess sustainability, the team needs to refine the nonstructural alternative.

5.2.1.8 Ecosystem Functionality

If measure NS1 is included in this alternative, structure removal and relocation could provide an opportunity for ecosystem restoration benefits through riparian/wetland habitat restoration and creation of open space.

5.2.1.9 Environmental Impacts

This alternative may have the least direct environmental impact compared to the other alternatives because it would involve the least amount of construction activity and would minimizes the potential for future growth. However, communities and historic structures could be impacted by certain nonstructural measures such as NS1 (relocation of structures and critical infrastructure in the floodplain), NS2 (floodproofing at isolated locations), and NS3 (elevating structures and transportation infrastructure).

5.2.2 Ring Levees Alternative

5.2.2.1 Cost

The total estimated first cost of this alternative is $582 to 1,248 million. A breakdown of approximate first cost for each ring levee is provided below:

- Measure S1 (Biggs Ring Levee): $60 to $129 million
- Measure S2 (Gridley Ring Levee): $95 to $204 million
- Measure S3 (Live Oak Ring Levee): $82 to $177 million
- Measure S4 (Yuba City Ring Levee): $313 to $671 million

5.2.2.2 Life Safety

This alternative would reduce flood risk for a majority of the concentrated population and property within Yuba City, Live Oak, Gridley, and Biggs. Locations outside of the ring

levees (non-urban areas) would not receive flood reduction benefits from the ring levees. However, these areas are relatively low in population density. The ring levee around Yuba City would include a reach of the Feather River levee system. Thus, there would only be one line of protection around Yuba City versus two lines of protection provided by the ring levees of the other communities. A drawback of this alternative is that ring levees would rely on flood gates and other measures at crossings with railroads and roadways that would need to be actively operated in order to be effective. This alternative would also require access to evacuation routes. An evacuation plan would be included as a nonstructural measure for this alternative to address life safety.

5.2.2.3 Flood Damage Benefits

This alternative provides flood risk reduction to key urban development areas, thus property damages from flood events would be minimized. The ring levees around the four urbanized communities would reduce the flood risk for much of the property within the study area. However, some agricultural and some rural structures would still be exposed to flood risk. A breakdown of the estimated annual net benefits for each ring levee is provided below. Based on this breakdown, Yuba City is the only potentially economically justified increment.

- Measure S1 (Biggs Ring Levee): $-5 to $-2 million
- Measure S2 (Gridley Ring Levee): $-6 to $0 million
- Measure S3 (Live Oak Ring Levee): $-5 to $0 million
- Measure S4 (Yuba City Ring Levee): $-10 to $29 million

5.2.2.4 Critical Infrastructure Impacts

Ring levees would reduce flood risk for key regional facilities and other critical infrastructure within the ring levees, but would not reduce the risk of flooding of roadways and railroads outside of the ring levees.

5.2.2.5 Design Capacity Exceedance

If design capacity was exceeded, the interior of the ring levees would flood rapidly, which could result in loss of life. In addition, the ring levee around Yuba City would include a reach that is part of the Feather River levee system. Thus, there would be only one line of protection for Yuba City versus two layers from the ring levees of the other three communities.

5.2.2.6 Wise Use of Floodplain (Minimize Growth Inducement)

This alternative would limit growth of local communities and future regional growth, while allowing in-fill and redevelopment within the existing developed area.

5.2.2.7 Sustainability

This alternative would require maintenance of pump stations and closure structures to ensure effective continued operation and flood risk management for the ring levees. In addition, this alternative would require maintaining the existing levees within the study area, which are currently at risk of failure due to through-seepage and underseepage. Maintenance of new ring levees would also be required. However, the maintenance requirements of new levees would be less than existing levees because they would be constructed on new foundations and to modern engineering standards.

5.2.2.8 Ecosystem Functionality

Opportunities may exist for ecosystem restoration near the reaches of levee at Yuba City that would be incorporated into the Yuba City ring levee. There are few opportunities for ecosystem restoration associated with the other ring levee locations. Constructing new ring levees may impact existing functionality.

5.2.2.9 Environmental Impacts

This alternative preserves the existing floodplain while minimizing the potential for future growth and associated adverse effects on air quality and other resources. However, this alternative has the potential to conflict with local land use plans. Construction of the ring levees would require multiple railroad crossings as well as crossings of two significant drainage canals in Yuba City. Significant borrow material would be required for construction of the new levees. Direct and indirect impacts associated with this alternative could affect environmentally and culturally sensitive areas. In addition, construction of the levees would occur in urban areas that are more susceptible to air and noise quality impacts. Ring levees would also separate the communities of Yuba City, Live Oak, Gridley, and Biggs from their surrounding supporting areas and would result in aesthetic impacts by disrupting existing viewsheds. Pump stations would have to be operated periodically, which may result in air quality and noise impacts. There may also be HTRW issues associated with new levee alignments.

5.2.3 Big "J" Alternative

5.2.3.1 Cost

The total estimated first cost of this alternative is $703 to $1,506 million.

5.2.3.2 Life Safety

This alternative would reduce flood risk to the majority of the population and property within the study area. Areas in the southern portion of the study located below the Big "J" cross-levee would be located within the 1% (1/100)ACE floodplain. No actively operated closures would be necessary to maintain this alternative. All existing evacuation routes would be maintained.

5.2.3.3 Flood Damage Benefits

This alternative would capture approximately 93% of total benefits within the study area. However, some agricultural and some rural structures would still be exposed to flood risk. The benefits would be limited by the performance of the Sutter Bypass levees, which have a lower performance than the Feather River levees. As presented in Table 7, the estimated annual net benefits for this alternative range from $-35 to $26 million.

5.2.3.4 Critical Infrastructure Impacts

This alternative would provide flood risk reduction for hospitals, power plants, and other critical infrastructure within the study area, but would not reduce risk for all critical roadways within study area limits.

5.2.3.5 Design Capacity Exceedance

If design capacity was exceeded, the evacuation route on westbound Route 20 would be impacted. If the levee failed, flood depths would be greater due to the height of the southern cross levee south of Yuba City. The flood depths within the urbanized area of Yuba City would increase at a faster rate due to changes in the location of floodplain storage. Areas in the southern portion of the study area (below Sutter Bypass levee) would remain at high risk to flooding.

5.2.3.6 Wise Use of Floodplain (Minimize Growth Inducement)

This alternative reduces flood risk in Yuba City and other communities, which would allow for growth in existing urbanized areas. The cost of complying with the floodplain regulations could limit growth in the study area outside the Big J levee.

5.2.3.7 Sustainability

This alternative would result in reduced maintenance on the majority of existing levees along the Feather River, which are currently at risk of failure due to through-seepage and underseepage. New cross-levees for this alternative would be constructed on new foundations and to modern engineering standards. In addition to the maintenance required for the existing levees, these new reaches would require additional maintenance.

5.2.3.8 Ecosystem Functionality

Opportunities exist for ecosystem restoration within the segments of this alternative that includes existing levees. There are few opportunities for ecosystem restoration on other segments of this alternative. Constructing cross-levees may invade existing functioning ecosystems. Preserving existing levees may allow for future ecosystem restoration projects.

5.2.3.9 Environmental Impacts

Construction of the new cross levee associated with this alternative would directly impact farmland and potential sensitive habitat areas. Construction impacts would be limited where land disturbance is confined to existing levee footprints. Seepage berms, canal relocations, and land requirements could impact adjacent environmentally sensitive habitats and structures. The alternative would significant borrow material to construct new levee reaches. Construction of cutoff walls could potentially disrupt groundwater flows. Potential HTRW issues exist for new levee alignments. The alternative would include construction of levee reaches in urban areas, which are more susceptible to air and noise quality impacts. These new levee reaches would result in aesthetic impacts by disrupting existing viewsheds. This alternative would also separate the agricultural areas in the southern portion of the study area from the communities located in the northern portion.

5.2.4 Little "J" Alternative

5.2.4.1 Cost

The total estimated first cost of this alternative is $560 to $1,201 million.

5.2.4.2 Life Safety

This alternative would reduce flood risk to the majority of the population and property within the study area due to the population density in Yuba City. Areas in the southern portion of the study located below the Little "J" cross-levee would remain at risk of flooding. This alternative would impact the evacuation route on westbound Route 20 and two major drainage areas in Yuba City.

5.2.4.3 Flood Damage Benefits

This alternative would capture approximately 93% of total benefits within the study area. However, some agricultural and some rural structures would still be exposed to flood risk. As shown in Table 7, the estimated annual net benefits for this alternative range from $-24 to $32 million.

5.2.4.4 Critical Infrastructure Impacts

This alternative reduces the risk of flooding for hospitals, power plants, and other critical infrastructure within the study area, but does not reduce risk for certain roadways within project limits.

5.2.4.5 Design Capacity Exceedance

If design capacity was exceeded, the evacuation route on westbound Route 20 and two major drainage areas in Yuba City would be impacted. Areas in the southern portion of the study area (below Sutter Bypass levee) would remain at risk to flood. The area north of the Little "J" levee would capture flood waters from the breach resulting in greater depths and faster stage increases.

5.2.4.6 Wise Use of Floodplain (Minimize Growth Inducement)

This alternative reduces flood risk in Yuba City and other communities, which would allow for growth in existing urbanized areas. It provides limited flood risk reduction in all other parts of the study area, which could limit future growth. It focuses development in areas designated or already developed in lieu of encouraging development scattered through floodplain.

5.2.4.7 Sustainability

This alternative would result in reduced maintenance on the majority of existing levees along the Feather River, which are currently at risk of failure due to through-seepage and underseepage. New levees for this alternative would be constructed on new foundations and to current engineering standards. In addition to the maintenance required for the existing levees, the new levee reaches would require additional maintenance. This alternative would also require maintenance of pump stations and closure structures to ensure effective continued operation and flood risk management.

5.2.4.8 Ecosystem Functionality

Opportunities exist for ecosystem restoration within the reaches of this alternative that include existing levees. There are few opportunities for ecosystem restoration on other reaches of this alternative. Constructing new levees may invade existing functioning ecosystems. Preserving existing levees may allow for future ecosystem restoration projects.

5.2.4.9 Environmental Impacts

Construction of the new levee associated with this alternative would directly impact farmland and potential sensitive habitat areas. Construction impacts would be limited if land disturbance is confined to existing levee footprints. Seepage berms, canal relocations, and land requirements could impact adjacent environmentally sensitive habitats and structures. The alternative would also require crossing two significant drainage systems in Yuba City and significant borrow material to construct levee reaches. Construction of cutoff walls could potentially disrupt groundwater flows. Potential HTRW issues exist for new levee alignments. The alternative would include construction of levee reaches near urban areas, which are more susceptible to air and noise quality impacts. These new levee reaches would result in aesthetic impacts by disrupting existing viewsheds. This alternative would also

separate the agricultural areas in the southern portion of the study area from the communities located in the northern portion.

5.2.5 Minimal Fix-In-Place Alternative

5.2.5.1 Cost

The total estimated first cost of this alternative is $177 to $381 million.

5.2.5.2 Life Safety

This alternative would reduce flood risk to portions of Yuba City and surrounding areas, but would not reduce flood risk for the communities in the northern study area (Live Oak, Gridley, and Biggs) and some portions of Yuba City. This alternative addresses high life risk areas south of the Yuba River and Feather River confluence and in Yuba City. In the event of flooding, the eastbound SR-20 evacuation route would be accessible, but evacuation routes SR-99 and Westbound SR-20 would be cut off.

5.2.5.3 Flood Damage Benefits

This alternative would provide flood risk reduction to approximately half of Yuba City, which includes approximately 77% of the total property within the study area. It would provide some protection to agricultural lands. The alternative would capture approximately 39% of total benefits within the study area. Compared to the other structural alternatives, it would provide the least amount of flood risk reduction and expose the maximum amount of property to potential damage. As presented in Table 7, the estimated annual net benefits for this alternative range from $-8 to $9 million.

5.2.5.4 Critical Infrastructure Impacts

The alternative would not provide flood risk reduction for all key critical infrastructure (hospitals, power plants) and would not provide flood risk reduction for roadways or railroads within the study area.

5.2.5.5 Design Capacity Exceedance

Given the limited extent of levee improvements, it is anticipated that design capacity would be exceeded on a frequent basis. In the event of flooding, the eastbound SR-20 evacuation route would be accessible, but evacuation routes SR-99 and Westbound SR-20 would be cut off. The alternative would not result in the ponding issues caused by the cross-levees in the J-levee alternatives.

5.2.5.6 Wise Use of Floodplain (Minimize Growth Inducement)

This alternative reduces flood risk in approximately half of Yuba City. It does not provide flood risk reduction in all other parts of the study area, which could limit future growth.

5.2.5.7 Sustainability

Compared to the other structural alternatives, this alternative would result in the minimum amount of existing levees being improved. Thus, maintenance efforts for existing levees would be greater as compared to the other alternatives. However, the alternative would not add any additional reaches of levees to be maintained.

5.2.5.8 Ecosystem Functionality

Opportunities exist for ecosystem restoration along existing levees. Preserving existing levees may allow for future ecosystem restoration projects.

5.2.5.9 Environmental Impacts

Construction impacts would be limited if land disturbance is confined to existing levee footprints. Seepage berms, canal relocations, and land requirements could impact adjacent environmentally sensitive habitats and structures. Construction of cutoff walls could potentially disrupt groundwater flows.

5.2.6 Fix-In-Place Thermalito to Star Bend Alternative

5.2.6.1 Cost

The total estimated first cost of this alternative is $422 to $905.

5.2.6.2 Life Safety

This alternative is estimated to provide a 0.5% (1/200) ACE with 90% assurance level of flood risk reduction to a majority of the northern areas and communities within the study area, including Yuba City. It would not provide flood risk reduction from an event in the western portion of the study area. This alternative would preserve eastbound SR-20 as an evacuation route, but would cut off SR-20 westbound and SR-113 as evacuation routes.

5.2.6.3 Flood Damage Benefits

The alternative would capture approximately 79% of total benefits within the study area. However, some agricultural and some rural structures would still be exposed to flood risk. As shown in Table 7, the estimated annual net benefits range from $-17 to $29 million.

5.2.6.4 Critical Infrastructure Impacts

This alternative would reduce risk for the majority of hospitals, power plants, and other critical infrastructure within the study area, but would not reduce risk for all roadways.

5.2.6.5 Design Capacity Exceedance

It is anticipated that design capacity of unimproved reaches would be exceeded on a frequent basis. However, the levees along the northern segments of the Feather River would be improved and the probability of potential breaches would decrease. This alternative would preserve eastbound SR-20, but would cut off SR-20 westbound and SR-113 as evacuation routes. The alternative would not result in the ponding issues caused by the new levees in the J-levee alternatives. However, deep ponding in the southern portion of the study area would exist.

5.2.6.6 Wise Use of Floodplain (Minimize Growth Inducement)

This alternative would provide flood risk reduction to a significant portion of study area, thus removing flood risk as an obstacle to future regional growth and development in these areas. By reducing risk to the existing urbanized areas, it focuses development in areas designated or already developed in lieu of encouraging development scattered through the floodplain.

5.2.6.7 Sustainability

This alternative would improve reaches of existing levees that currently have issues related to underseepage and through-seepage, thus reducing maintenance requirements. The alternative would not add any additional levees to be maintained. The Sutter Bypass levees and Feather River levees below Star Bend would not be improved and maintenance requirements are anticipated to remain the same.

5.2.6.8 Ecosystem Functionality

Opportunities exist for ecosystem restoration along existing levees. Preserving existing levees may allow for future ecosystem restoration projects.

5.2.6.9 Environmental Impacts

Construction impacts would be limited if land disturbance is confined to existing levee footprints. Seepage berms, canal relocations, and land requirements could impact adjacent environmentally sensitive habitats and structures. Construction of cutoff walls could potentially disrupt groundwater flows.

5.2.7 Fix-In-Place Without Raising Alternative

5.2.7.1 Cost

The total estimated first cost of this alternative is $737 to $1,579 million.

5.2.7.2 Life Safety

This alternative would provide flood risk reduction to most of the study area, including Yuba City, Live Oak, Gridley, and Biggs. In comparison to the previous alternatives, it would also reduce flood risk in the southern part of the study area. This alternative would preserve SR-20 and SR-113 as evacuation routes.

5.2.7.3 Flood Damage Benefits

The alternative would capture most of the total benefits within the study area. However, some agricultural and some rural structures would still be exposed to flood risk. As presented in Table 7, the estimated annual net benefits range from $-36 to $29 million.

5.2.7.4 Critical Infrastructure Impacts

The alternative would reduce risk for hospitals, power plants, and other critical infrastructure as well as roadways and railroads within the study area.

5.2.7.5 Design Capacity Exceedance

This alternative would provide flood risk reduction to most of the study area. Flooding from an event that exceeded the design capacity would be similar to the existing (without-project condition). This alternative would preserve SR-20 and SR-113 as evacuation routes.

5.2.7.6 Wise Use of Floodplain (Minimize Growth Inducement)

This alternative would provide flood risk reduction to a significant portion of study area, thus removing flood risk as an obstacle to future regional growth and development to these areas. However, existing building codes and land use restrictions could limit future growth.

5.2.7.7 Sustainability

This alternative would improve the majority of reaches of existing levees, thus reducing maintenance requirements. The alternative would not add any additional levees to be maintained.

5.2.7.8 Ecosystem Functionality

Opportunities exist for ecosystem restoration along existing levees. Preserving existing levees may allow for future ecosystem restoration projects.

5.2.7.9 Environmental Impacts

Construction impacts would be limited if land disturbance is confined to existing levee footprints. Seepage berms, canal relocations, and land requirements could impact adjacent environmentally sensitive habitats and structures. Construction of cutoff walls could potentially disrupt groundwater flows.

5.2.8 Primarily Fix-In-Place With Modest Setbacks Alternative

5.2.8.1 Cost

The total estimated first cost of this alternative is $882 to $1,900 million.

5.2.8.2 Life Safety

This alternative would provide flood risk reduction to most of the study area, including Yuba City, Live Oak, Gridley, and Biggs. This alternative would preserve SR-20 and SR-113 as evacuation routes. There would be a marginal factor of safety improvements due to setback levees being built on new foundations.

5.2.8.3 Flood Damage Benefits

The alternative would capture almost 100% of total benefits within the study area. However, some agricultural and some rural structures would still be exposed to flood risk. As presented in Table 7, the estimated annual net benefits for this alternative vary from $-48 to $22 million.

5.2.8.4 Critical Infrastructure Impacts

The alternative would reduce risk for hospitals, power plants, and other critical infrastructure as well as roadways and railroads within the study area.

5.2.8.5 Design Capacity Exceedance

This alternative would provide flood risk reduction to most of the study area. It would not create the ponding issue that would be caused by the cross-levees of the Big "J" and Little "J" alternatives and would provide more area for ponding in the southern portion of the study area. In comparison to the previous alternatives, it would also reduce flood risk in the southern part of the study area. This alternative would preserve SR-20 and SR-113 as evacuation routes. There would be a marginal factor of safety improvement due to setback levees being built on new foundations.

5.2.8.6 Wise Use of Floodplain (Minimize Growth Inducement)

This alternative would provide 1% (1/100) ACE with 90% assurance flood risk reduction to a significant portion of study area, thus removing flood risk as an obstacle to future regional growth and development to these areas. However, existing building codes and land use restrictions could limit future growth.

5.2.8.7 Sustainability

This alternative would improve the majority of reaches of existing levees, thus reducing maintenance requirements. Setback levees would be constructed on new foundations and to latest engineering standards, thus reducing maintenance efforts. Setback levees would have access points and distances to allow maintenance vehicles access.

5.2.8.8 Ecosystem Functionality

Levee setbacks would create opportunities for restoration of riparian and wetland habitats within the setback areas (approximately 700 acres). A wider river channel would contribute to improvements in fish habitats.

5.2.8.9 Environmental Impacts

Construction impacts would be limited if land disturbance is confined to existing levee footprints. Seepage berms, canal relocations, and land requirements could impact adjacent environmentally sensitive habitats and structures. Construction of cutoff walls could potentially disrupt groundwater flows. Where setback levees are proposed, construction may require removal or relocation of structures and include conversion of farmland to upland, riparian or wetland habitats.

5.2.9 Setbacks With Ecosystem Restoration Alternative

5.2.9.1 Cost

The total estimated first cost of this alternative is $1,543 to $3,308 million.

5.2.9.2 Life Safety

This alternative would provide flood risk reduction to most of the study area, including Yuba City, Live Oak, Gridley, and Biggs. It would reduce flood risk for most of the study area. This alternative would preserve SR-20 and SR-113 as evacuation routes. Setback levees would reduce the water surface elevation. There would be a marginal factor of safety improvement due to setback levees being built on new foundations.

5.2.9.3 Flood Damage Benefits

The alternative would capture almost 100% of total benefits within the study area. However, some agricultural and some rural structures would still be exposed to flood risk. As shown in Table 7, the estimated annual net benefits for this alternative range from $-100 to $-3 million.

5.2.9.4 Critical Infrastructure Impacts

The alternative would reduce risk for hospitals, power plants, and other critical infrastructure as well as roadways and railroads within the study area.

5.2.9.5 Design Capacity Exceedance

This alternative would provide flood risk reduction to most of the study area. It would not create the ponding issue that would be caused by the cross-levees of the Big "J" and Little "J" alternatives and would provide more area for ponding in the southern portion of the study area. In comparison to the previous alternatives, it would also reduce flood risk in the southern part of the study area. This alternative would preserve SR-20 and SR-113 as evacuation routes. Setback levees would allow levees to withstand erosion during design exceedance better than fixing the existing levees in place.

5.2.9.6 Wise Use of Floodplain (Minimize Growth Inducement)

This alternative would provide flood risk reduction to a significant portion of study area, thus removing flood risk as an obstacle to future regional growth and development to these areas. However, existing building codes and land use restrictions could limit future growth.

5.2.9.7 Sustainability

This alternative would improve the majority of existing levees, thus reducing maintenance requirements. Setback levees would be constructed on new foundations and to latest engineering standards, thus reducing maintenance efforts. Setback levees would have access points and distances to allow maintenance vehicles access.

5.2.9.8 Ecosystem Functionality

Levee setbacks would create opportunities for restoration of riparian and wetland habitats within the setback areas (approximately 4,100 acres). A wider river channel would contribute to improvements in fish habitats.

5.2.9.9 Environmental Impacts

Construction impacts would be limited if land disturbance is confined to existing levee footprints. Seepage berms, canal relocations, and land requirements could impact adjacent environmentally sensitive habitats and structures. Construction of cutoff walls could potentially disrupt groundwater flows. Where setback levees are proposed, construction may require removal or relocation of structures and include conversion of farmland to upland, riparian, and wetlands habitats.

5.3 VE STUDY/CHARETTE RESULTS

Based on the discussions during the combined VE Study/Charette, the team identified alternatives with very similar functions as well as alternatives with little probability of implementation. This resulted in combining and eliminating some of the alternatives as well as refining and optimizing those that were retained by adding or removing measures in order to ensure a robust array. Following is a summary of the recommendations for the array of alternatives to be carried forward.

The existing measures establishing a flood-warning system and evacuation plan, as well as a new measure establishing floodfight pre-staging equipment and supply areas, should be the first added increments to all alternatives.

It was decided that a purely non-structural alternative was not likely feasible due to the extent and depths of probable floods. The team recommended combining Alternative 1.1 (Nonstructural) and Alternative 2.4 (Minimal Fix-In-Place) into a new alternative titled "Minimal Fix-in-Place plus Non-Structural" that would reduce residual risk. This alternative is a combination of minimal levee improvements to Feather River levees with the implementation of nonstructural measures focused on reducing risk to loss of life. A map of this alternative is provided as Plate 13.

The team determined that the costs of constructing ring levees around Biggs, Gridley, and Live Oak are significantly greater than the estimated annual benefits could support. Therefore, Alternative 2.1 (Ring Levees) should be refined by eliminating the individual ring levees around Biggs, Gridley, and Live Oak. This new alternative is titled "Yuba City Ring Levee" and consists of constructing a ring levee around Yuba City in combination with nonstructural measures focused on reducing risk in areas outside of the ring levee. A map of this alternative is provided as Plate 14.

The team recommended that Alternative 2.2 (Big "J" levee) be eliminated from further evaluation and that Alternative 2.3 (Little "J" levee) be retained. The Big "J" levee and the Little "J" levee are very functionally similar and are expected to have similar flood damage benefits. However, the Big "J" levee would be approximately 30% greater in cost based on conceptual cost estimates. In addition, if the design capacity of the Sutter Bypass reach of the Big "J" levee was exceeded, flood depths would be greater than existing conditions due to the height of the southern cross portion of the "J" levee (south of Yuba City). The flood depths would also increase at a faster rate due to less floodplain storage. Finally, the benefits associated with the Big "J" levee would be limited by the performance of the Sutter Bypass levees, which have a lower performance than the Feather River levees. The Little "J" levee does not utilize the Sutter Bypass levees and can therefore obtain a higher level of performance. A map of the Little "J" levee alternative is provided as Plate 15.

Based on an assessment of Alternative 2.5 (Fix-In-Place Thermalito to Star Bend) in relation to the evaluation criteria utilized for the combined VE Study/Charette, it was determined that this alternative should be retained. A map of the Fix-In-Place from Thermalito to Star Bend alternative is provided as Plate 16.

The team recommended that Alternative 3.1 (Fix-In-Place Without Raising) should be combined with Alternative 3.2 (Primarily Fix-In-Place with Modest Setbacks). These two alternatives were essentially the same alternative except for the optional setbacks. The setbacks can be evaluated as standalone additions to the combined alternative. This new alternative is titled "Fix in Place Feather River, Sutter Bypass, and Wadsworth Canal with Select Setbacks for Ecosystem Restoration." A map of this alternative is provided as Plate 17. The team also recommended that Alternative 4.1 (Setbacks with Ecosystem Restoration) be eliminated from further evaluation because the additional cost of this alternative compared to combined Alternatives 3.1 and 3.2

exceeds the additional restoration benefits and it has little probability of implementation. The ecosystem benefits from setbacks can be evaluated as standalone additions to the alternatives that are retained for further evaluation.

Finally, it was determined that the team should evaluate an optional measure that would provide FRM to the area south of the community of Sutter between the Sutter Bypass levee and Wadsworth Canal Levee. This was recommended to address completeness within the study area.

A matrix with the array of alternatives to be carried forward and measures associated with each of these alternatives is included in Table 8. This array will be evaluated in further detail as the team progresses toward selection of the Tentatively Selected Plan (TSP).

Table 8. Refined Alternatives to be Evaluated in Further Detail

ID	Management Measure	Primarily Nonstructural with Minimal Levee Improvement Reaches	Yuba City Ring Levee	Little "J" Levee	Fix in Place Feather River Thermalito to Star Bend	Fix in Place Feather River[1], Sutter Bypass[2], and Wadsworth Canal[3] with select setbacks for ecosystem restoration
S4	Yuba City Ring Levee		X			
S5	Fix-In-Place Feather River West Levee from Thermalito to Shanghai Bend	X SBFCA segment 4 and 5 only (Sunset Weir to Shanghai Bend)		X	X	X
S6	Southern Portion of J-Levee			X		
S7	Fix-in-Place Feather River West Levee from Shanghai Bend to Sutter Bypass; plus Wadsworth Canal East Levee; plus Sutter Bypass East Levee				X Shanghai Bend to Star Bend	X
S9	Sutter Bypass Setback Levee					O
S10	Northern Feather River Setback Levee			O	O	O
S11	Sutter Bypass and Feather River Confluence Setback Levee					O
S12	Star Bend Setback Levee	O	O	O	O	O
S13	Oroville DFG Wildlife Management Area –Degrade Land Surface and Restore Wetlands	O	O	O	O	O
S15	Southern Relief Structure	O	O	O	O	O
S23	Sunset Weir Modification	O		O		O
S26	Managed overtopping (levee superiority) on Feather River and Sutter Bypass.	O		O	O	O
S27	Improve upstream fish passage in Sutter Bypass. (Remove fish passage barriers). Dependent on					O

	S9					
S28	Sutter Bypass Sediment Removal			O	O	O
NS1	Relocate structures and critical infrastructure in floodplain.	O	O	O	O	O
NS2	Floodproof at isolated locations.	O	O	O	O	O
NS3	Elevate structures and transportation infrastructure	O	O	O	O	O
NS4	Establish flood-resistant housing	O	O	O	O	O
NS5	Secure large floatable objects	O	O	O	O	O
NS6	Flood-warning system	X	X	X	X	X
NS7	Evacuation plan	X	X	X	X	X
NS8	Construct ring levees at isolated locations	O	O	O	O	O
NS9	Floodfight pre-staging equipment and supply area	X	X	X	X	X
R1	Multi-Use Trails	O	O	O	O	O
R2	Bicycle Trails	O	O	O	O	O
R3	Equestrian Trails	O	O	O	O	O
R4	Day Use Area	O	O	O	O	O
R5	River Access	O	O	O	O	O
R6	Scenic Overlook	O	O	O	O	O
R7	Recreational parkway	O	O	O	O	O

X: Included in alternative
O: Optional to alternative

1 Feather River West Levee from Thermalito to Sutter Bypass
2 Sutter Bypass East Levee, Wadsworth Canal to Feather River
3 Wadsworth Canal East Levee, East Interceptor to Sutter Bypass

6.0 COMPARISON OF REFINED ALTERNATIVES

6.1 REFINED ARRAY OF ALTERNATIVES

Following is a summary of the refined array of alternatives that will evaluated in further detail as the team progresses toward selection of the TSP for In Progress Review (IPR) 4. The No Action Alternative is designated as Alternative SB-1.

6.1.1 Minimal Fix-in-Place plus Non-Structural SB-2

A map of this alternative including estimated residual floodplains is provided as Plate 13. This alternative consists of fixing-in-place the Feather River levees from Sunset Weir up- to and including a Star Bend set back (partial S5 and S7 measures). This alternative also includes non-structural measures of a flood warning system, evacuation plan, & flood fight pre-staging areas.

Options:

- Other non-structural measures include relocation of structures and critical infrastructure in the floodplain; flood proofing at isolated locations; elevating structures and transportation infrastructure; establishing flood-resistant housing, securing large floatable objects, constructing ring levees at isolated locations, and incorporating a southern relief structure.

- Construct a Southern Relief Structure.

- Department of Fish and Game Wildlife Management Area (DFGWMA) Re-contour Floodplain.

- Sunset Weir Modification.

6.1.2 Yuba City Ring Levee Alternative SB-3

A map of this alternative including estimated residual floodplains is provided as Plate 14. This alternative consists of a ring levee around Yuba City. The height of the Yuba City ring levee was estimated based on the 0.5% (1/200) ACE levee breach floodplain and additional height to provide 90% reliability. The eastern flank of the Yuba City ring levee would utilize the existing Feather River levee. The ring levee was assumed to require two new pump stations to address interior drainage. This alternative also includes non-structural measures of a flood warning system, evacuation plan, & flood fight pre-staging areas.

Options:

- Construct a Star Bend setback levee.

- DFGWMA Re-contour Floodplain.

- Construct a Southern Relief Structure

6.1.3 Little J Levee Alternative SB-4

A map of this alternative including estimated residual floodplains is provided as Plate 15. This alternative includes fixing-in-place in place Feather River levees from Thermalito to Shanghai Bend (partial S5 measure), and constructing a new levee to the south and west of Yuba City (Little J). The "J" levee was assumed to require two new pump stations to address interior drainage. This alternative also includes non-structural measures of a flood warning system, evacuation plan, & flood fight pre-staging areas.

Options:

- Construct a Star Bend setback.

- Northern Feather River Setback.

- DFGWMA Re-contour Floodplain.

- Sunset Weir Modification.

- Construct a Southern Relief Structure.

6.1.4 Fix-In-Place Feather River, Thermalito to Star Bend Alternative SB-5

A map of this alternative including estimated residual floodplains is provided as Plate 16. This alternative consists of fixing- in -place Feather River levees from Thermalito up-to and including a Star Bend set back (partial S5 & S7 measures). This alternative also includes non-structural measures of a flood warning system, evacuation plan, & flood fight pre-staging areas.

Options:

- Construct a Star Bend setback levee in lieu of a fix-in-place.
- Northern Feather River Setback.
- DFGWMA Re-contour Floodplain.
- Construct a Southern Relief Structure

6.1.5 Fix-In-Place Feather River, Sutter Bypass, and Wadsworth Canal Alternative SB-6

A map of this alternative including estimated residual floodplains is provided as Plate 17. This alternative consists of fixing –in- place the Feather River levees from Thermalito to the confluence with the Sutter Bypass, and fixing-in-place the east levees of the Sutter Bypass (partial S5 & S7 measures). Levees along the south side of Wadsworth Canal would also be fixed-in-place. This alternative also includes a Star Bend setback. This alternative also includes non-structural measures of a flood warning system, evacuation plan, & flood fight pre-staging areas.

Options:

- Construct a new setback levee at the Sutter Bypass and Northern Feather River confluence.
- DFGWMA Re-contour Floodplain.
- Sunset Weir Modification.
- Improve Fish Passage- dependant on a Sutter Bypass setback.
- Construct a Southern Relief Structure.

7.0 DRAFT ARRAY OF ALTERNATIVES

Further refinement and evaluation of the of the refined array of alternatives led to the addition of two additional alternatives identified as SB-7 and SB-8 that further reduced flood risk and addresses residual risk in terms of life safety. The alternative descriptions are as follows:

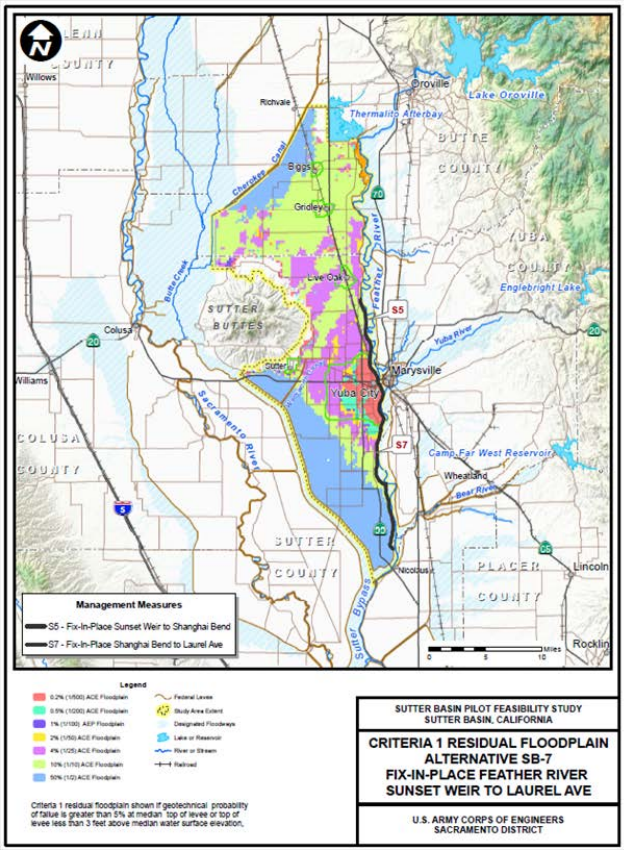


Plate 18: Alternative SB-7

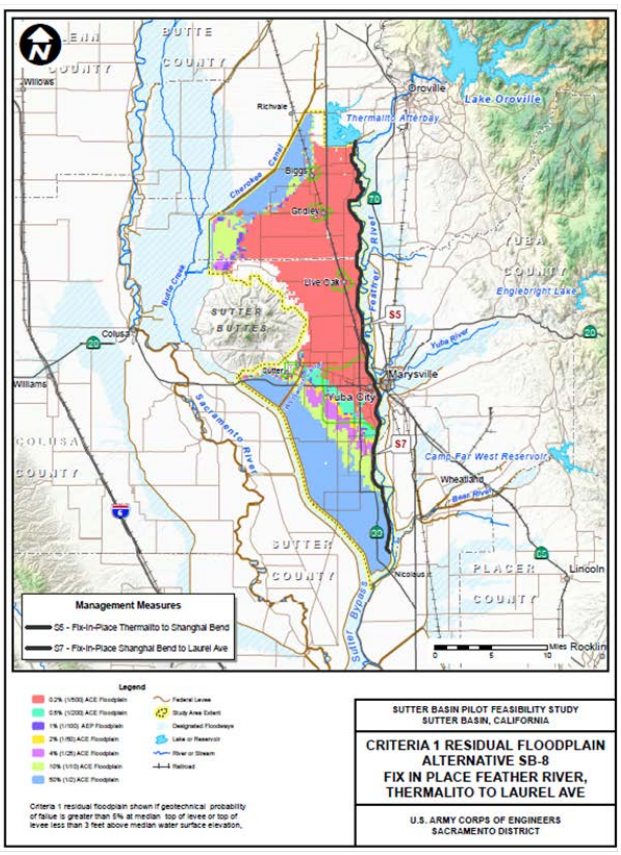


Plate 19: Alternative SB-8

Alternative SB-7: Fix-in-Place Feather River Levees, Sunset Weir to Laurel Avenue

This alternative includes SB-2 and extends Feather River fix-in-place levee improvements south of Yuba City to Laurel Ave. Reduction of flood risk includes SB-2 and additional flood risk reduction in the Yuba City southeastern areas. This alternative also includes non-structural measures of a flood warning system, evacuation plan, & flood fight pre-staging areas.

Alternative SB-8: Fix-in-Place Feather River Levees, Thermalito Afterbay to Laurel Avenue

This alternative is inclusive of SB-7 and extends Feather River levee improvements north to Thermalito. Reduction in flood risk includes all of SB-7 and provides extensive flood risk reduction in the northern areas and communities of the Sutter Basin which includes the towns of Live Oak, Gridley, and Biggs. This alternative also includes non-structural measures of a flood warning system, evacuation plan, & flood fight pre-staging areas.

These final eight alternatives were further refined and evaluated as the Draft Array of Alternatives:

Alternative SB-1: No Action Alternative
Alternative SB-2: Minimal Fix-in-place Feather River Levees, Sunset Weir to Star Bend
Alternative SB-3: Yuba City Ring Levee
Alternative SB-4: Little "J" Levee
Alternative SB-5: Fix in Place Feather River Levees, Thermalito Afterbay to Star Bend
Alternative SB-6: Fix-in-Place Feather River Levees, Sutter Bypass, and Wadsworth Canal
Alternative SB-7: Fix-in-Place Feather River Levees, Sunset Weir to Laurel Avenue
Alternative SB-8: Fix-in-Place Feather River Levees, Thermalito Afterbay to Laurel Avenue

The final array of alternative process from this draft array are described in Decision Point 2 Report Summary document and Draft Report, Chapter that leads to the Tentatively Selected Plan.

8.0 REFERENCES

A number of existing reports and references have been utilized as part of the Pilot Study effort. The following contain the most relevant information for the current Pilot Study effort:

ASTM International. January 2011. ASTM Standard E2516-11, Standard Classification for Cost Estimate Classification System, Annual Book of ASTM Standards.

Butte County. October 2010. Butte County General Plan 2030.

California Department of Finance. 2007a. Population Projections for California and Its Counties 2000-2050, by Age, Gender and Race/Ethnicity. Sutter County. Sacramento, California, July. Available: http://www.dof.ca.gov/research/demographic/reports/ projections/p-3/. Accessed: February 1, 2011.

California Department of Finance. 2007b. Population Projections for California and Its Counties 2000-2050, by Age, Gender and Race/Ethnicity. Butte County. Sacramento, California, July. Available: http://www.dof.ca.gov/research/demographic/reports/ projections/p-3/. Accessed: February 1, 2011.

California Department of Finance. 2007c. New State Projections Show 25 Million More Californians by 2050; Hispanics to be State's Majority Ethnic Group by 2042. Last revised: July 7, 2007. Available: http://www.dof.ca.gov/research/demographic/reports/ projections/p-1/documents/P1_Press_Release_7-07.pdf . Accessed: February 1, 2011.

California Department of Water Resources. 2008. Urban Levee Geotechnical Evaluations Program, Phase 1 Preliminary Geotechnical Evaluation Report.

California Department of Water Resources. 2010. Urban Levee Geotechnical Evaluations Program, Phase 1 Supplemental Geotechnical Data Report.

California Department of Water Resources. November 2010. State Plan of Flood Control Descriptive Document, Central Valley Flood Management Planning Program.

City of Biggs. January 1998. City of Biggs General Plan 1997–2015.

City of Gridley. February 2010. City of Gridley 2030 General Plan.

City of Live Oak. May 2010. City of Live Oak 2030 General Plan.

City of Yuba City. April 2004. Yuba City General Plan.

HDR, MHM, URS, & Wood Rodgers. August 2011. Pre-Design Formulation Report Sutter Butte Flood Control Agency Feather River West Levee Project Segments 1 through 7.

ICF International. July 2011. Sutter Basin Feasibility Study Environmental Without-Project Conditions Report.

ICF International. August 2011. Environmental Constraints Analysis for the Feather River West Levee Project.

Kleinfelder Inc. September 2009. Preliminary Problem Identification and Conceptual Alternatives Analysis Report, Feather River West Levee Evaluation, Thermalito Afterbay to Yuba City, Butte and Sutter Counties, California.

MWH Americas, Inc. August 2010. Sutter Basin Feasibility Study Nonstructural Flood Risk Management Alternative Report.

Schwarm, Walter. Demographic Research Unit. California Department of Finance, Sacramento, CA. November 22, 2011—Email to Ellen Unsworth, Senior Associate,
ICF International, Sacramento, CA.

Stillwater Sciences and Wood Rodgers Inc. November 2008. Feather River Levee Setback and Habitat Enhancement Project at Star Bend, Sutter County, California, Project Summary Report – Section 104 and Section 408 Applications.

Stillwater Sciences and Wood Rodgers Inc. April 2009. Feather River Levee Setback and Habitat Enhancement Project at Star Bend, Sutter County, California, Final Environmental Assessment.

Sutter County, September 2010. Draft Sutter County 2030 General Plan.

USACE. March 1984. ER 1165-2-26, Implementation of Executive Order 11988 on Flood Plain Management.

USACE. 1990. Sacramento River Flood Control Systems Evaluation, Phase II, Initial Appraisal Report, Marysville/Yuba City Area. Sacramento District, Sacramento, CA.

USACE. July 1999. Sutter Basin, CA, Expedited Reconnaissance Study for Flood Damage Reduction, Section 905(b) (WRDA 86) Analysis. Sacramento District, Sacramento, CA.

USACE. December 2002. Sacramento and San Joaquin River Basins, California, Comprehensive Study, Interim Report. Sacramento District, Sacramento, CA.

USACE. December 2010. American River Watershed Common Features Project Natomas Basin Post-Authorization Change Report and Interim General Reevaluation Report. Sacramento District, Sacramento, CA.

USACE. January 2011. Recommendations for Transforming the Current Pre-Authorization Study Process.

USACE. January 2011. Yuba River Basin, California, Alternative Formulation Briefing F4A Milestone Conference Document. Sacramento District, Sacramento, CA.

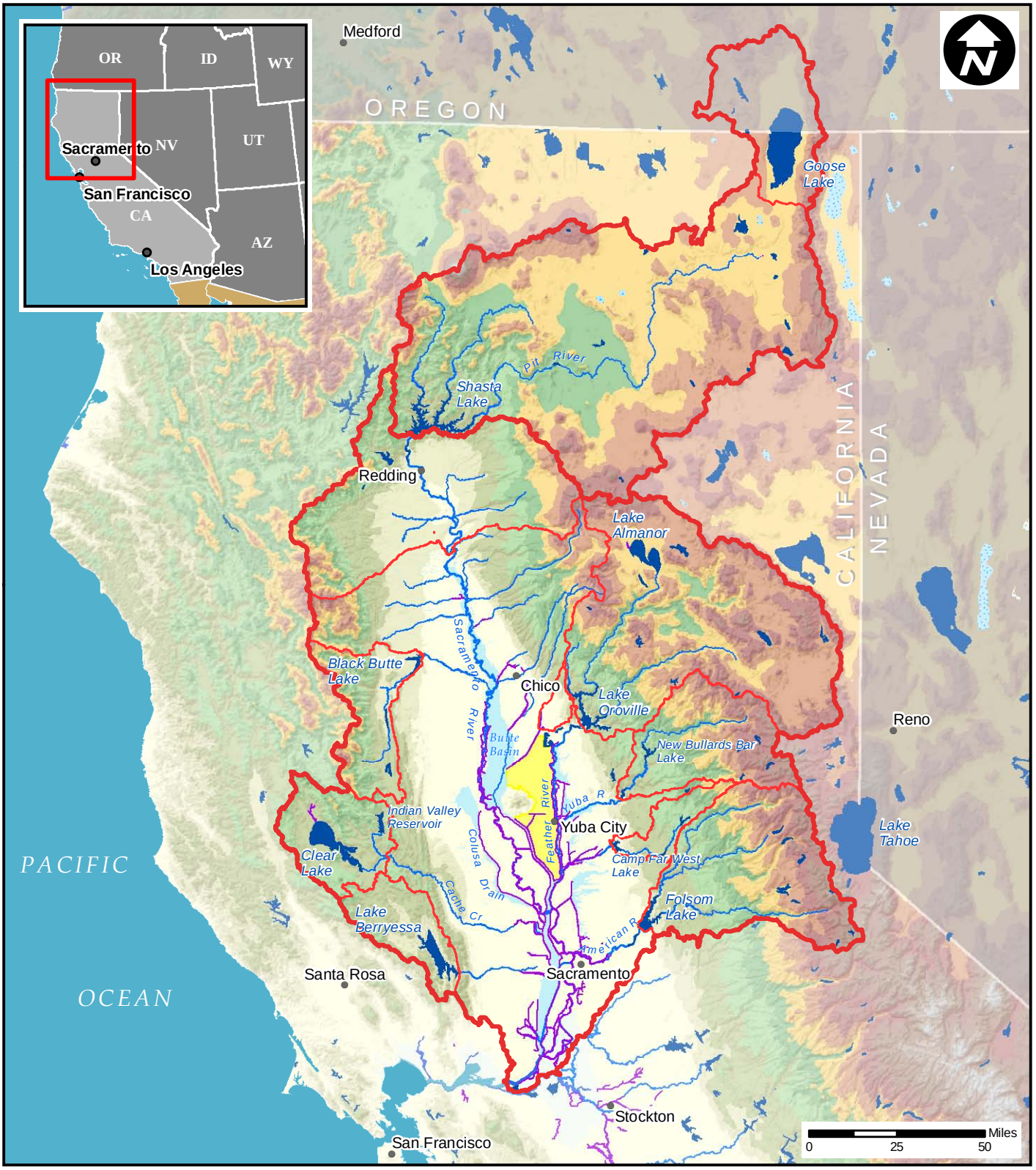
USACE. February 2011. Draft Geotechnical Engineering Report for Sutter Basin, California Feasibility Study, Updated Without-Project Conditions Report, Geotechnical Appendix. Sacramento District, Sacramento, CA.

USACE. October 2011. Environmental Site Assessment, Sutter Basin Pilot Study Preliminary Assessment of Alternatives. Sacramento District, Sacramento, CA.

USACE. February 2012. Memorandum for Major Subordinate Commands. U.S. Army Corps of Engineers Civil Works Feasibility Study Program Execution and Delivery.

Sutter Basin Pilot Feasibility Study
Progress #1 Document:
Without Project and Alternative Development

Plates



Legend

- Study Area Extent
- Sacramento Basin
- Watershed Boundaries
- Designated Floodways
- Lake or Reservoir
- River or Stream
- Federal Levees
- City

SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA

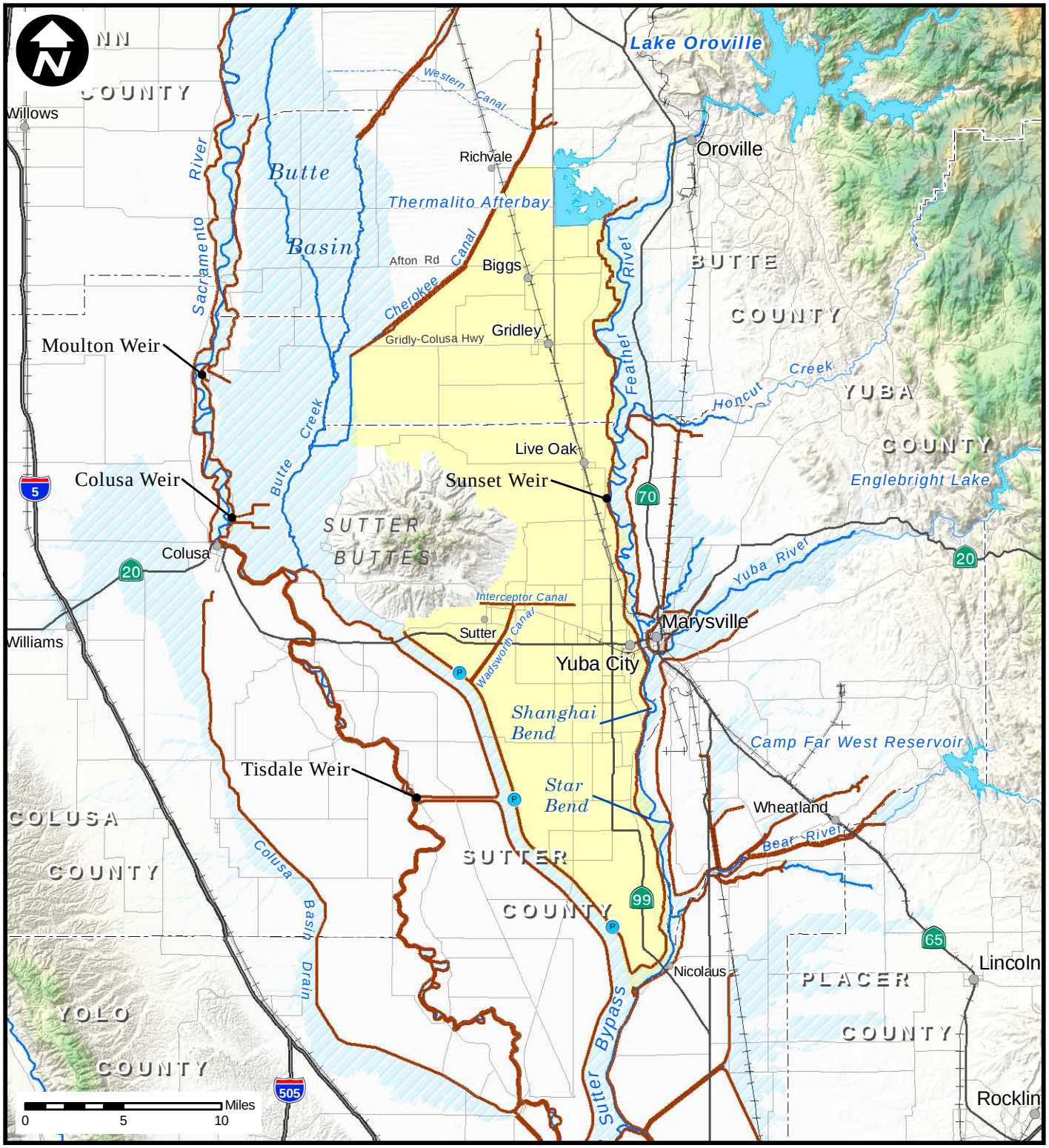
PROGRESS DOCUMENT #1
SACRAMENTO RIVER WATERSHED

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Prepared by Jim Mars

MAY 2012

PLATE 1



Legend

- Study Area Extent
- Designated Floodways
- Lake or Reservoir
- River or Stream
- Federal Levee
- Pump Station
- Highway
- Major Road
- Railroad
- County Boundary
- City or Town

SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA

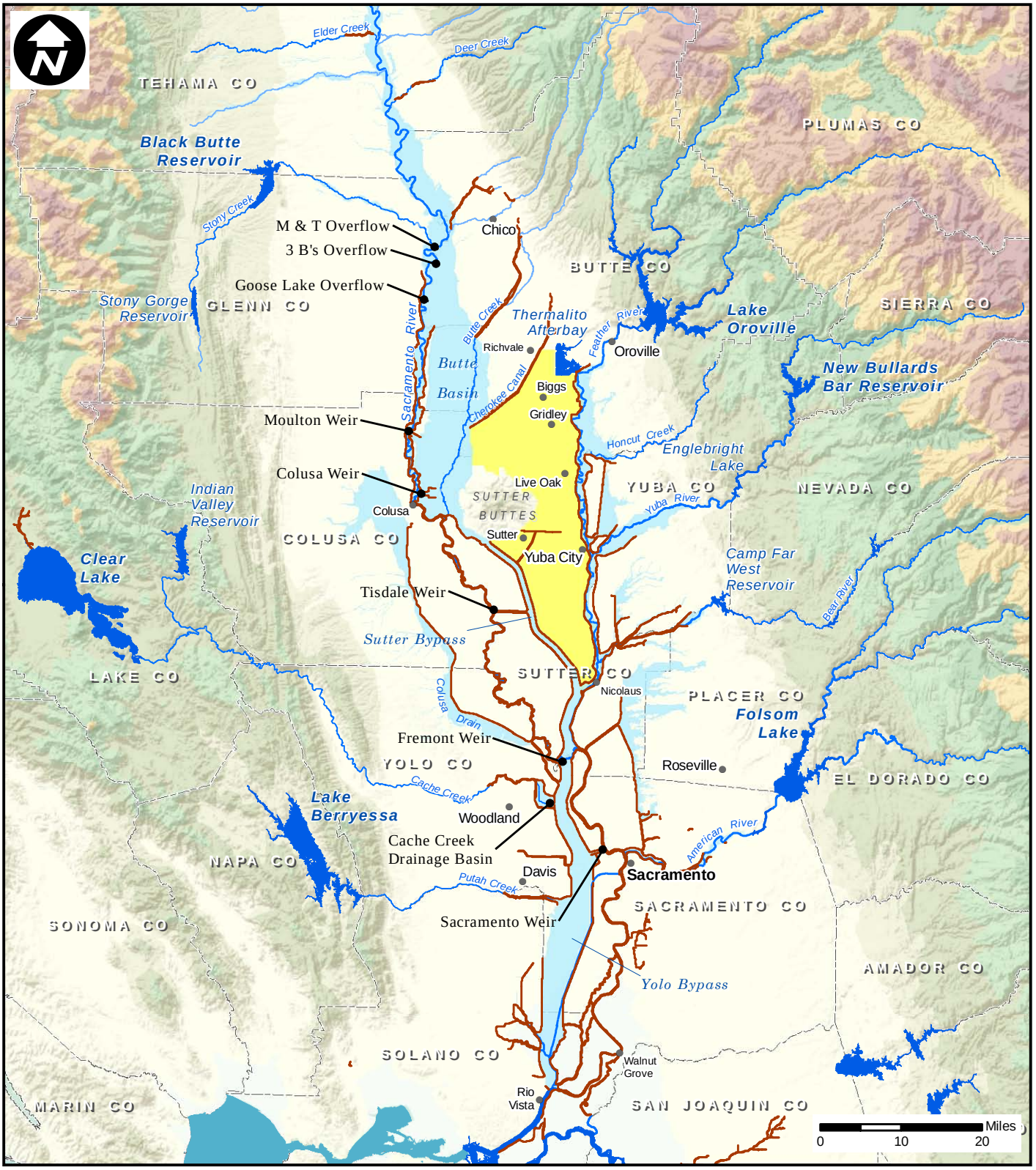
PROGRESS DOCUMENT #1
STUDY AREA

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Prepared by Jim Mars

MAY 2012

PLATE 2



Legend

- Study Area Extent
- Designated Floodways
- Lake or Reservoir
- River or Stream
- Federal Levee
- County Boundary
- City

SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA

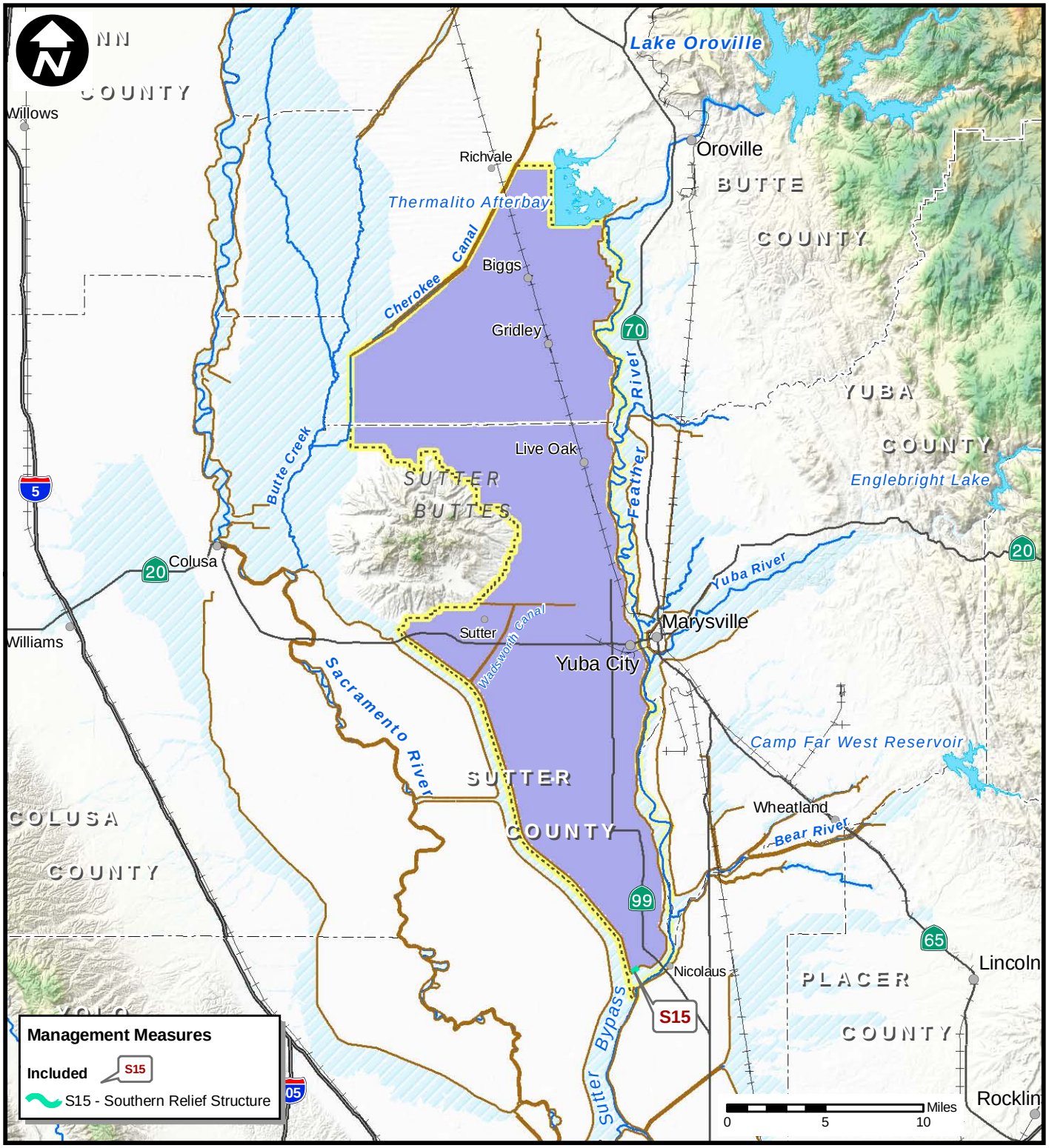
PROGRESS DOCUMENT #1
SACRAMENTO RIVER
FLOOD CONTROL PROJECT

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Prepared by Jim Mars

MAY 2012

PLATE 3



Legend

- 1/100 AEP Floodplain
- 1/200 AEP Floodplain
- 1/500 AEP Floodplain
- Federal Levee
- Study Area Extent
- Designated Floodways

SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA

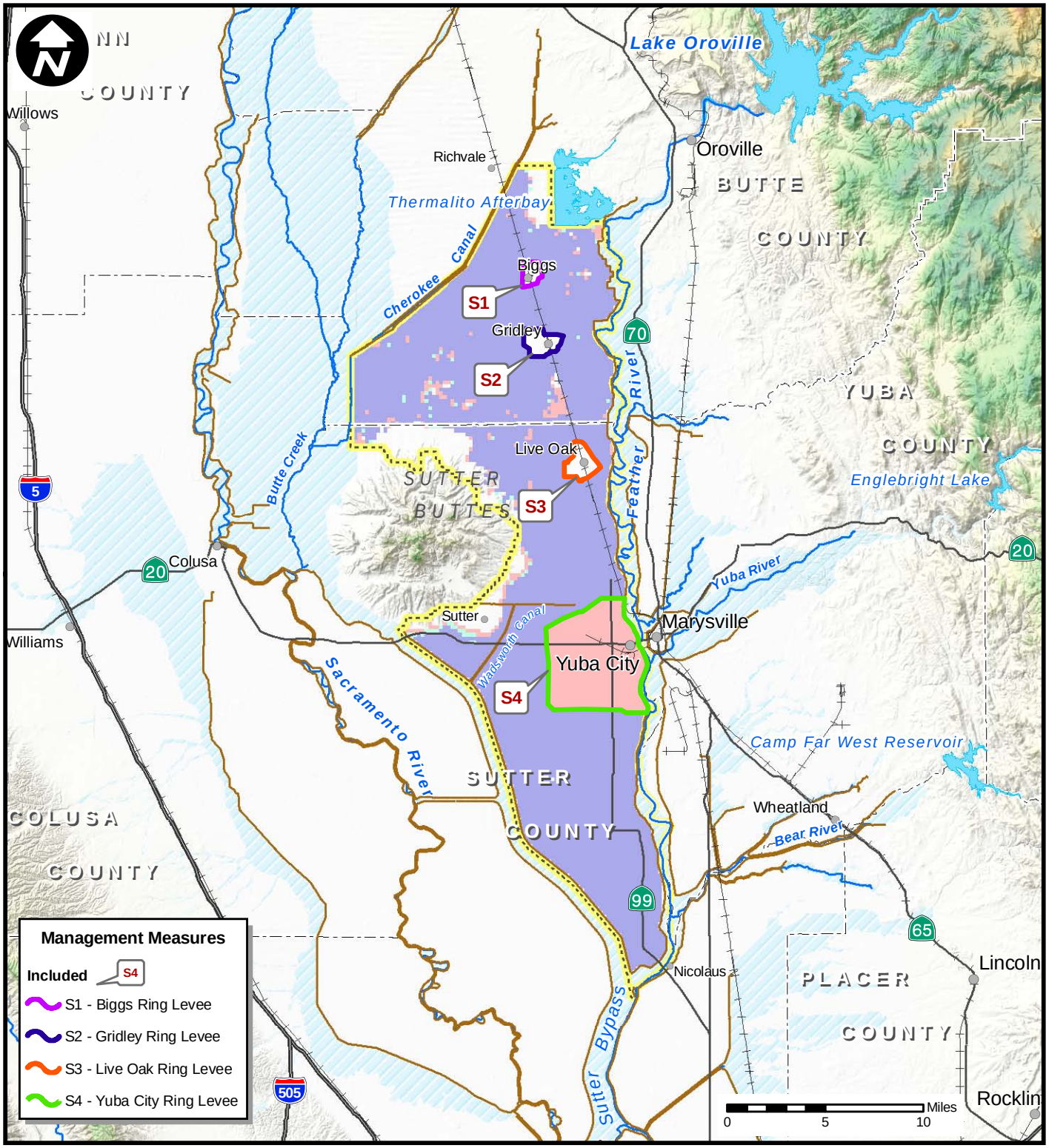
PROGRESS DOCUMENT #1
CONCEPTUAL ALTERNATIVE 1.1

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Prepared by Jim Mars

MAY 2012

PLATE 4



Legend

- 1/100 AEP Floodplain
- 1/200 AEP Floodplain
- 1/500 AEP Floodplain
- Federal Levee
- Study Area Extent
- Designated Floodways

NOTE: *Floodplains are based on conceptual analysis*

SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA

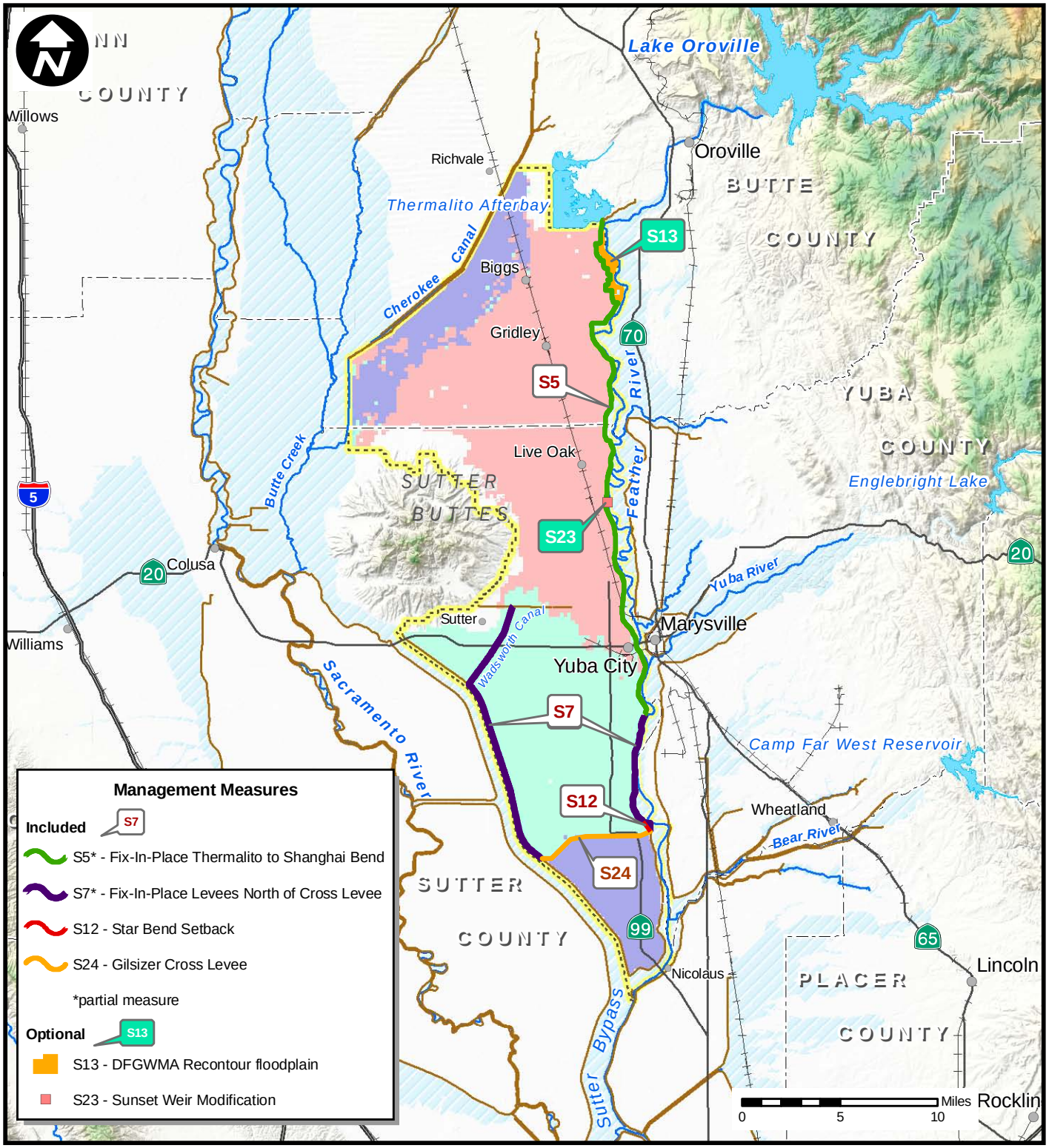
PROGRESS DOCUMENT #1
CONCEPTUAL ALTERNATIVE 2.1

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Prepared by Jim Mars

MAY 2012

PLATE 5



Legend

- 1/100 AEP Floodplain
- 1/200 AEP Floodplain
- 1/500 AEP Floodplain
- Federal Levee
- Study Area Extent
- Designated Floodways

NOTE: *Floodplains are based on conceptual analysis*

SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA

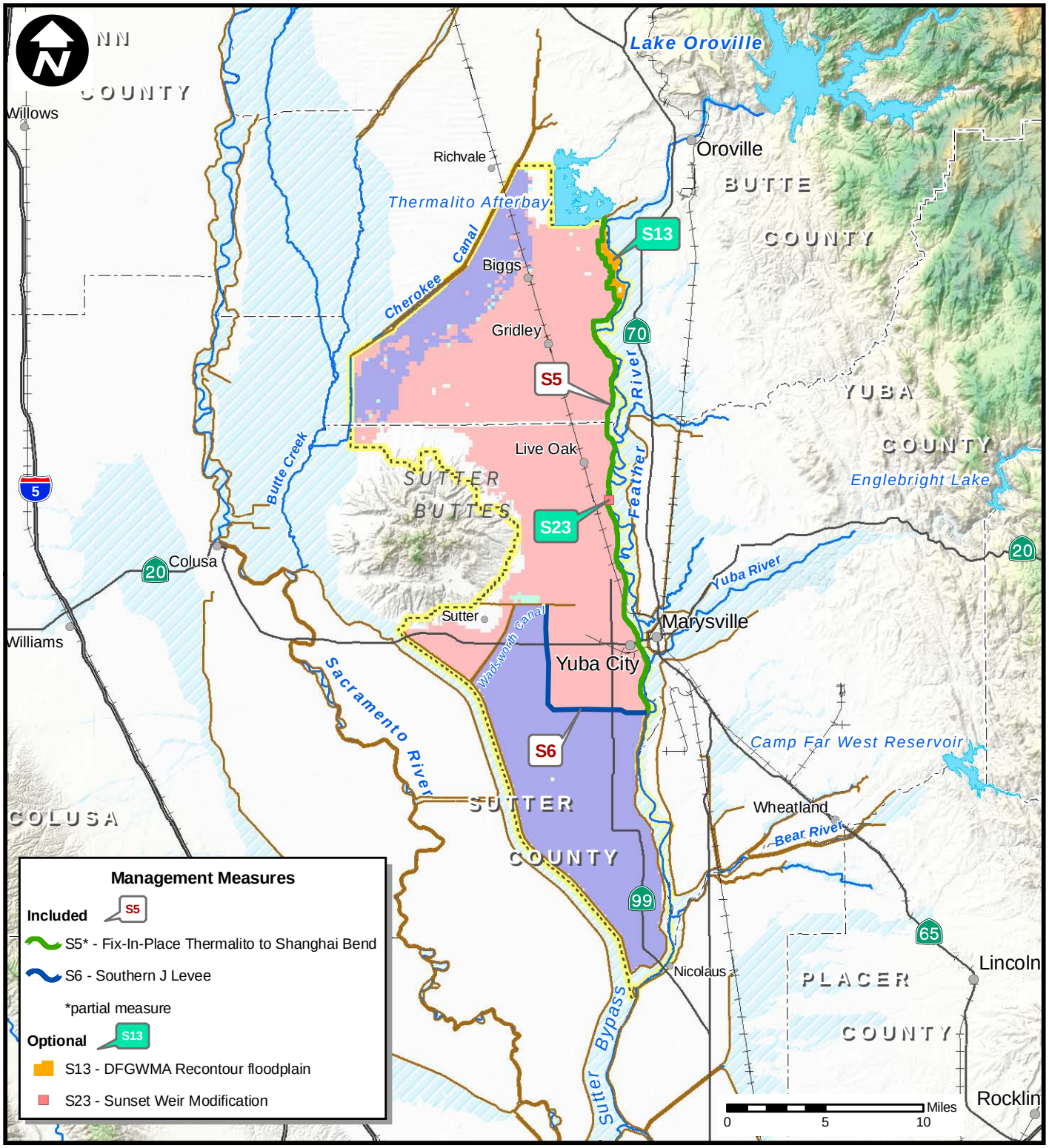
PROGRESS DOCUMENT #1
CONCEPTUAL ALTERNATIVE 2.2

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Prepared by Jim Mars

MAY 2012

PLATE 6



Legend

- 1/100 AEP Floodplain
- 1/200 AEP Floodplain
- 1/500 AEP Floodplain
- Federal Levee
- Study Area Extent
- Designated Floodways

NOTE: *Floodplains are based on conceptual analysis*

SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA

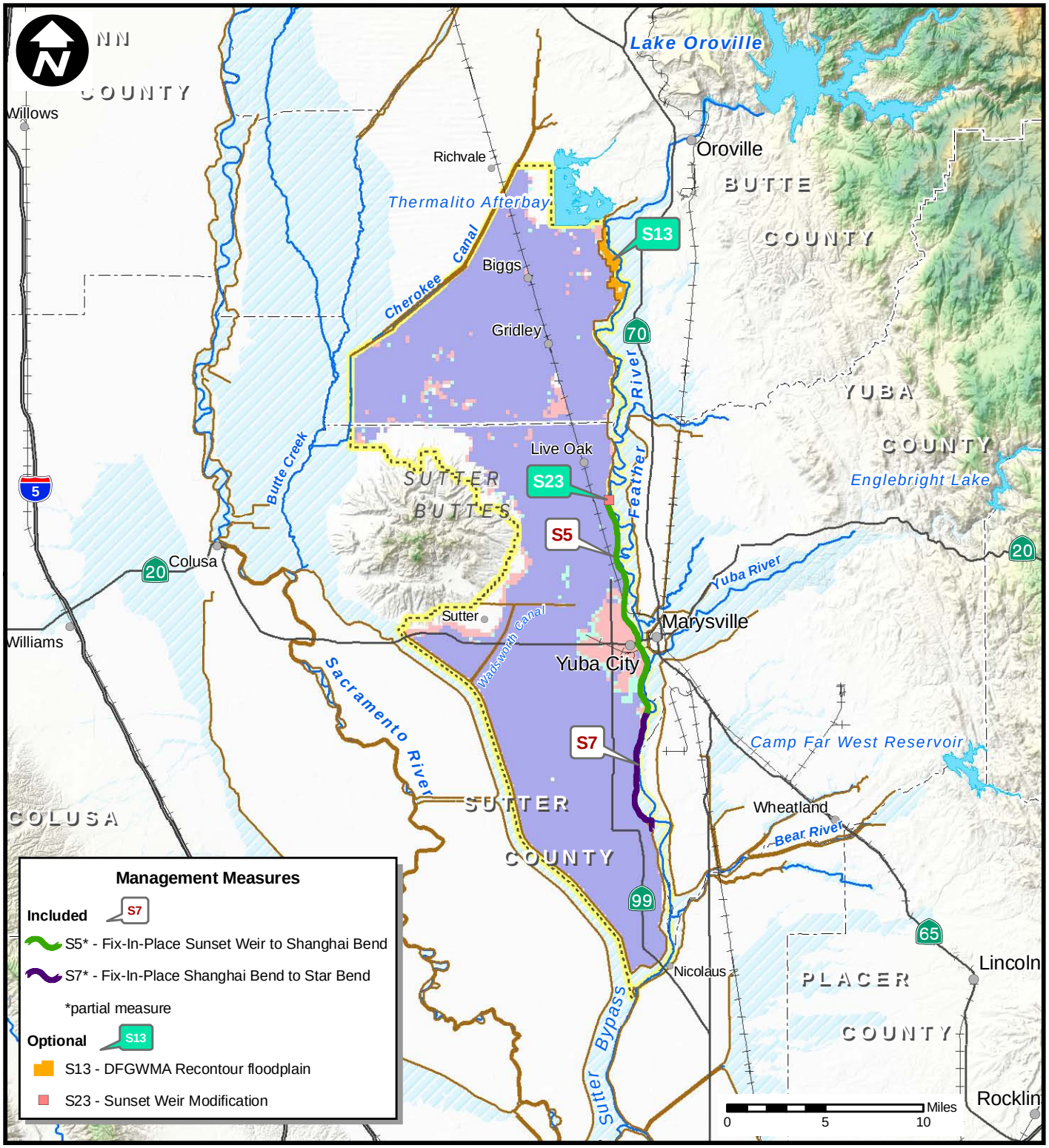
PROGRESS DOCUMENT #1
CONCEPTUAL ALTERNATIVE 2.3

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Prepared by Jim Mars

MAY 2012

PLATE 7



Legend

- 1/100 AEP Floodplain
- 1/200 AEP Floodplain
- 1/500 AEP Floodplain
- Federal Levee
- Study Area Extent
- Designated Floodways

NOTE: *Floodplains are based on conceptual analysis*

SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA

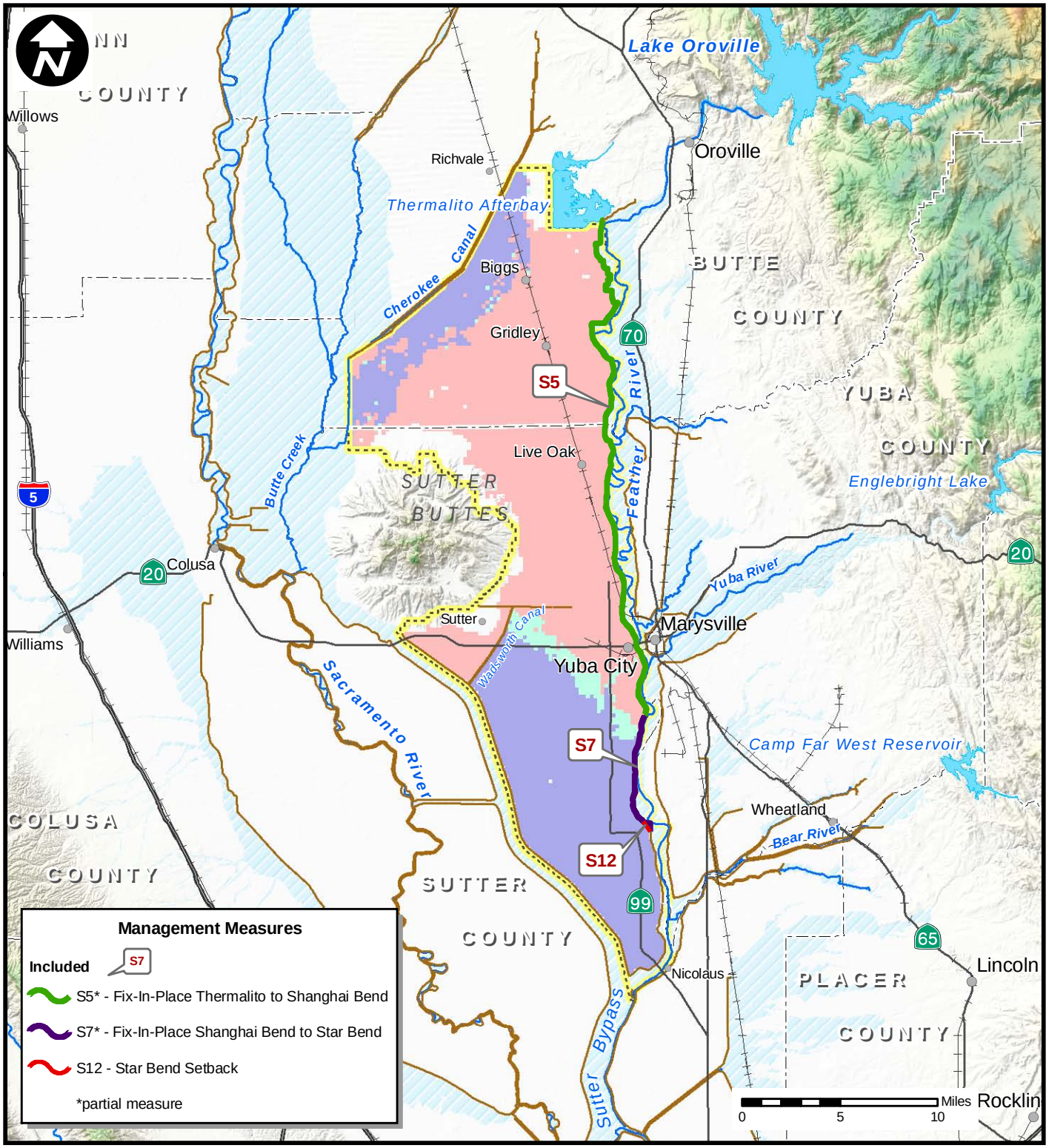
PROGRESS DOCUMENT #1
CONCEPTUAL ALTERNATIVE 2.4

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Prepared by Jim Mars

MAY 2012

PLATE 8



Legend

- 1/100 AEP Floodplain
- 1/200 AEP Floodplain
- 1/500 AEP Floodplain
- Federal Levee
- Study Area Extent
- Designated Floodways

NOTE: *Floodplains are based on conceptual analysis*

SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA

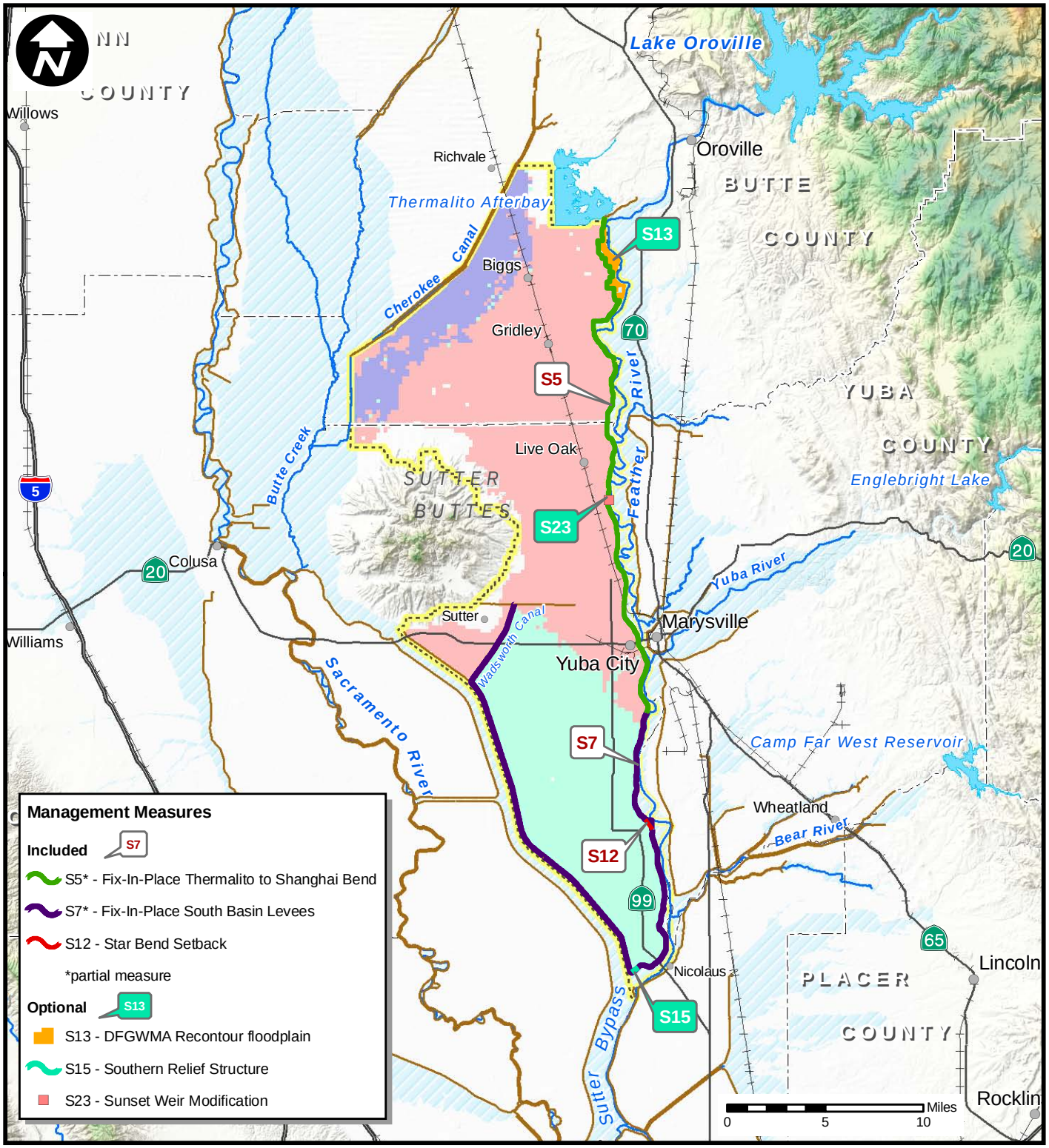
PROGRESS DOCUMENT #1
CONCEPTUAL ALTERNATIVE 2.5

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Prepared by Jim Mars

MAY 2012

PLATE 9



Legend

- 1/100 AEP Floodplain
- 1/200 AEP Floodplain
- 1/500 AEP Floodplain
- Federal Levee
- Study Area Extent
- Designated Floodways

NOTE: *Floodplains are based on conceptual analysis*

SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA

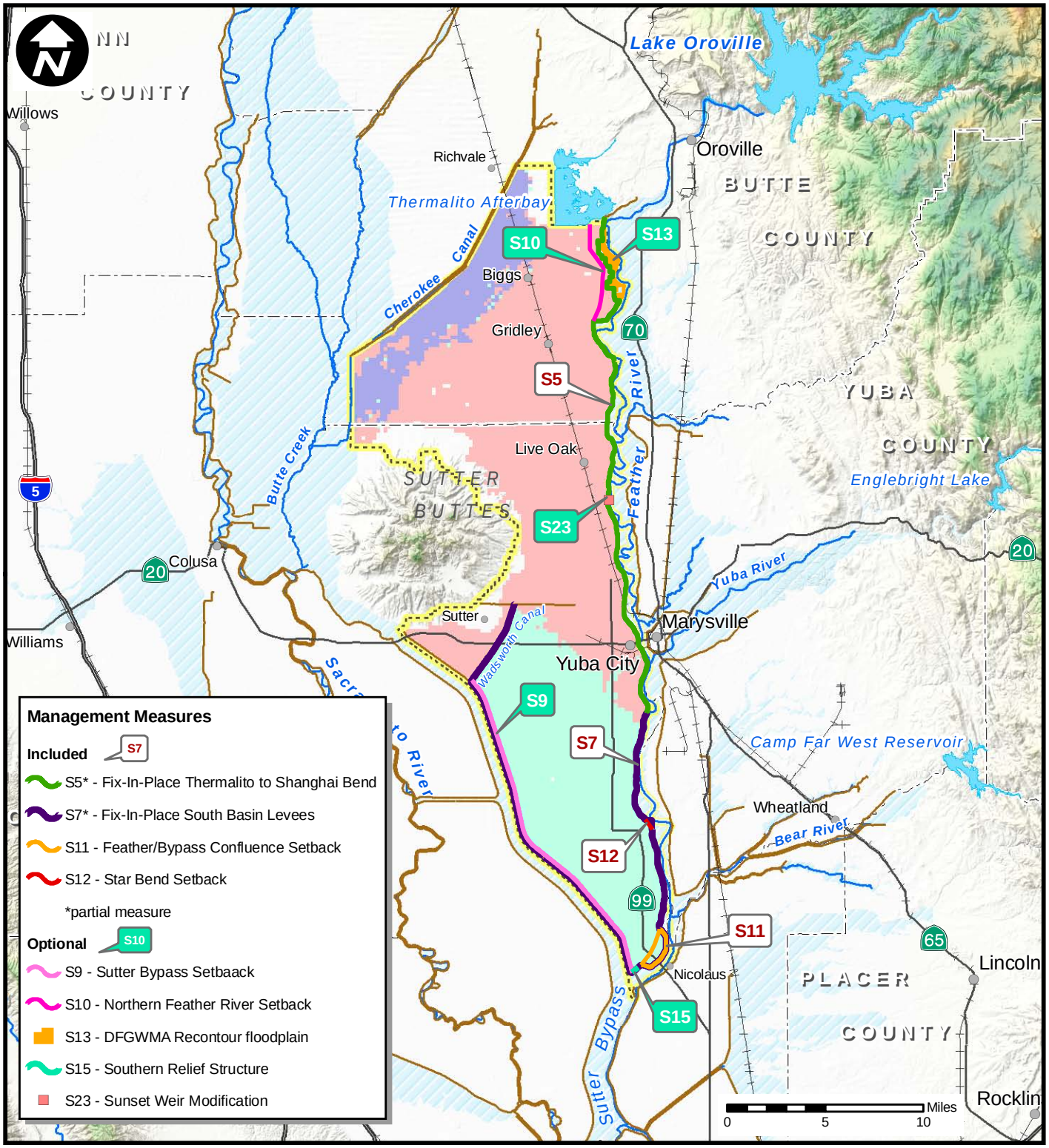
PROGRESS DOCUMENT #1
CONCEPTUAL ALTERNATIVE 3.1

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Prepared by Jim Mars

MAY 2012

PLATE 10



Legend

- 1/100 AEP Floodplain
- 1/200 AEP Floodplain
- 1/500 AEP Floodplain
- Federal Levee
- Study Area Extent
- Designated Floodways

NOTE: *Floodplains are based on conceptual analysis*

SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA

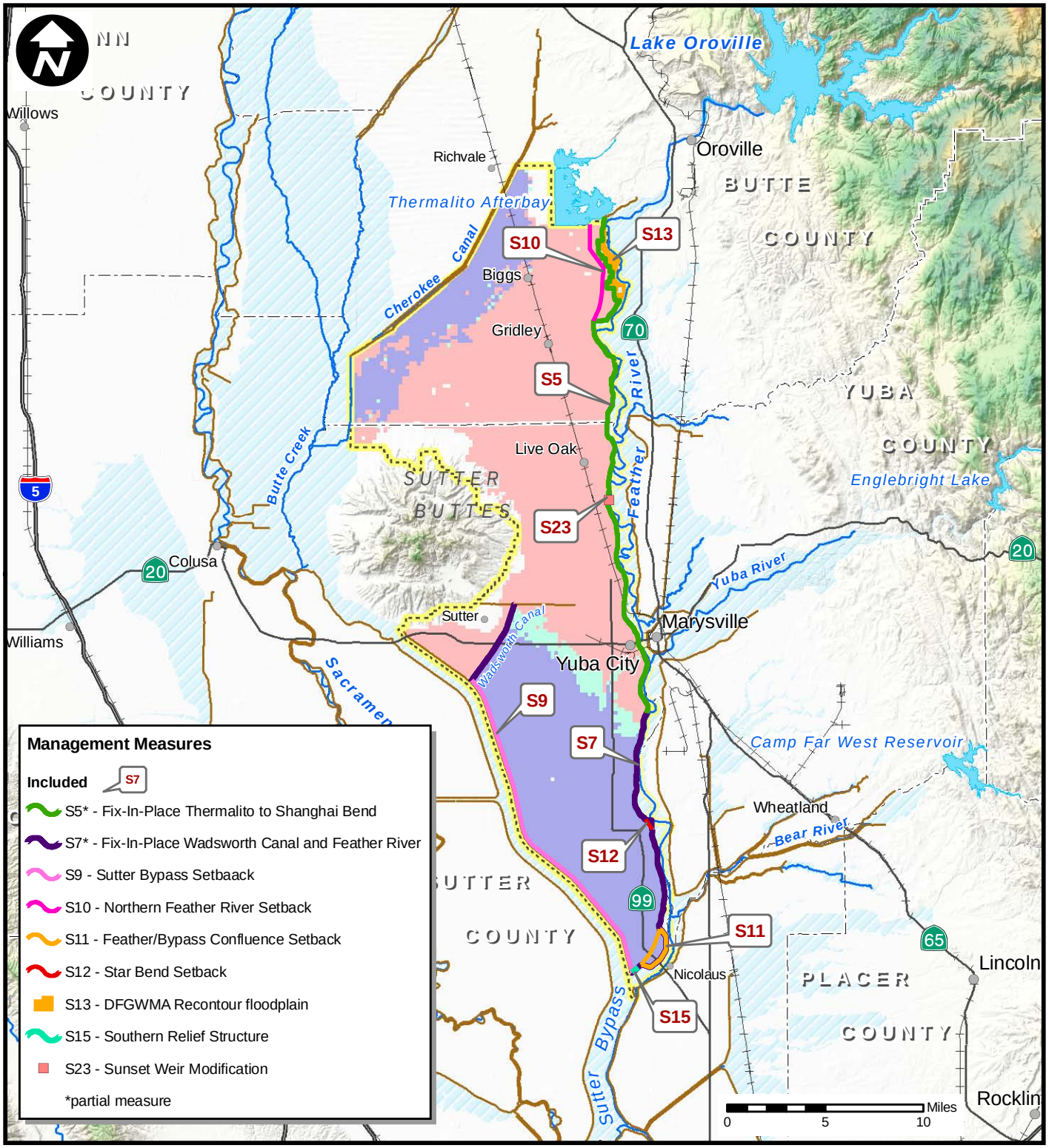
PROGRESS DOCUMENT #1
CONCEPTUAL ALTERNATIVE 3.2

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Prepared by Jim Mars

MAY 2012

PLATE 11



Legend

- 1/100 AEP Floodplain
- 1/200 AEP Floodplain
- 1/500 AEP Floodplain
- Federal Levee
- Study Area Extent
- Designated Floodways

NOTE: *Floodplains are based on conceptual analysis*

SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA

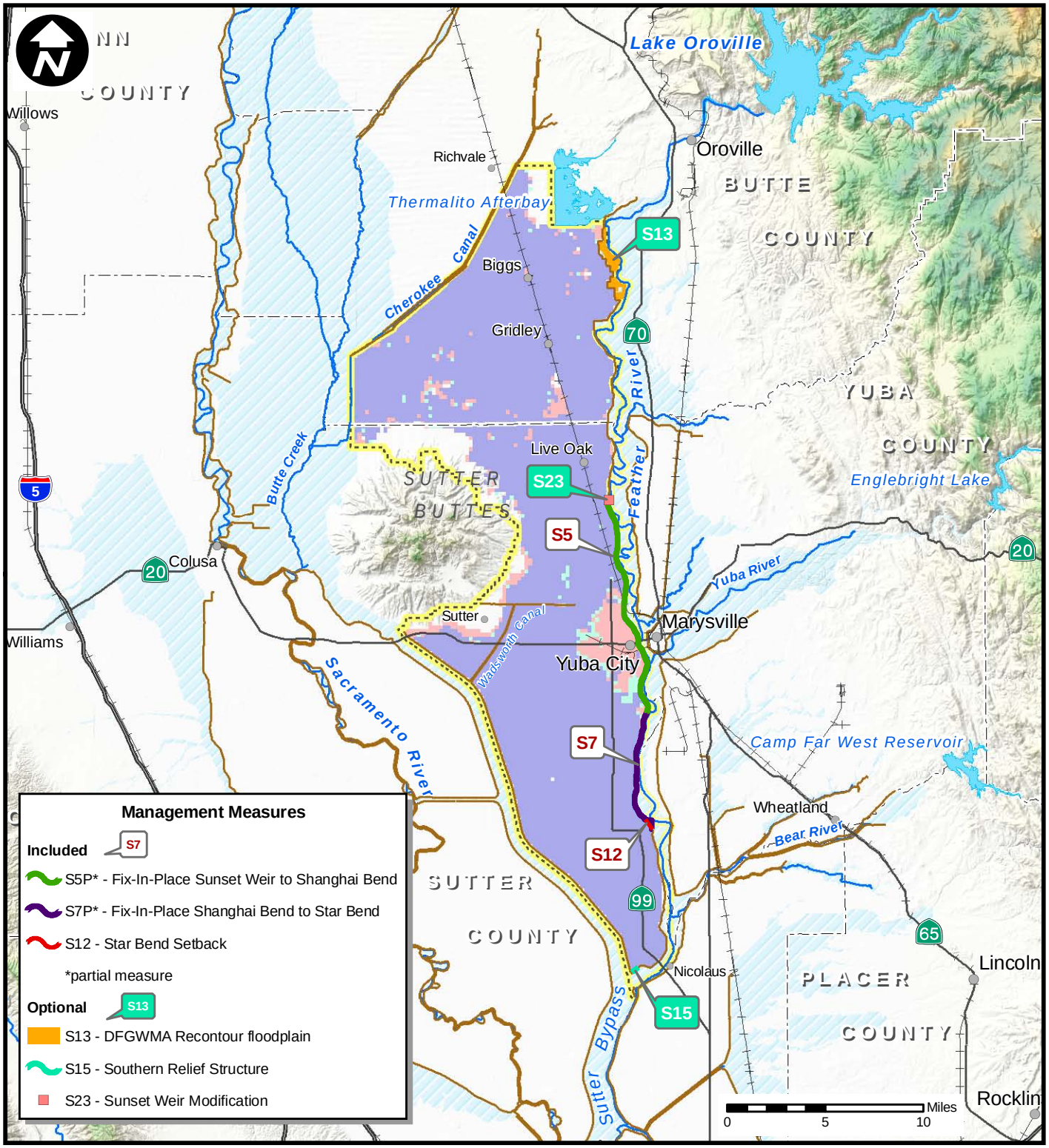
PROGRESS DOCUMENT #1
CONCEPTUAL ALTERNATIVE 4.1

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Prepared by Jim Mars

MAY 2012

PLATE 12



Legend

- 1/100 AEP Floodplain
- 1/200 AEP Floodplain
- 1/500 AEP Floodplain
- Federal Levee
- Study Area Extent
- Designated Floodways

NOTE: *Floodplains are based on conceptual analysis*

SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA

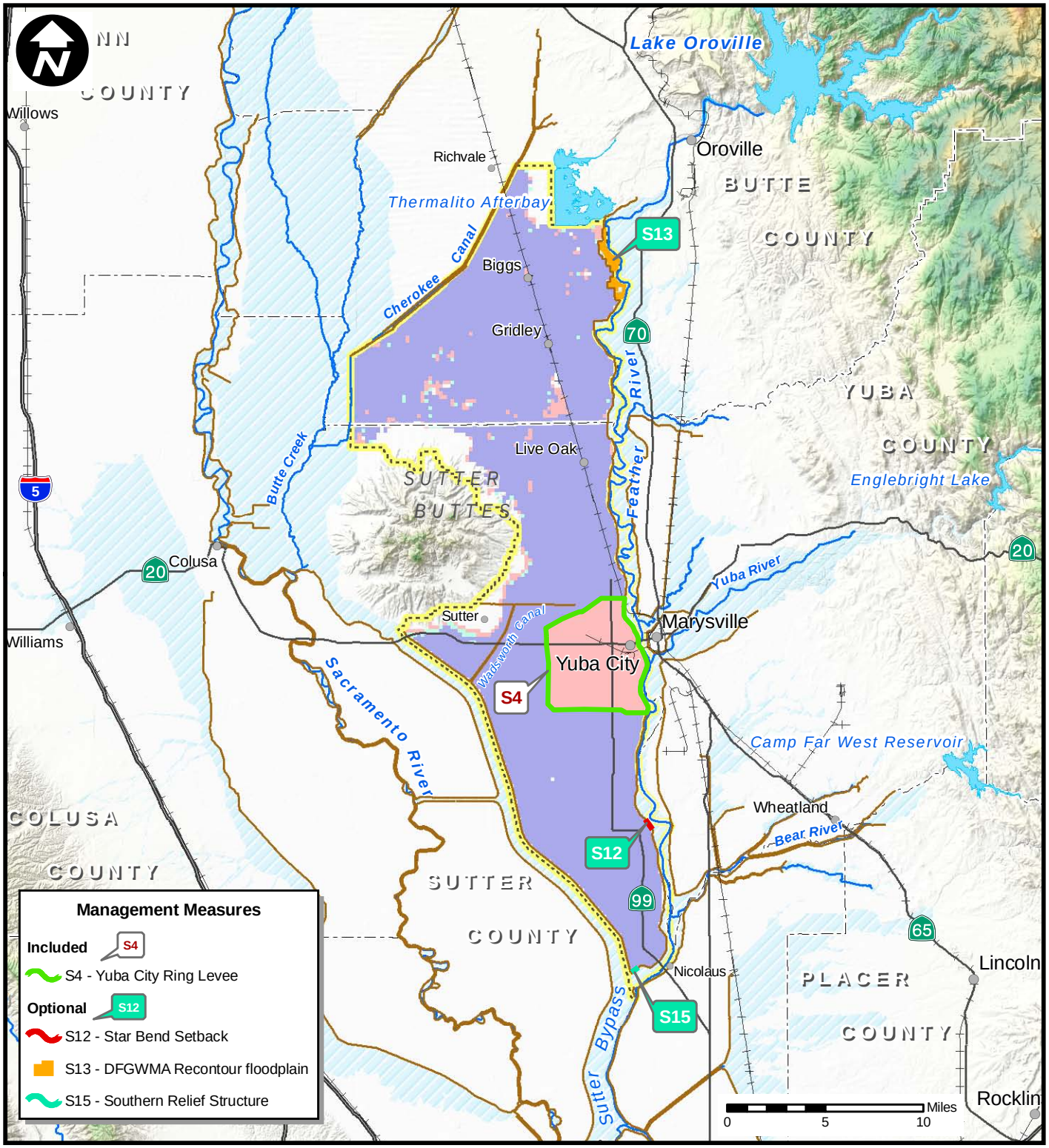
PROGRESS DOCUMENT #1
ALTERNATIVE SB-2
MINIMAL FIX-IN-PLACE
PLUS NONSTRUCTURAL

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Prepared by Jim Mars

MAY 2012

PLATE 13



Legend

- 1/100 AEP Floodplain
- 1/200 AEP Floodplain
- 1/500 AEP Floodplain
- Federal Levee
- Study Area Extent
- Designated Floodways

NOTE: *Floodplains are based on conceptual analysis*

SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA

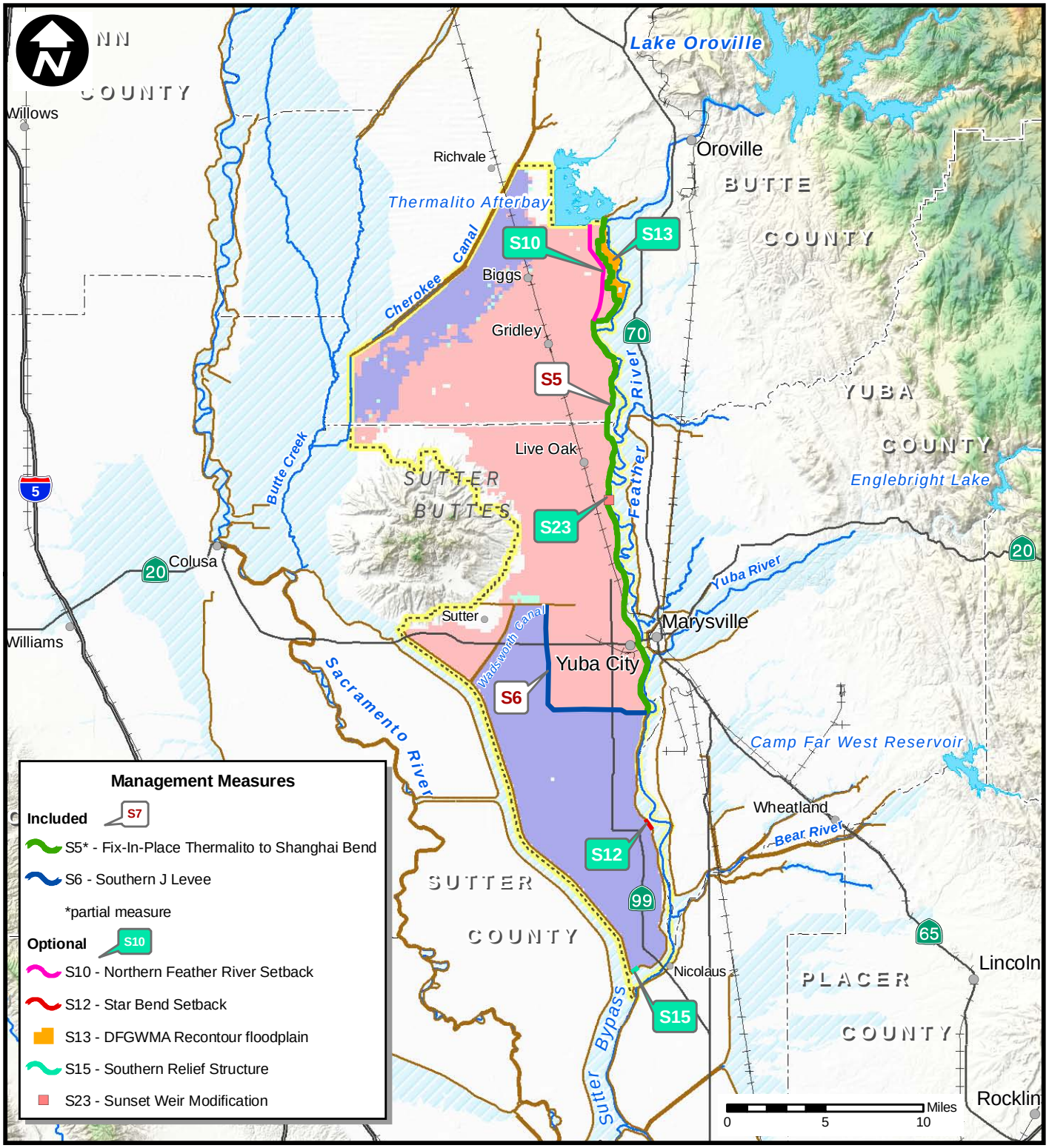
PROGRESS DOCUMENT #1
ALTERNATIVE SB-3
YUBA CITY RING LEVEE

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Prepared by Jim Mars

MAY 2012

PLATE 14



Legend

- 1/100 AEP Floodplain
- 1/200 AEP Floodplain
- 1/500 AEP Floodplain
- Federal Levee
- Study Area Extent
- Designated Floodways

NOTE: *Floodplains are based on conceptual analysis*

SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA

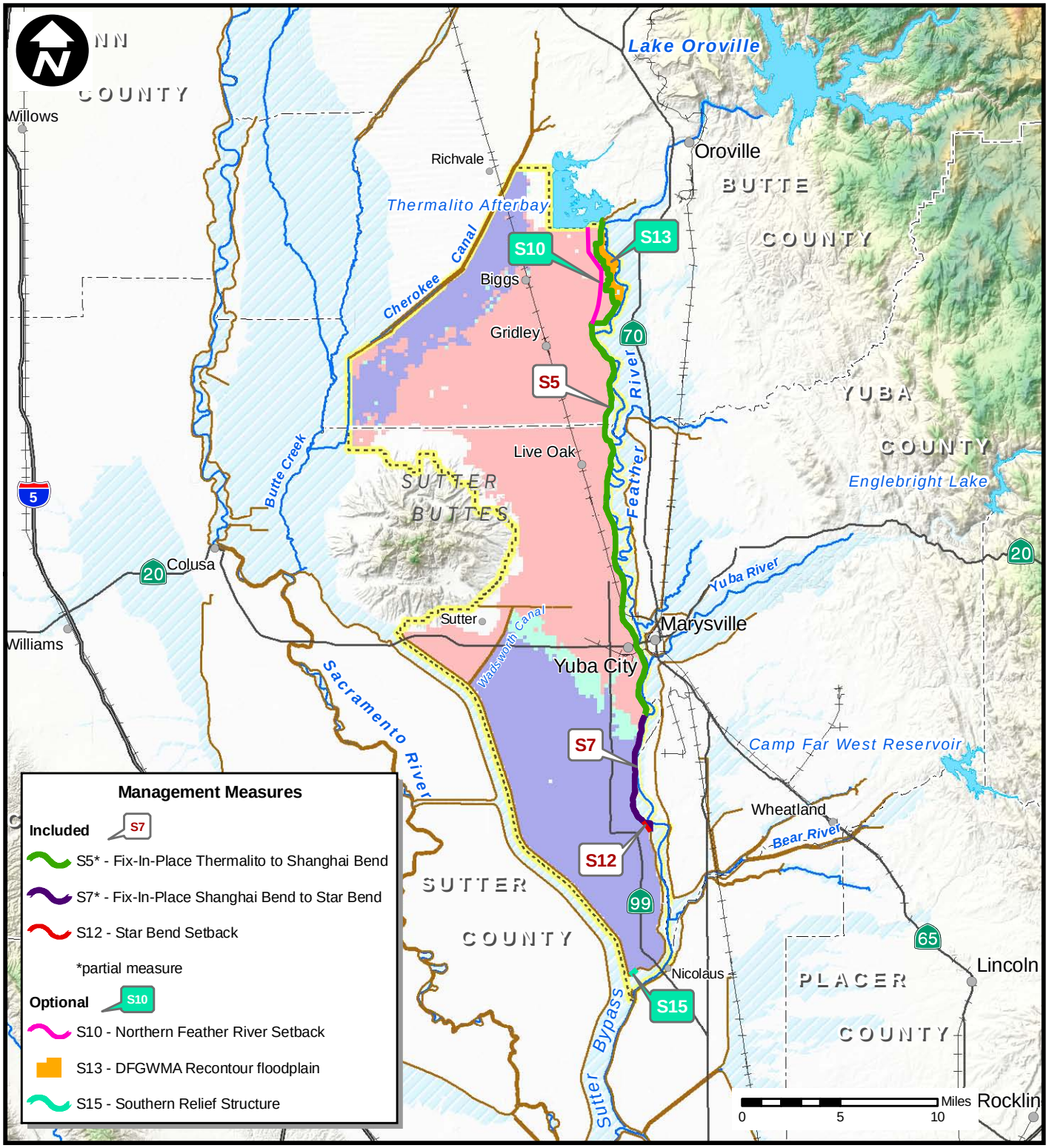
PROGRESS DOCUMENT #1
ALTERNATIVE SB-4
LITTLE "J" LEVEE

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Prepared by Jim Mars

MAY 2012

PLATE 15



Legend

- 1/100 AEP Floodplain
- 1/200 AEP Floodplain
- 1/500 AEP Floodplain
- Federal Levee
- Study Area Extent
- Designated Floodways

NOTE: *Floodplains are based on conceptual models*

SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA

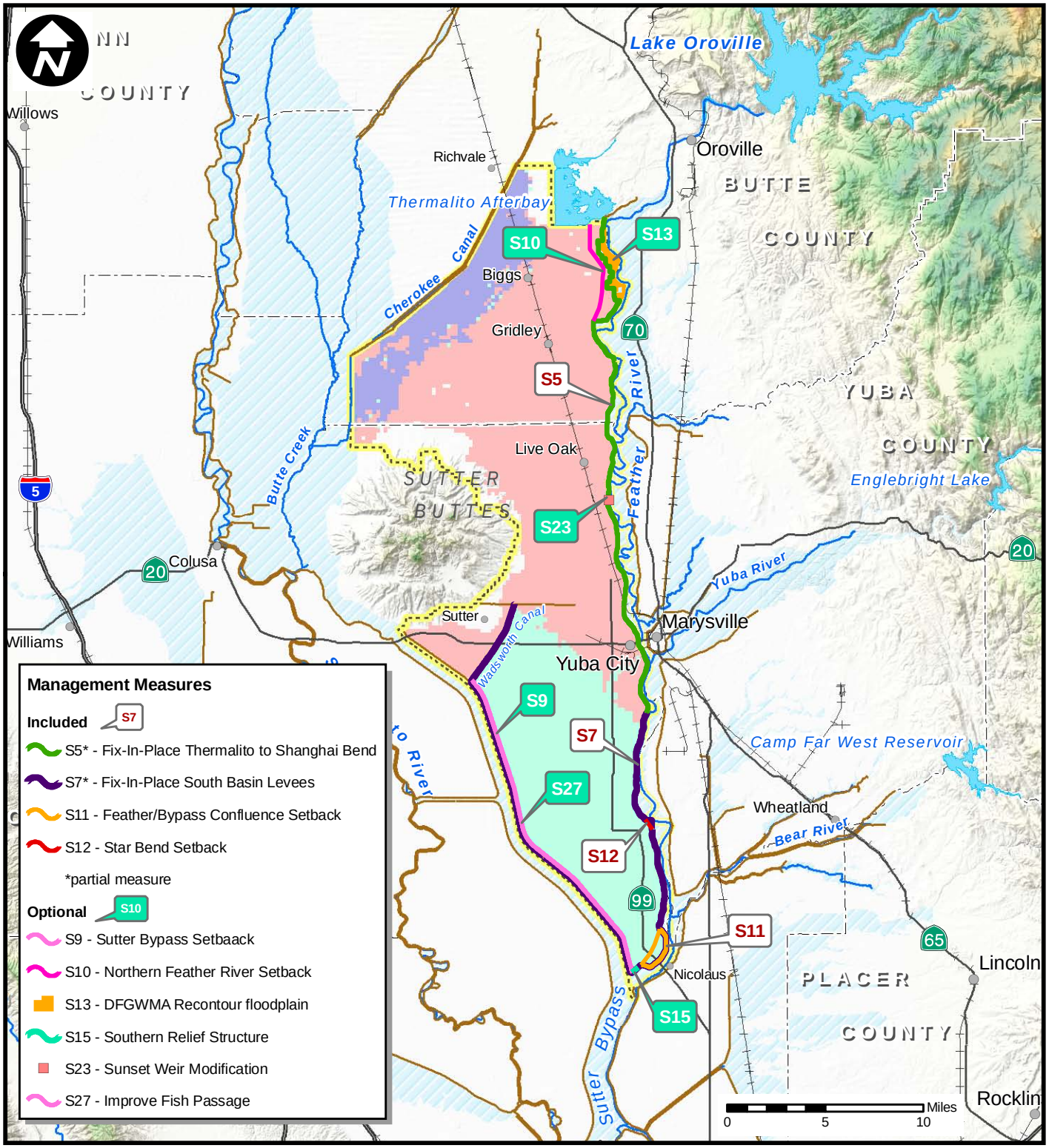
PROGRESS DOCUMENT #1
ALTERNATIVE SB-5
FIX IN PLACE FEATHER RIVER, THERMALITO TO STAR BEND

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Prepared by Jim Mars

MAY 2012

PLATE 16



Legend

- 1/100 AEP Floodplain
- 1/200 AEP Floodplain
- 1/500 AEP Floodplain
- Federal Levee
- Study Area Extent
- Designated Floodways

NOTE: *Floodplains are based on conceptual analysis*

SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA

PROGRESS DOCUMENT #1
ALTERNATIVE SB-6
FIX IN PLACE FEATHER RIVER, SUTTER BYPASS, AND WADSWORTH

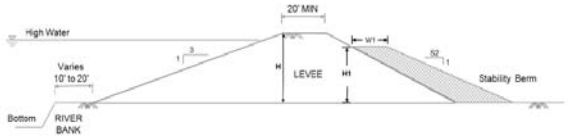
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Prepared by Jim Mars

MAY 2012

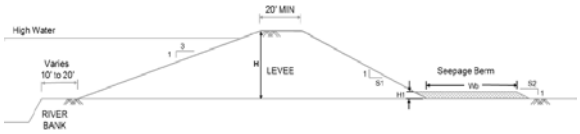
PLATE 17

Stability Berm Element

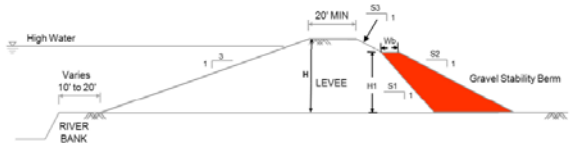


Stability Berm with Relief Wells Element

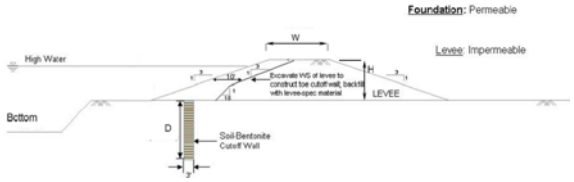
Seepage Berm Element



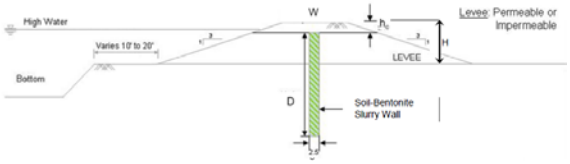
Gravel Stability Berm Element



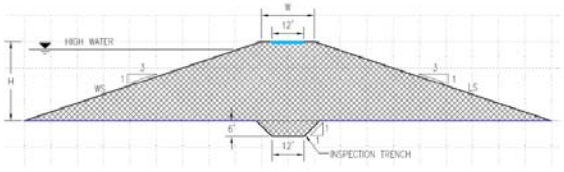
Waterside Soil-Bentonite Slurry Cutoff Wall Element



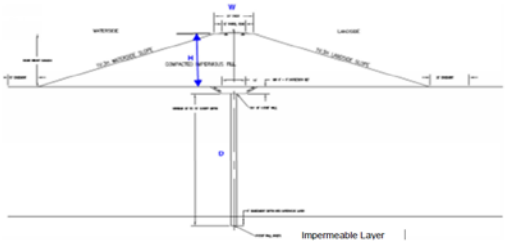
Centerline Soil-Bentonite Slurry Cutoff Wall Element



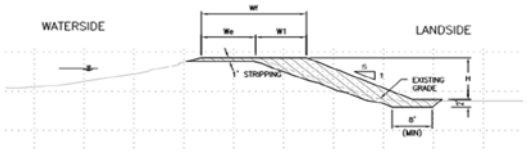
New Levee Element



New Levee with Centerline Soil-Bentonite Cutoff Wall Element



Levee Crest Widening Element



Source:

SUTTER BASIN PILOT FEASBILITY STUDY
SUTTER BASIN, CALIFORNIA

PROGRESS DOCUMENT #1

LEVEE DESIGN TEMPLATES

U.S ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Value Engineering Study/ Planning Charette Report

Sutter Basin Pilot Study

January 2012

Prepared by

Value Management Strategies, Inc.

VMS
Value Management Strategies, Inc.

"Value Leadership"

CORPORATE OFFICE:
613 W Valley Parkway
Suite 240
Escondido, CA 92025-2504
T: 760 741 5518
F: 760 741 5617

1724 SW Clay Street
Portland, OR 97201-2529
T: 503 957 9642
F: 760 741 5617

1874 Deer Park Circle S
Grand Junction, CO 81507-9578
T: 970 242 5531
F: 760 741 5617

3909 208th Pl SE
Bothell, WA 98021-6948
T: 206 679 8029
F: 760 741 5617

9022 West 65th Drive
Merriam, KS 66202-3602
T: 816 206 0067
F: 760 741 5617

2020 X Street, Unit A
Sacramento, CA 95818-2461
T: 916 224 9812
F: 760 741 5617

8532 Woodbriar Drive
Sarasota, FL 34238-5666
T: 941 323 5438
F: 760 741 5617

2670 Ravenoaks Place NE
Marietta, GA 30062-5630
T: 678 488 4287
F: 760 741 5617

1474 Sweet Saddle Court
Carmel, IN 46032
T: 586 322 6690
F: 760 741 5617

321 Riverview Drive W
Great Falls, MT 59404-1335
T: 406 952 4473
F: 760 741 5617

Date: January 25, 2012

Mary Diel
U.S. Army Corps of Engineers – Sacramento District
CESPK-ED-SC
1325 J Street
Sacramento, CA 95814-2922

Subject: Value Engineering Study/Planning Charette Report
Sutter Basin Pilot Study

Dear Mary:

Value Management Strategies, Inc. is pleased to transmit an electronic copy of the Final Value Engineering Study / Planning Charette Report.

This report summarizes the results and events of the workshop conducted October 31 – November 4, 2011 at the U.S. Army Corps of Engineers, Sacramento District offices.

We enjoyed working with you and are looking forward to continuing efforts to assist you and the Sacramento District in its value engineering efforts.

Sincerely,

VALUE MANAGEMENT STRATEGIES, INC.
Mark Watson, PE, CVS, PMP
VE Study Team Leader

VALUE MANAGEMENT STRATEGIES, INC.
Ronald J. Tanenbaum, PhD, PE, CVS
VE Study Team Leader

CC: Laura Whitney, Project Manager, USACE – Sacramento District

TABLE OF CONTENTS

FINAL

EXECUTIVE SUMMARY 1

Project Summary
Workshop Timing
VE Study/Planning Charette Objectives
Baseline Conceptual Alternatives and Measures
Workshop Results
Evaluation of Baseline Conceptual Alternatives
- Performance Attributes
- Comparison of Value – Baseline Concepts

VE Concepts Summary
Final Alternative Array
Conclusion

PROJECT INFORMATION 7

Background
Project Description
Baseline Conceptual Alternatives
Baseline Conceptual Alternative Sketches
Baseline Conceptual Alternatives and Measures
Function Analysis
- Random Function Determination
- FAST Diagram

VALUE ANALYSIS OF BASELINE CONCEPTS 19

Summary of Analysis
Value Metrics
- Define Performance Requirements
- Define Performance Attributes
- Prioritize Performance Attributes
- Performance Attributes Prioritization Rationale
- Measure Performance of Baseline Concepts
- Comparison of Performance
- Compare Value
- Value Matrix
- Comparison of Value – Baseline Conceptual Alternatives

VALUE ENGINEERING 41

Creative Idea Speculation
VE Concepts
VE Concepts Summary
VE Concepts Development
Refinement of Measures
Modifications to Preliminary Conceptual Alternatives
Revised Conceptual Alternative Array
Idea Evaluation
Evaluation Process
Idea Summary List

VALUE ANALYSIS OF FINAL ALTERNATIVES ARRAY 58

Final Alternative Array Summary
Value Metrics
- Measure Performance of Final Alternatives
- Compare Performance – Final Alternatives
- Compare Value
- Value Matrix
- Comparison of Value – Final Conceptual Alternatives

VALUE ENGINEERING/PLANNING CHARETTE PROCESS 70

Pre-Study Preparation
VE Study/Planning Charette Workshop
Post-Study Procedures
Workshop Agenda
Meeting Attendees

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

FINAL

A combined Value Engineering (VE) study and Planning Charette, sponsored by the US Army Corps of Engineers (USACE), Sacramento District and facilitated by Value Management Strategies, Inc., was conducted on the Sutter Basin Pilot Study. The study was conducted in Sacramento, California October 31 – November 4, 2011. The VE study involved the USACE Sacramento District Project Development Team (PDT) working with designated representatives from USACE South Pacific Division, the California Department of Water Resources (DWR), and Sutter Butte Flood Control Agency (SBFCA).

PROJECT SUMMARY

USACE and SBFCA, in coordination with DWR and the California Central Valley Flood Protection Board are undertaking efforts to study flood risk management measures in Sutter and Butte Counties. The Sutter Basin, California Feasibility Study will investigate flood damage reduction, ecosystem restoration and recreation within the project's study area.

The Sutter Basin Feasibility Study was selected for inclusion in the National Pilot Program in February 2011. The pilot initiative provides an opportunity to test principles that have been outlined in the U.S. Army Corps of Engineers (USACE) Recommendations for Transforming the Current Pre-Authorization Study Process (January 2011), which was drafted by a workgroup of planning and policy experts from USACE and the Office of the Assistant Secretary of the Army for Civil Works referred to as the 17+1 Team. Based on these principles, the Sutter Pilot Study plan formulation strategy focuses on a qualitative analysis that will be increasingly detailed at each Decision Point or In-Progress Review, and early elimination of plans with little probability of implementation.

WORKSHOP TIMING

The VE study/Planning Charette was conducted early in Project Development prior to the Feasibility Report being prepared by USACE Sacramento District.

VE STUDY/PLANNING CHARETTE OBJECTIVES

The objectives of the VE study as identified in the scope of work were to:

- **Validate, Refine, and Optimize Alternatives** – Integrate VE principles, tools and techniques into the project's early decision making processes to validate, refine, and optimize preliminary alternatives and ensure a robust final array of alternatives.
- **Facilitate Communication** – Utilize the VE process to facilitate and encourage the understanding, consideration, and integration of the needs of the PDT members, project sponsors, partners, and other stakeholders.
- **Improve Value** – Identify VE Concepts that improve the project's ability to meet its objectives through increased performance and/or reduced cost.

- **Improve Planning Process** – Combine the VE methodology (5-step job plan) with USACE's 6-step planning process in order to meet both the project and pilot study objectives.

BASELINE CONCEPTUAL ALTERNATIVES AND MEASURES

Prior to the workshop, the PDT in conjunction with the local sponsors, identified a wide array of potential Flood Risk Management (FRM) structural and nonstructural measures, Ecosystem Restoration (ER) measures (in conjunction with FRM), and recreation measures.

The measures were then grouped into one or more conceptual alternatives. Measures listed under each conceptual alternative were designated as either required measures or optional measures that could be incrementally added to the alternative. The measures were formed into nine preliminary alternatives which are summarized in the Project Information section of this report. Since the measures to be included in the nonstructural alternative have not yet been well defined, this alternative was not rated during the VE Study. By policy, a primarily nonstructural alternative will be included in the final array.

WORKSHOP RESULTS

The VE team undertook the task assignment using the VE work plan and methodology. Given that this study was conducted at an early stage of design development, the VE team considered a "top down" approach where the team identified and discussed the general objectives of the project as they relate to the project's purpose and need.

The most notable result of this workshop was the use of the VE methodology at an early stage of design. Traditionally, VE studies are performed later in the design process with the intent to identify cost savings and value improvement suggestions on an existing design. For this study, the VE team used the tools and techniques of the VE methodology to accomplish the stated objectives. The VE study completed the following activities:

- Discuss and concur on the project's mission (purpose and need)
- Identify and prioritize the performance criteria for the project
- Evaluate the Baseline Conceptual Alternatives per the performance criteria and relative costs
- Revise Conceptual Alternatives and identify Final Alternative Array
- Evaluate Final Alternative Array per the performance criteria and relative costs

EVALUATION OF BASELINE CONCEPTUAL ALTERNATIVES

During the course of the workshop, a number of analytical tools and techniques were applied to develop a better understanding of the Baseline Alternative Concepts and begin the process of identifying a final array of alternatives. A major component of this analysis was Value Metrics which seeks to assess cost and performance as they relate to project value. These elements required a deeper level of analysis, the results of which are detailed in this report. Key performance attributes identified for the project are listed in the table, "Performance Attributes."

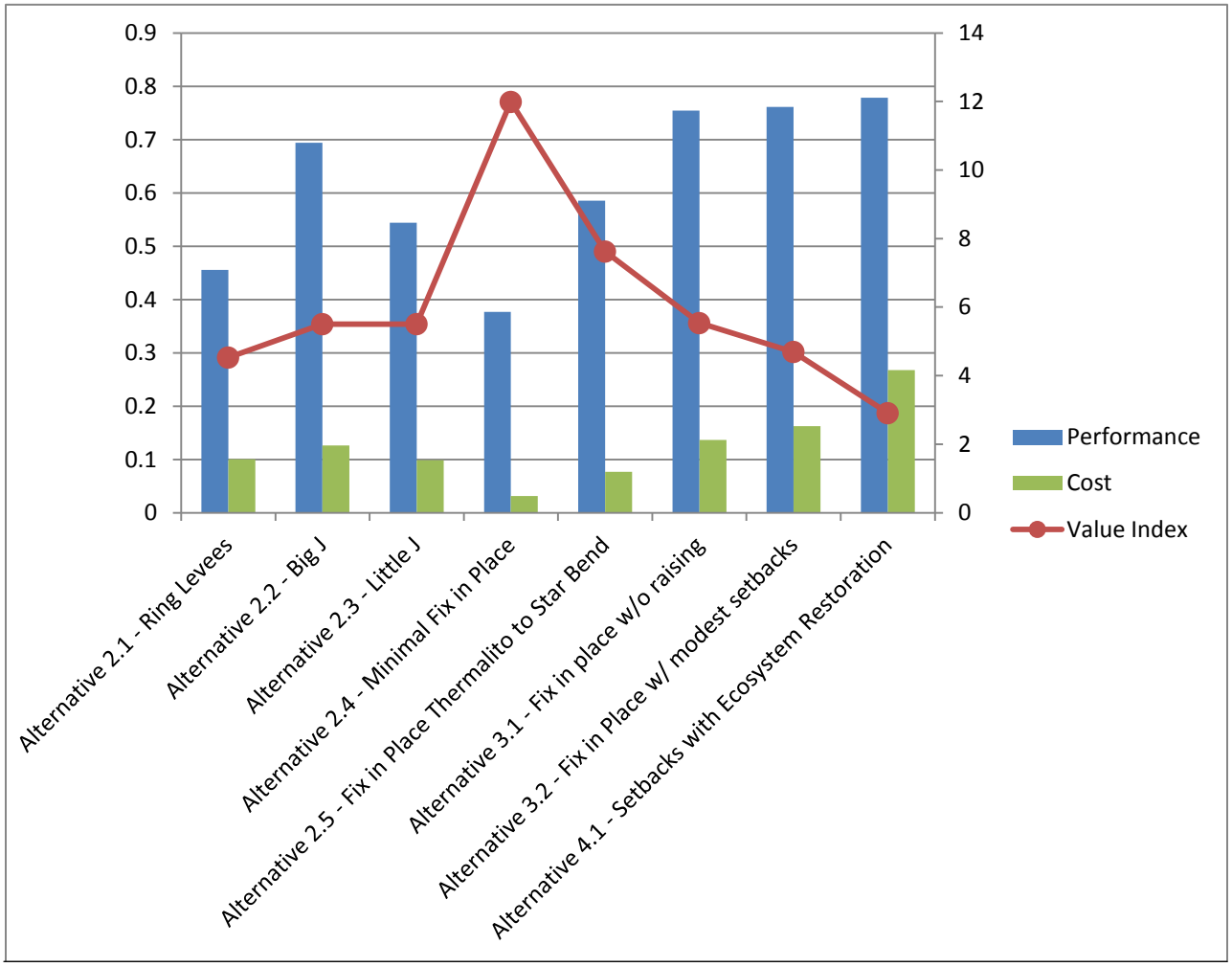
Performance Attributes
Flood Risk Management
Residual Risks
Sustainability
Ecosystem Functionality
Minimize Environmental Impacts

The *Comparison of Value* chart presented below was prepared to summarize the comparison of the Baseline Conceptual Alternatives. The performance scores calculated from the summation of the weighted priority of a performance attribute times an alternative's rating score for the attribute were divided by the total cost scores for each alternative to derive a value index.

The basic equation for value is:

$$Value = \frac{Performance}{Cost + Time}$$

Comparison of Value – Baseline Concepts



Below is a summary of the major observations and conclusions identified during the value analysis of the Baseline Conceptual Alternatives:

- USACE policy requires a predominantly non-structural alternative, however, a stand-alone non-structural alternative (*Alternative 1.1 – Non-Structural Measures*) does not significantly address project objectives due to residual risk. Non-structural measures would enhance all project alternatives in achieving objectives and should be considered in combination with other alternatives.

- *Alternative 4.1 – Setbacks with Ecosystem Restoration* has significantly higher costs than the other alternatives with only slightly added performance. This alternative was eliminated from further consideration because the additional cost of this alternative compared to combined alternatives 3.1 and 3.2 exceeds the additional restoration benefits. The ecosystem benefits from setbacks can be evaluated as standalone additions to other alternatives.

- The performance and costs of *Alternative 3.1 – Fix in Place without Raising* and *Alternative 3.2 – Primarily Fix in Place, Including Modest Setbacks* are relatively the same. The alternatives differ primarily in the optional setbacks they include. The setbacks can be evaluated as standalone additions to the combined alternative.
- Early economic benefit analysis leads to preliminary conclusion that smaller rings around the communities of Biggs, Gridley and Live Oak would not be economically justified, however, the Yuba City ring levee may be justified.
- *Alternative 2.4 – Minimal Fix in Place* provides flood risk reduction to a significant portion of the economic development of the study area for a relatively low construction cost.

VE CONCEPTS SUMMARY

The VE portion of the workshop identified 18 concepts, which are intended to assist the project development team in refining plans to carry forward into the next phase of project development. The concepts could potentially add value to the project, either through enhancing project functionality and alignment with project objectives, performance improvements, risk reduction, or any combination thereof. The alternatives are organized by category based on the project issue or project aspect they address. A summary list and developed content of all of the VE Concepts is included in the *VE Concepts* section of this report.

FINAL ALTERNATIVE ARRAY

Using the results of the previous exercises, the VE team developed a suggested Final Alternative Array. The alternatives are summarized below. Additional information, assumptions, and the performance assessment for each alternative are included in the *Value Analysis of Final Alternatives Array* section of this report.

- **Primarily Nonstructural with Minimal Levee Improvement Reaches**
  This alternative is a combination of minimal levee improvements to Feather River Levees with the implementation of non-structural measures focused on reducing risk to loss of life.

- **Yuba City Ring Levee**
  This alternative consists of constructing a ring levee around Yuba City only with the implementation of non-structural measures focused on reducing risk to loss of life in areas not provided with new or improved levees.

- **Little "J" Levee**
  This alternative consists of improving the Feather River levees from Thermalito to Shanghai Bend and constructing a new levee to the south and west of Yuba City.

- **Fix in Place Feather River Thermalito to Star Bend**
  This alternative consists of improving the Feather River levees from Thermalito to Star Bend. The alternative also includes the Star Bend setback levee.

- **Fix in Place Feather River, Sutter Bypass, and Wadsworth Canal with select setbacks for ecosystem restoration**
  This alternative is a combination of Alternatives 3.1 and 3.2 as originally identified with the Star Bend setback levee and the Northern Feather River setback levees included. The alternative will consider economic and flood risk reduction justification for other setback levee alignments and isolated weak spots as supplemental options where feasible.

CONCLUSION

This study accomplished each of its objectives as summarized below.

Validate, Refine, and Optimize Alternatives – The VE Study/Planning Charette resulted in narrowing the alternative array to a select number of alternatives. The study further provides information on the performance of each alternative as it relates to the purpose and need of the project. Given that this project is at an early stage in project development, no specific alternative or concepts were selected by the VE team as a "most preferred" solution. However, as the feasibility study process continues, it is recommended that the results documented in this report be utilized to aid in the decision-making process.

Facilitate Communication – The VE team incorporated the project objectives and discussions on the project's purpose and need into a mission statement that succinctly summarizes the project's scope. The VE team then utilized function analysis techniques to translate the project's purpose and need into functions in order to further understand how the project is accomplishing its objectives.

Improve Value – The VE team identified 15 VE Concepts that focus primarily on optimization of the Baseline Conceptual Alternatives array through either incorporating additional flood risk reduction measures and/or modifying the Conceptual Alternatives per lessons learned during the previous workshop exercises (Function Analysis and Value Metrics). The VE team also identified suggested revisions to the Baseline Conceptual Alternative array through the combination of certain alternatives or the elimination of alternatives from further consideration.

Integration with Planning Process – The following comments and lessons learned were generated by the participants at the conclusion of the workshop:

- The VE study allowed decisions to be made based on logical, repeatable, and defendable means without the need for significant data generation. The Value Metrics process utilized multi-criteria decision making without the need for full development of all the alternatives in order to reach preliminary screening decisions. This will result in time and effort savings as the planning process continues.
- The Performance Attributes as identified, defined, and prioritized by the Value Metrics process need to be reviewed to ensure that they reflect current USACE policies. Challenge ahead is to get more quantification of the information for rating the alternatives per the attributes identified.

- The VE Process as it has been adapted for this workshop is a complimentary method to USACE's traditional planning process and allowed issues to be brought up and discussed in an open forum and then resolved through creative and consensus-building activities. This collaborative approach allows more to happen in a reduced timeframe than the traditional report/comment/revision methods.
- This was the right time to incorporate VE into the project development process. Validated the effort to this point is in the right direction without requiring significant re-work. Using internal team at this point in the process is essential for good evaluation of the project and taking advantage of the institutional knowledge of the project and alternatives.

PROJECT INFORMATION

PROJECT INFORMATION

BACKGROUND

The U.S. Army Corps of Engineers and the Sutter Butte Flood Control Agency, in coordination with the California Department of Water Resources and the California Central Valley Flood Protection Board are investigating flood risk management in Sutter and Butte Counties. The purpose of the investigation is to address deficiencies in the existing levee system along the Feather River and Sutter Bypass that may lead to flood damage.

This project was one of two projects selected for a new pilot program to shorten the Corps' current study process target of three years. The pilot program is intended to test and confirm ideas for shortening the Corps' planning study process to as few as 18 months, as part of a broader Corps effort to respond to the nation's needs by moving more quickly from studying a problem to fixing it. One method for fast-tracking the Corps' planning process is to screen potential alternatives using logical, transparent, and policy-compliant methods based more on expert judgment rather than detailed quantitative analysis.

PROJECT DESCRIPTION

The Sutter Basin, California Feasibility Study is investigating flood risk management, ecosystem restoration and recreation within the study area. The study is considering improvement of the existing levees, as well as construction of new levees and other structural and non-structural measures for flood damage reduction. The ecosystem restoration and recreation objectives would be secondary to the flood damage reduction objective.

There exists a high risk of flooding from levee failure which threatens the public safety of approximately 80,000 people, as well as property and critical infrastructure throughout the study area. In addition, existing levees have isolated the floodplains from waterways, which eliminated significant floodplain habitats for native species, including federally listed species and other special status species.

Project Objectives

Based upon the information and discussions generated prior to the workshop, the following are the project objectives:

- Reduce the risk to life, health, and public safety due to flooding
- Reduce the risk of property damage due to flooding
- Reduce the risk of damage to critical infrastructure due to flooding
- Encourage wise use of the floodplain
- In conjunction with FRM, restore floodplain connectivity and associated dynamic riverine processes

- In conjunction with FRM, restore aquatic, wetland, riparian, and terrestrial habitats for special status and other native species
- In conjunction with FRM and ER, improve the public's access to and use of outdoor recreational opportunities in the study area

Project Mission Statement

The VE team incorporated the project objectives and discussions on the project's purpose and need into the following mission statement:

> *The Sutter Basin Flood Risk Management project is a multi-purpose approach to fix an unacceptable risk (probability and consequences) to life safety, public safety, critical infrastructure and property from flooding in the project area through structural and non-structural measures, incorporating ecosystem restoration and recreation opportunities, where appropriate.*

BASELINE CONCEPTUAL ALTERNATIVES

Prior to the VE Study/Planning Charette, the project team evaluated potential flood risk reduction, ecosystem restoration and recreation measures with respect to the study objectives and constraints. The result of a Critical Thinking Charette was an array of 33 measures. These measures were formed into eight preliminary alternatives as follows:

- **Alternative 1.1 – Non-Structural Measures**
  Since the measures to be included in the nonstructural alternative have not yet been well defined, this alternative was not evaluated during the combined VE Study/Charette. By policy, a primarily nonstructural alternative will be included in the final array.

- **Alternative 2.1 – Ring Levees**
  This alternative consists of ring levees around the communities of Biggs, Gridley, Live Oak, and Yuba City. The heights of the Biggs, Gridley, and Live Oak ring levees were estimated based on the 1/500 AEP levee breach inundation depths and an assumed additional height to provide 90% reliability. The height of the Yuba City ring levee was estimated based on the 1/200 AEP levee breach floodplain and additional height to provide 90% reliability. The eastern flank of the Yuba City ring levee would utilize the existing Feather River levee. The existing levee would be strengthened in place to its existing authorized height with no raising and would meet current USACE design standards. The higher level of performance for the Biggs, Gridley, and Live Oak ring levees was utilized because the flood depths are relatively shallow and do not vary significantly between flood frequencies. Each ring levee was assumed to require a pump station to address interior drainage. The capacity of the pump station was based on the rational method.

- **Alternative 2.2 – Big J**
  This alternative includes strengthening the Feather River levees from Thermalito to Star Bend, constructing a new cross-levee from Star Bend to Gilsizer Slough, strengthening the Sutter Bypass levee from Gilsizer slough to Wadsworth canal, and strengthening the south levee of the Wadsworth canal. All fix in place levees would meet current USACE design standards and

would be strengthened to the existing authorized height with no raising. The new levee reach was assumed to be a straight line profile from the Feather River levee to the Sutter Bypass levee. The levee footprint follows the approximate drainage divide to the two existing DWR pumping plants. Therefore, additional pumping plants would not be required. This alternative also includes the Star Bend setback levee.

- **Alternative 2.3 – Little J**
  This alternative includes strengthening in place Feather River levees from Thermalito to Shanghai Bend and constructing a new levee to the south and west of Yuba City. All fix in place levees would meet current USACE design standards and would be strengthened to the existing authorized height with no raising. The "J" levee was assumed to require a pump station to address interior drainage. The capacity of the pump station was based on the rational method.

- **Alternative 2.4 – Minimal Fix in Place**
  This alternative consists of strengthening in place the Feather River levees from Sunset Weir to Star Bend. All fix in place levees would meet current USACE design standards and would be strengthened to the existing authorized height with no raising.

- **Alternative 2.5 – Fix in Place Thermalito to Star Bend**
  This alternative consists of fixing in place Feather River levees from Thermalito to Star Bend and corresponds to the Feather River West Levee Project. The alternative also includes the Star Bend setback levee. All fix in place levees would meet current USACE design standards and would be strengthened to the existing authorized height with no raising.

- **Alternative 3.1 – Fix in Place without Raising**
  This alternative consists of fixing in place the Feather River levees from Thermalito to the confluence with the Sutter Bypass and improving the east levees of the Sutter Bypass in the southern basin. Levees along the south side of Wadsworth Canal would also be improved. The alternative also includes the Star Bend setback levee. All fix in place levees would meet current USACE design standards and would be strengthened to the existing authorized height with no raising.

- **Alternative 3.2 – Primarily Fix in Place, Including Modest Setbacks with Ecosystem Restoration**
  This alternative is similar to Alternative 3.1. However, in lieu of fixing in place the existing levees, new setback levees would be constructed at Northern Feather River and at the Sutter Bypass and Feather River confluence. The alternative also includes the Star Bend setback levee.

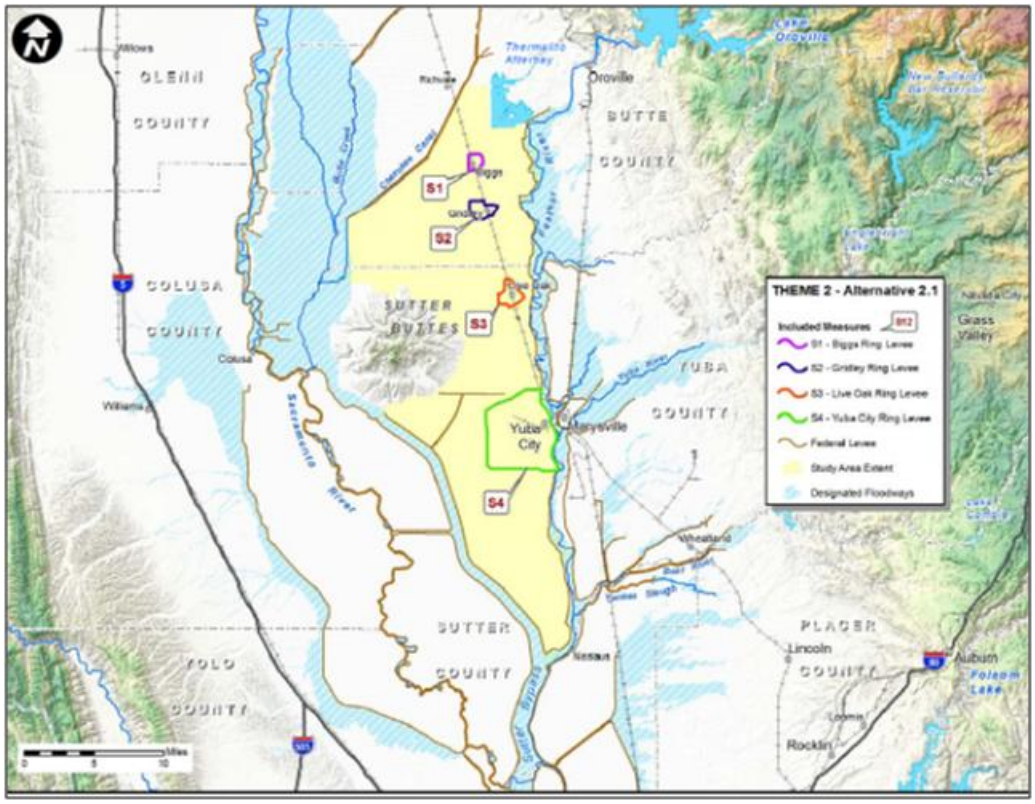
- **Alternative 4.1 – Setbacks with Ecosystem Restoration**
  This alternative is similar to Alternative 3.2. However, in lieu of improving the existing Sutter Bypass levee, a new setback levee would be constructed along the Sutter Bypass.

BASELINE CONCEPTUAL ALTERNATIVE SKETCHES

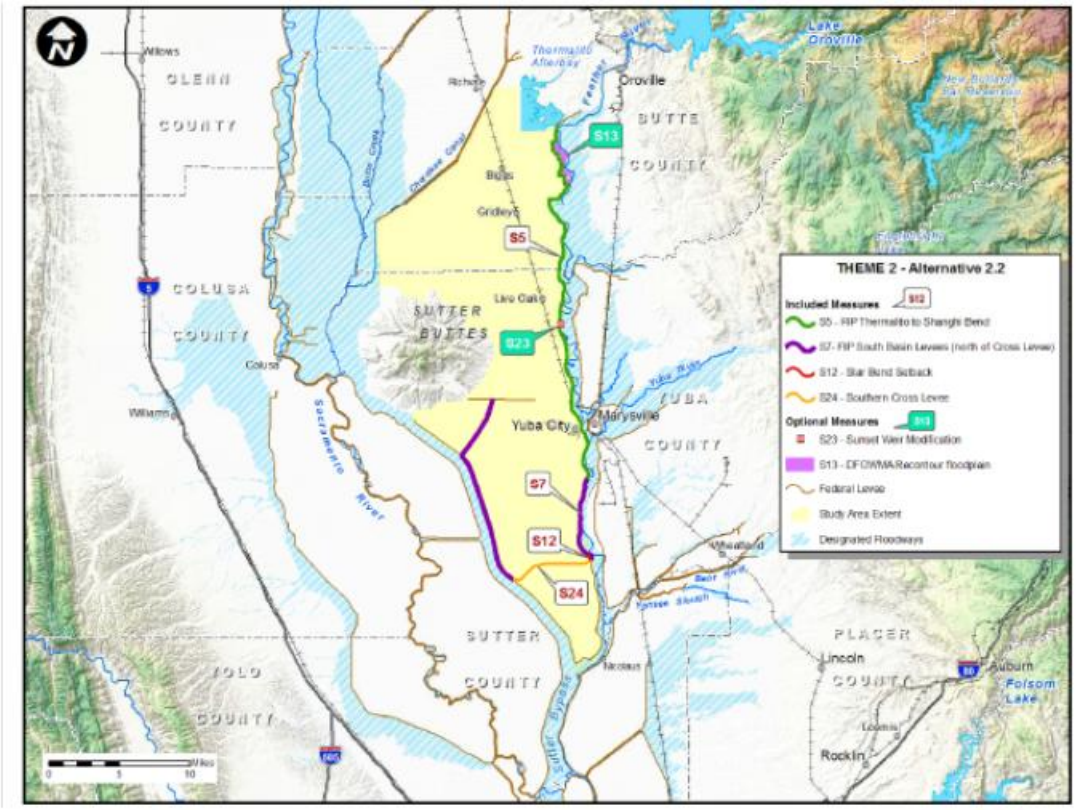
Conceptual illustrations of the Baseline Alternatives are included below and on the following pages.

BASELINE CONCEPTUAL ALTERNATIVES AND MEASURES

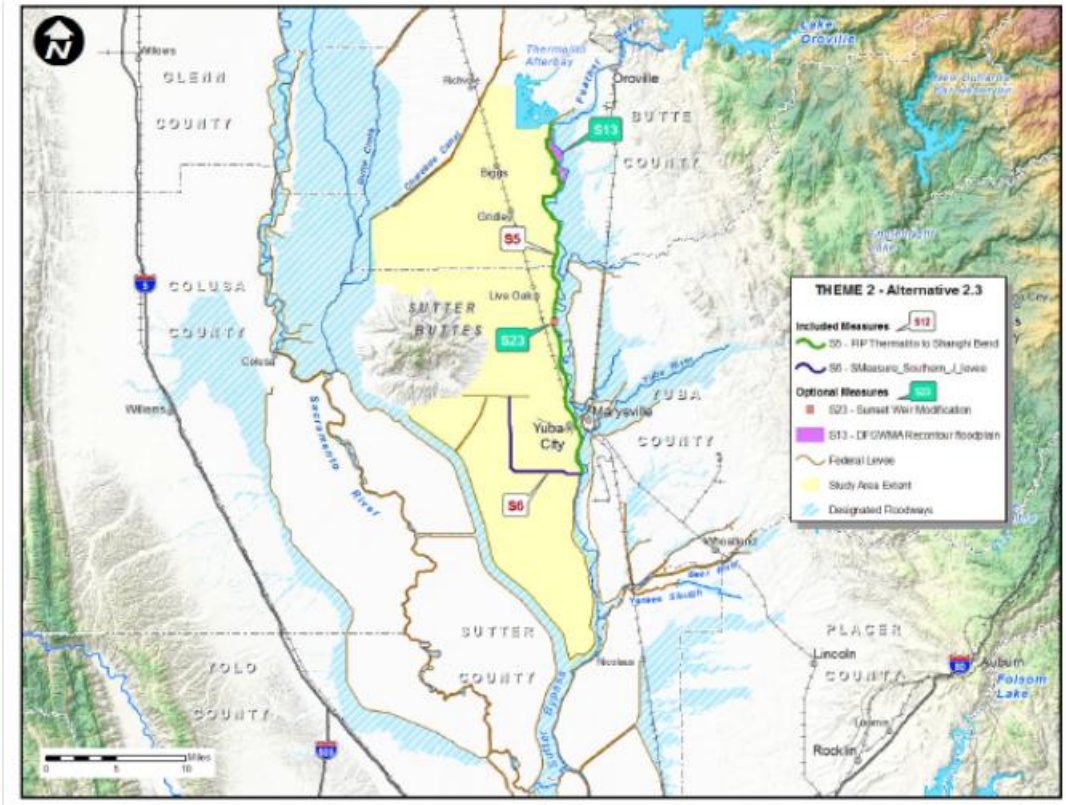
A table summarizing the potential flood risk reduction measures and the measures that comprise the Baseline Conceptual Alternatives is included at the end of this section.



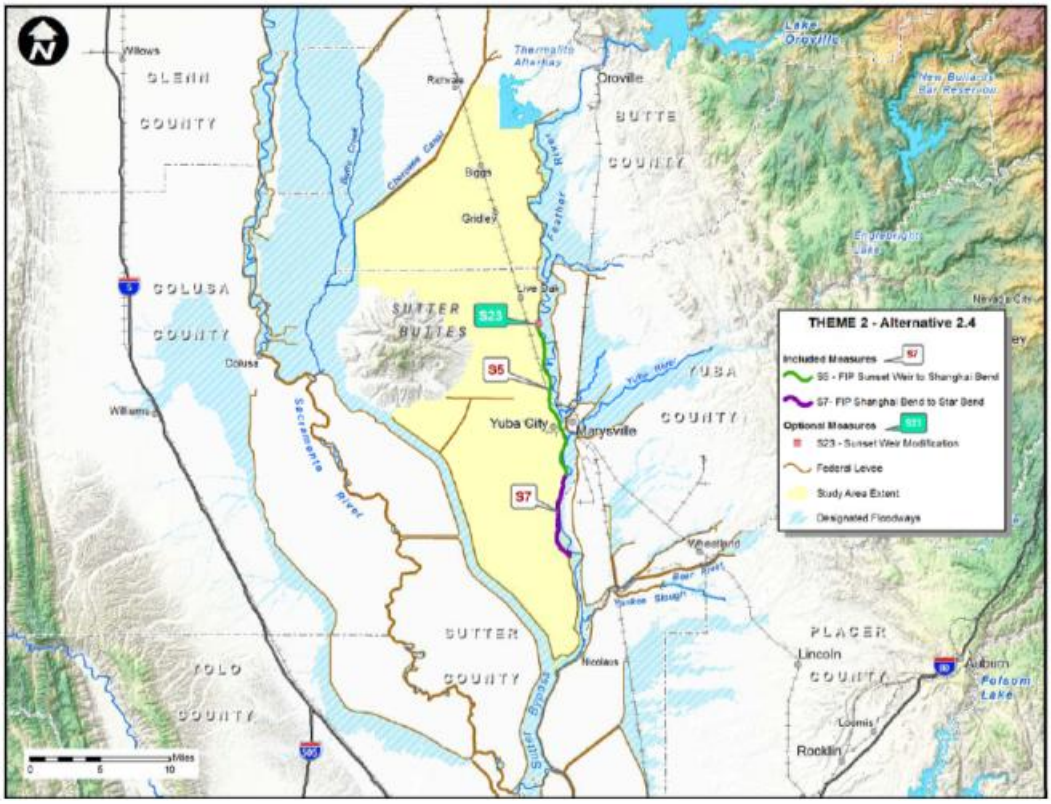
Alternative 2.1 – Ring Levees



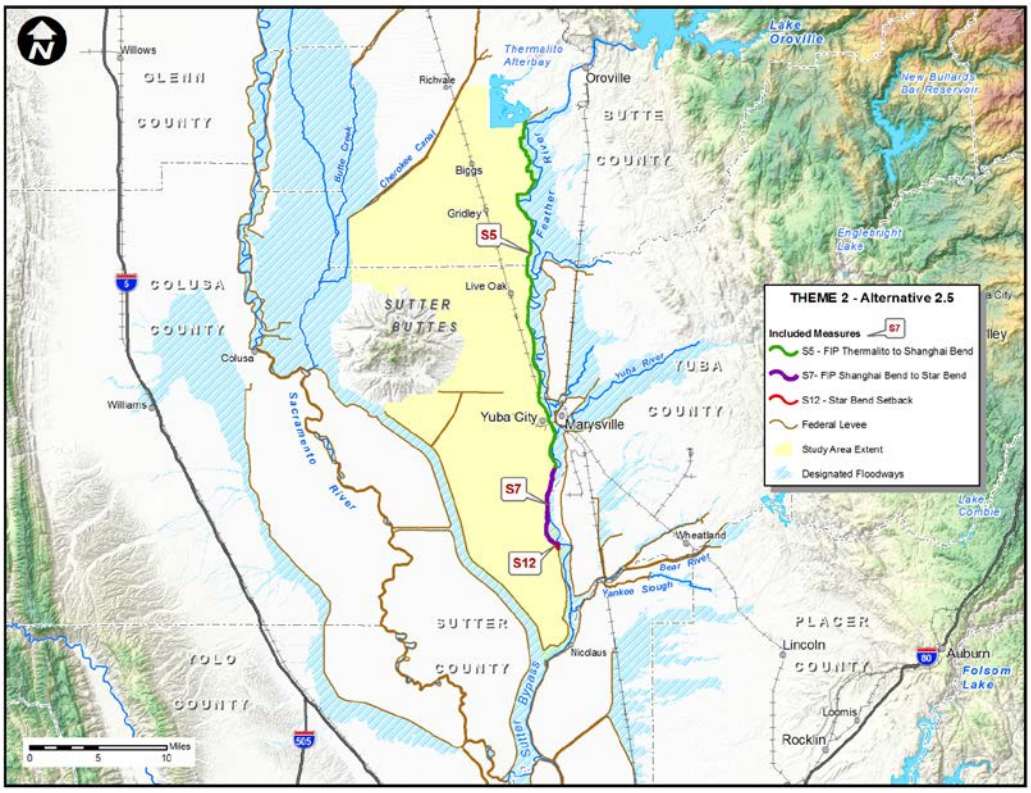
Alternative 2.2 – Big J



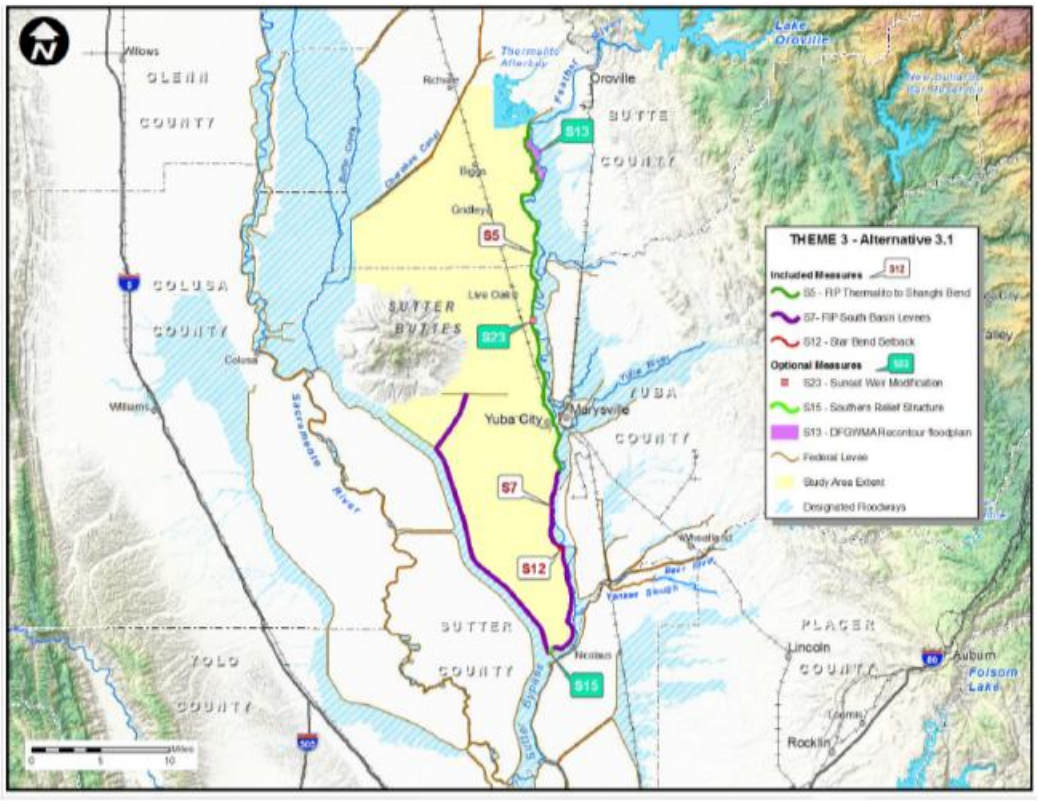
Alternative 2.3 – Little J



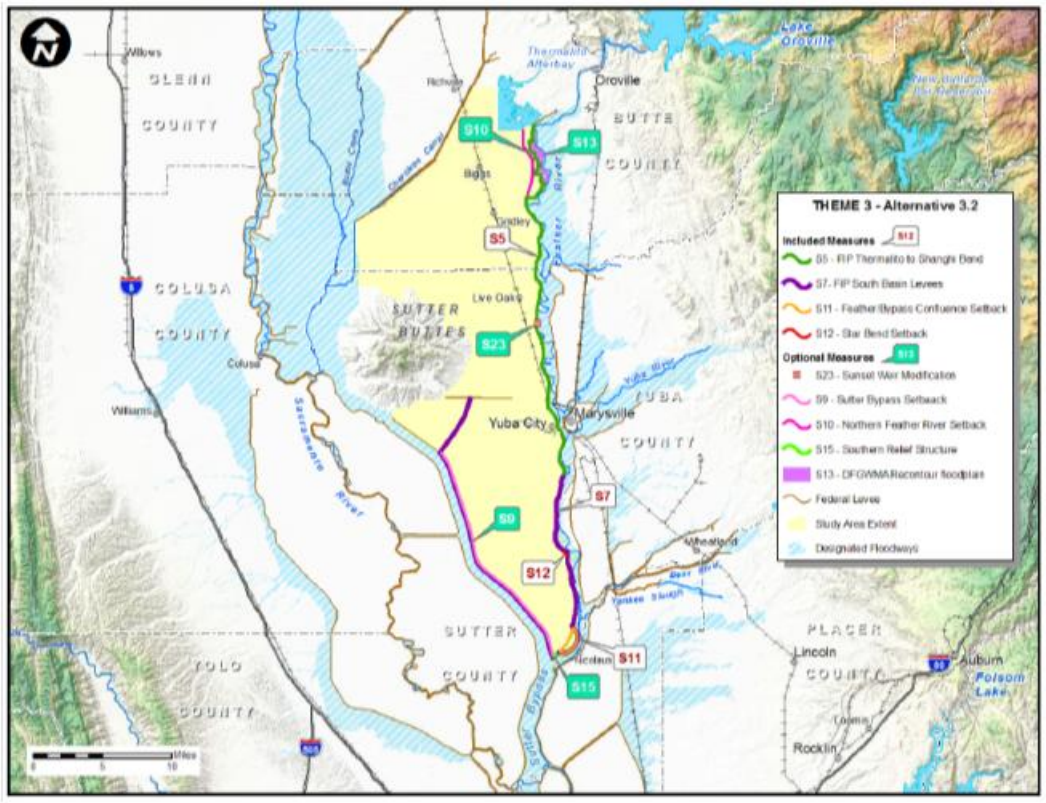
Alternative 2.4 – Minimal Fix in Place



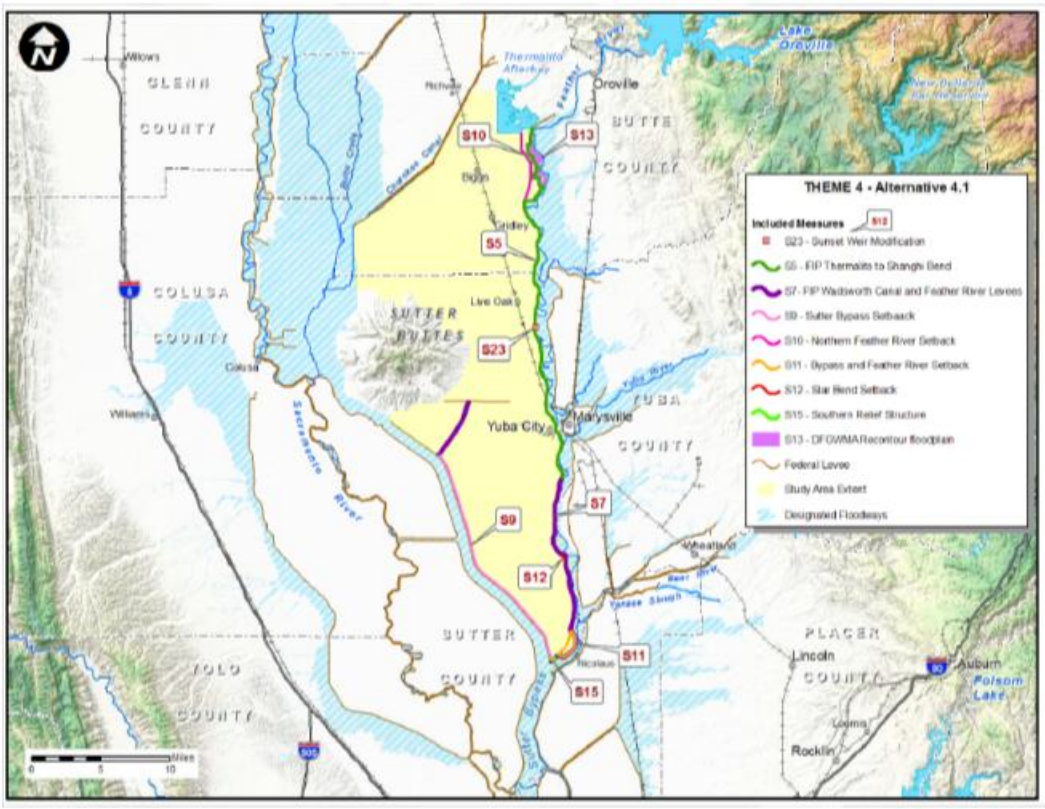
Alternative 2.5 – Fix in Place Thermalito to Star Bend



Alternative 3.1 –Fix in Place without raising



Alternative 3.2 – Primarily Fix in Place with modest setbacks



Alternative 4.1 – Setbacks with Ecosystem Restoration

Conceptual Alternatives and Measures

ID	Management Measures	**Theme 1 Consequence Management focused on Public Safety**	**Alternative 1.1:** Nonstructural	**Theme 2 Urban FRM Focus**	**Alternative 2.1:** Ring Levees	**Alternative 2.2:** Big J	**Alternative 2.3:** Little J	**Alternative 2.4:** Minimal Fix in Place	**Alternative 2.5:** Fix in Place Thermalito to Star Bend	**Theme 3 Maximize Existing System with FRM Emphasis**	**Alternative 3.1:** Fix in place w/o raising	**Alternative 3.2:** Primarily Fix in Place including modest setbacks	**Theme 4 Ecosystem Emphasis**	**Alternative 4.1:** Setbacks with Ecosystem Restoration
S1	Biggs Ring Levee			*	X									
S2	Gridley Ring Levee			*	X									
S3	Live Oak Ring Levee			*	X									
S4	Yuba City Ring Levee			*	X									
S5	Fix-In-Place Feather River West Levee from Thermalito to Shanghai Bend			*		X	X	X-SBFCA segment 4 and 5 only (Sunset Weir to Shanghai Bend)	X	*	X-may include sub reaches	X	*	X
S6	Southern Portion of J-Levee			*			X							
S7	Fix-In-Place Feather River West Levee from Shanghai Bend to Sutter Bypass; plus Wadsworth Canal East Levee; plus Sutter Bypass East Levee			***- south to star bend only**		X-Feather River North of Star bend and SB north of Gilsizer slough		X- Shanghai Bend to Star Bend	X- Shanghai Bend to Star Bend	*	X- may include sub reaches	X	***-w/o Sutter bypass fix in place**	X-w/o Sutter bypass fix in place
S9	Sutter Bypass Setback Levee									*		O	*	X
S10	Northern Feather River Setback Levee			*						*		O	*	X
S11	Sutter Bypass and Feather River Confluence Setback Levee									*		X	*	X
S12	Star Bend Setback Levee			*		X			X	*	X	X	*	X
S13	Oroville DFG Wildlife Management Area – Degrade Land Surface and Restore Wetlands					O	O				O	O	*	X
S15	Southern Relief Feature	*	O	*						*	O	O	*	X
S23	Sunset Weir Modification			*		O	O	O		*	O	O	*	X
S24	Gilsizer Cross Levee with flap gates	*		*		X								
S25	Wadsworth Canal Tributary Drainage			*		O	O			*	O	O		

ID	Management Measures	**Theme 1 Consequence Management focused on Public Safety**	**Conceptual Alternative 1.1:** Nonstructural	**Theme 2 Urban FRM Focus**	**Conceptual Alternative 2.1:** Ring Levees	**Conceptual Alternative 2.2:** Big J	**Conceptual Alternative 2.3:** Little J	**Conceptual Alternative 2.4:** Minimal Fix in Place	**Conceptual Alternative 2.5:** Local Early Implementation Plan Project #1	**Theme 3 Maximize Existing System with FRM Emphasis**	**Conceptual Alternative 3.1:** Fix in place w/o raising	**Conceptual Alternative 3.2:** Primarily Fix in Place including modest setbacks	**Theme 4 Ecosystem Emphasis**	**Conceptual Alternative 4.1:** Setbacks with Ecosystem Restoration
S26	Managed overtopping (levee superiority) on Feather River and Sutter Bypass. (e.g. selective levee raising)			*		O	O	O		*	O	O		
S27	Improve upstream fish passage in Sutter Bypass. (Remove fish passage barriers). Dependent on S9												*	X
NS1	Strategic relocation of structures and critical infrastructure in floodplain	*	O	*	O	O	O	O	O		O	O	*	O
NS2	Floodproof at isolated locations	*	O	*	O	O	O	O	O	*	O	O	*	O
NS3	Elevate structures and transportation infrastructure	*	O	*	O	O	O	O	O	*	O	O	*	O
NS4	Establish flood-resistant housing	*	O	*	O	O	O	O	O		O	O	*	O
NS5	Secure large floatable objects	*	O	*	O	O	O	O	O	*	O	O	*	O
NS6	Flood-warning system	*	X	*	X	X	X	X	X	*	X	X	*	X
NS7	Evacuation plan	*	X	*	X	X	X	X	X	*	X	X	*	X
NS8	Construct ring levees at isolated locations.	*	O	*	O	O	O	O	O		O	O	*	O
R1	Multi-Use Trails	*	O	*	O	O	O	O	O	*	O	O	*	O
R2	Bicycle Trails	*	O	*	O	O	O	O	O	*	O	O	*	O
R3	Equestrian Trails	*	O	*	O	O	O	O	O	*	O	O	*	O
R4	Day Use Area	*	O	*	O	O	O	O	O	*	O	O	*	O
R5	River Access	*	O	*	O	O	O	O	O	*	O	O	*	O
R6	Scenic Overlook	*	O	*	O	O	O	O	O	*	O	O	*	O
R7	Recreational parkway	*	O	*	O	O	O	O	O	*	O	O	*	O

* Included in theme
X Included in alternative
O Optional to alternative

FUNCTION ANALYSIS

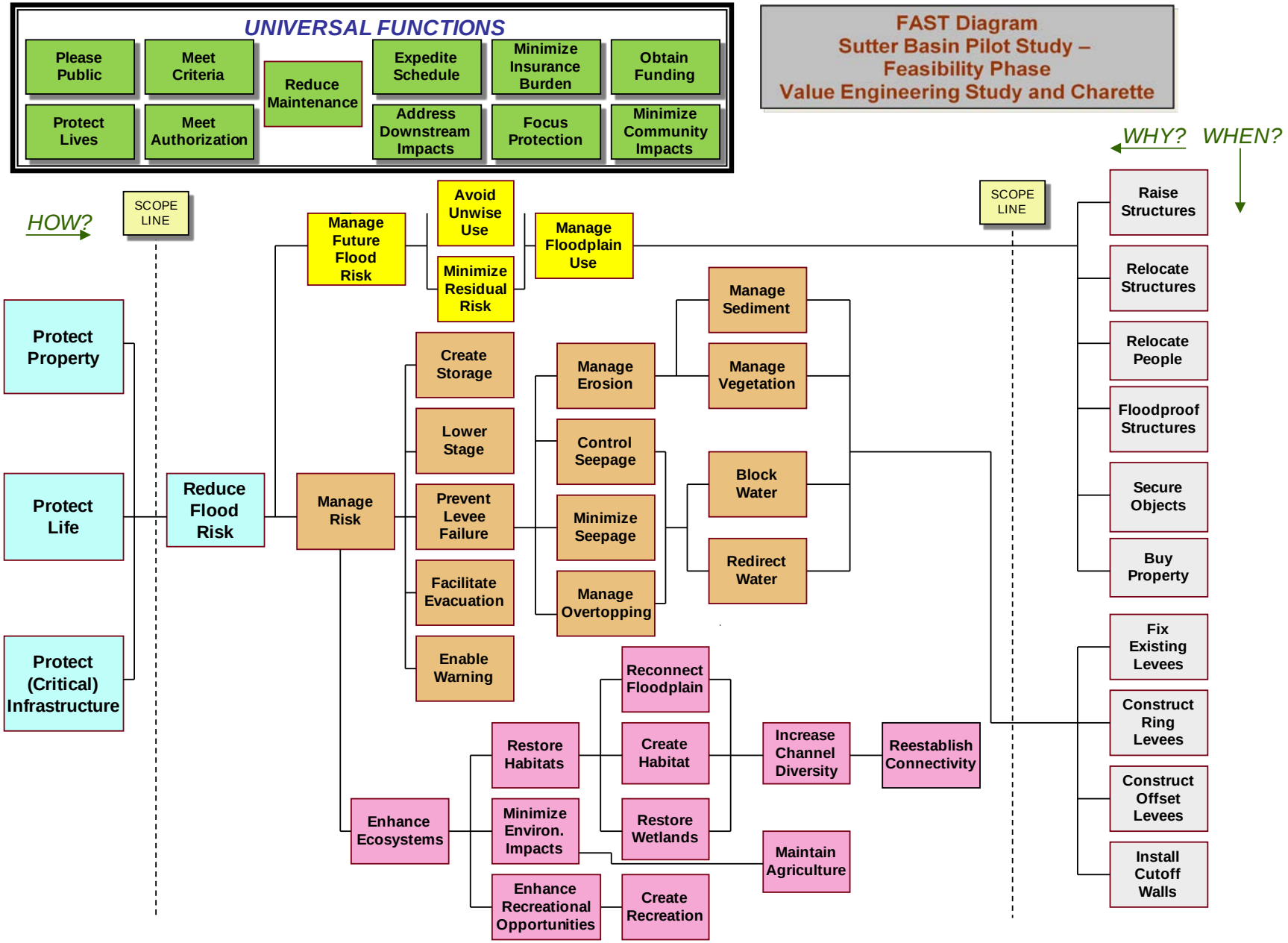
Function analysis was performed and a Function Analysis System Technique (FAST) Diagram was produced, which revealed the key functional relationships for the project. This analysis provided a greater understanding of the total project and how the project's performance, cost, time, and risk characteristics are related to the various functions identified.

The FAST diagram arranges the functions in logical order so that when read from left to right, the functions answer the question, "How?" If the diagram is read from right to left, the functions answer the question, "Why?" Functions connected with a vertical line are those that happen at the same time as, or are caused by, the function at the top of the column (a "When?" relationship).

Random Function Determination

Function	Function
Protect Life	Reconnect Floodplain
Reduce Flood Risk	Create Habitat
Protect Property	Restore Wetlands
Protect Infrastructure	Lower Stage
Enhance Ecosystems	Manage Floodplain Use
Restore Habitats	Create Recreation
Enhance Recreational Opportunities	Reestablish Connectivity
Fix Existing Levees	Maintain Agriculture
Construct Offset Levees	Meet Criteria
Minimize Environmental Impacts	Avoid Unwise Use
Relocate People	Manage Future Flood Risk
Raise Structures	Manage Vegetation
Relocate Structures	Protect Critical Infrastructure
Floodproof Structures	Create Storage
Control Seepage	Obtain Funding
Minimize Seepage	Minimize Community Impacts
Secure Objects	Increase Channel Diversity
Improve Access	Minimize Residual Risk
Facilitate Evacuation	Reduce Maintenance
Manage Overtopping	Address Downstream Impacts
Provide Warning	Manage Sediment
Block Water	Manage Erosion
Construct Ring Levees	Expedite Schedule

FAST Diagram



VALUE ANALYSIS OF BASELINE CONCEPTS

VALUE ANALYSIS OF BASELINE CONCEPTS

SUMMARY OF ANALYSIS

Value Metrics was used as an analysis tool to evaluate the Baseline Alternative Concepts that were identified prior to the workshop.

VALUE METRICS

Value Methodology (VM) has traditionally been perceived as an effective means for reducing project costs. This paradigm only addresses one part of the value equation, oftentimes at the expense of the role that VM can play with regard to improving project performance. Project costs are fairly easy to quantify and compare; performance is not.

Project performance must be properly defined and agreed to by the stakeholders at the beginning of the VE study/Planning Charette. The performance requirements and attributes developed are then used throughout the study to identify, evaluate, and document alternatives. This process, Value Metrics, emphasizes the interrelationship between the elements of performance, cost, and time and can be quantified and compared in terms of how they contribute to overall value. The basic equation for value is:

$$Value = \frac{Performance}{Cost + Time}$$

Value Metrics provides a standardized means of identifying, defining, evaluating, and measuring performance. Once this has been achieved and costs for all VE alternatives have been developed, measuring value is very straightforward.

The following pages describe the steps in the Value Metrics process.

Define Performance Requirements

Performance requirements represent essential, non-discretionary aspects of project performance. Any concept that fails to meet the project's performance requirements, regardless of whether it was developed during the project's design process or during the course of the VE study, cannot be considered as a viable solution. Concepts that do not meet a performance requirement cannot be considered further unless such shortcomings are addressed through the VE study process in the form of VE alternatives. It should be noted that in some cases, a performance requirement may also represent the minimum acceptable level of a performance attribute. The following performance requirements were selected for this project.

Performance Requirement	Definition
Meet Applicable Environmental Regulatory Standards and Policies	Project must meet the environmental regulatory standards and policies applicable to the respective project development stage. Examples include the National Environmental Policy Act, Endangered Species Act, Fish and Wildlife Coordination Act, Clean Water Act, Clean Air Act, and the National Historic Preservation Act. Meet State of California policies and regulatory standards.
Maintain Existing Flood Protection	The level of protection provided by floodwalls and levees must not be reduced.
Distinctiveness	Alternative measures should be unique and identifiable to allow distinguishing amongst the final array of alternatives.
Complete and Independent Project	This requirement is a determination of whether or not the plan includes all elements necessary to achieve the objectives of the plan. It is an indication of the degree that the outputs of the plan are dependent upon the actions of others. Plans that depend upon the actions of others to achieve the desired output do not meet this requirement.
COE authorization guidelines	The federal government has specific guidelines on the types of projects that USACE has authorization to fund. Project must meet the defined project type guidelines as well as meet applicable economic justification criteria for USACE participation.
Levee Design Standards	All levee designs must meet COE standards.

Define Performance Attributes

Performance attributes represent those aspects of a project's scope that may possess a range of potential values. For example, an attribute called "Environmental Impacts" may have a range of acceptable values for a project ranging from 1 acre to 20 acres of wetlands mitigation. It is clear that a concept that offered 15 acres of mitigation would perform at a higher level than one that offered 5 acres, but both would meet the project's need and purpose, and their values (i.e., the relationship between performance and cost) could be rationally compared. Please note that the values assigned to attribute performance were relative to the other alternatives. They were not based on absolute values. The following performance attributes were selected for this project.

Life Safety

This criterion focuses on the potential for life safety risk including the potential for the loss of human life and immediate health impacts that result from flood conditions as well as to facilities such as medical—hospitals, critical care units, helipads for medical; concentrated overnight places– nursing homes, motels; administrative coordination and assistance facilities. It also includes an assessment of the ability to maintain evacuation routes such as road systems leaving major population centers during flood events. Levees with lower geotechnical performance (higher probability of failure prior

to overtopping) were considered to have higher life safety risk due to unexpected failure. A qualitative assessment of life safety was also conducted during the VE study.

Property Damages

This criterion focuses on flood damage benefits which account for the reduction of flood damages to property. Property includes, for example, buildings, economic assets, and loss of standing crops and livestock in agriculture. Each alternative was qualitatively rated based on the geographic distribution of damageable property and the estimated 1/100, 1/200, and 1/500 AEP residual floodplains for the alternative. The analysis was based on a conceptual level of detail.

Critical Infrastructure Damages

This criterion focuses on the potential for impacts to critical infrastructure such as power plants; transportation– road, rail, and air; power– energy supply and distribution systems, including oil; communications– telecommunications network including; public health services– regional healthcare facilities; and water supply and treatment facilities.

Design Capacity Exceedance

Design capacity exceedance measures the remaining flood risks after project measures are constructed that are above and beyond those risks being addressed by the project. This criterion also considers the issue of levee superiority to manage residual risk of catastrophic failures and measures the consequences to life and property if a given alternative's design is exceeded.

Minimize Growth Inducement (Wise Use of Floodplain)

This criterion considers the characteristics of the alternative which could encourage or facilitate growth in the floodplain in an unwise manner. Each alternative was qualitatively rated based on the degree to which the alternative would discourage development in the most high risk areas of the floodplain.

Sustainability

This criterion is a measure of the extent to which future funds and effort will be required to sustain the project measures provided. It is defined as developing and protecting the constructed measures in a manner that enables people to meet current needs and provides that future generations can also meet future needs, from the joint perspective of environmental, economic and community objectives.

Ecosystem Functionality

Ecosystem functionality is a measure of the project's ability to maintain or enhance the natural environment to support a functioning ecosystem. This criterion includes an assessment of the opportunities for riparian and wetland habitat preservation and restoration as well as the efforts to minimize impacts to environmentally sensitive areas adjacent to floodplain such as the riparian forest, oak woodland, and giant garter snake habitats . The criterion also considers the restoration or preservation of natural riverine processes in the floodplain. A wider river channel would also

contribute to improvements in fish habitat. Alternatives should restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities.

Minimize Environmental Impacts

This criterion focuses on the project's temporary and permanent impacts to the environment. It includes the preservation of the existing floodplain and avoiding adverse effects on air quality, water quality, and other resources. Land disturbance outside the existing levee footprint should be minimized. The criterion also considers the loss of farmland and impacts to existing structures.

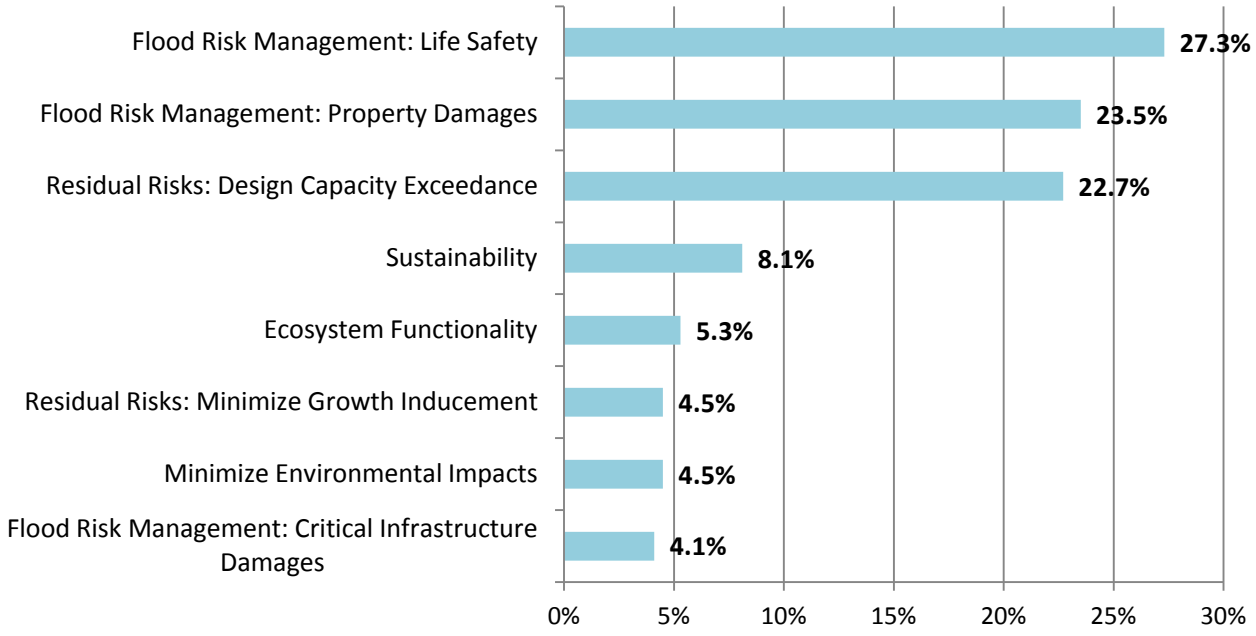
Prioritize Performance Attributes

The performance attributes of a project are seldom of equal importance. Therefore, a systematic approach must be utilized in order to determine their relative importance in meeting the project's need and purpose.

Once the performance attributes were defined and their scales developed, the Project Team and stakeholders prioritized them based on their relative importance to the project. The Analytic Hierarchy Process (AHP) was utilized in the prioritization process. The performance attributes were systematically compared in pairs, asking the question: "An improvement to which attribute will provide the greatest benefit relative to the project's need and purpose?" Participants were then asked to indicate their priorities and the relative intensities of their preferences. The following chart provides the results of this analysis and includes the complete breakdown of the priorities, expressed as a percentage of the whole.

It is important to note that this section describes discussion during the VE study and may not reflect SBFCA, State of California, or USACE policy.

Performance Attribute Prioritization



Performance Attributes Prioritization Rationale

The following information was captured during the performance attribute prioritization process as a means of documenting why a particular attribute was chosen over another and the rationale of the VE Study participants for the priorities indicated above.

Flood Risk Management vs. Residual Risks

Priority is in favor of Flood Risk Management.

Flood risk management is the primary purpose of the project. All alternatives assume a certain level of long-term residual risks, to one level or another. The more that is done under flood risk management, the lower the residual flood risks (but possibly more growth inducement). State floodplain management plans should address growth inducement. The priority still needs to be "fix what is there now". The selected alternative cannot protect people/property outside the project area, and there will be events that will exceed the design that will affect people/property present now. The selected project could provide a lower level of flood risk protection in order to discourage unintended use of land in the future. There is an interest in preserving the rural economy, but this is not fully addressed in the plan where protection of urbanized areas takes priority. By not fixing the levees, for example, one may be unintentionally inducing growth and development in floodplain areas outside the project boundaries.

Flood Risk Management vs. Ecosystem Functionality

Priority is in favor of Flood Risk Management.

Flood risk management is the primary purpose of the project and that ecosystem functionality is a secondary purpose/function. As it relates to life safety, flood risk management takes full priority over ecosystem restoration.

Flood Risk Management vs. Sustainability

Priority is in favor of Flood Risk Management.

Flood risk management is the primary purpose of the project. However, to optimize flood risk management, sustainability must be considered a component of the plan and design. If the alternative does not meet the goal of flood risk management, it does not matter if it is sustainable.

Flood Risk Management vs. Minimize Environmental Impacts

Priority is in favor of Flood Risk Management.

Flood risk management is the primary purpose of the project. Large easements for new or setback levees could be a significant impact to the environment, but would not impede the selection of this approach, if appropriate. In some cases, the socioeconomic impacts need to be considered.

Residual Risks vs. Minimize Environmental Impacts

Priority is in favor of Residual Risks.

All alternatives assume a certain level of long-term residual risks, to one level or another. Each alternative has a very different type and level of residual risks that need to be considered in the alternative selection process. Environmental impacts can be mitigated, especially if unavoidable. Likewise, some residual risks are unavoidable. Economic evaluations of alternatives take into account property damages, etc., but do not account for life loss, which could be significant when associated with the residual risks. Wise use of the floodplain is a basic requirement of the decision making process. This should be addressed by the State Floodplain Management Plan.

Residual Risks vs. Ecosystem Functionality

Priority is in favor of Residual Risks.

The long-term residual risk conditions needs to be of greater importance since the ecosystem is currently performing well. Since the project driver is flood risk management, long-term conditions is a component of such management and should be weighted greater than ecosystem functionality which is supported in conjunction with risk management.

Residual Risks vs. Sustainability

Priority is in favor of Residual Risks.

All alternatives assume a certain level of long-term residual risks, to one level or another. An increase in sustainability should correspond to a reduction in residual risks. In many cases, the project does not have control of residual risks whereas there is control of sustainability. In theory, all levees fail eventually, and there is some control over what will be the residual impact when this event occurs. Additional design components added to a concept could reduce the residual risks, but at additional cost. Also, if an area is outside the protection of the system, it is considered outside of the evaluation of this project. Residual risks relative to property damage are considered in the economic analysis of without project, but not the residual risks associated with life loss.

Ecosystem Functionality vs. Sustainability

Priority is in favor of Sustainability.

Need to have ecosystem functionality in order to have sustainability for future generations. The longevity of the system from an operational point of view, and the need to keep the system operational, is important.

Ecosystem Functionality vs. Minimize Environmental Impacts

Priority is in favor of Ecosystem Functionality.

In general, there is a close balance between the two attributes, where there may be some disturbance of the environment, there would be some benefits to the attributes. But it is better to

minimize damages rather than take aspects from an alternative – that is "do no harm" (which would benefit the ecosystem restoration). There was some opinion that minimizing environmental impacts were really cost issues.

Sustainability vs. Minimize Environmental Impacts

Priority is in favor of Sustainability.

Significant and unavoidable impacts still exist. The level of effort to keep the project operational is paramount, regardless of the impacts to the environment. If the project cannot be sustained, the environmental impacts could be very large.

Sub-attributes under Flood Risk Management

Property Damages vs. Life Safety

Priority between Property Damages and Life Safety is nearly equal, but leans toward Life Safety.

The Corps makes its decision based on the economics of damages. The project must be economically justified. Life safety has not displaced economic considerations. In a post-Katrina world, more emphasis is being placed on life safety, and decisions are being tailored to incorporate life safety to a greater degree. The USACE has made the case of selecting a larger plan with lower net benefits (where the economic NED plan was lower), but it could be justified based on life safety. A levee failure may not have a large life loss impact but property damage could be significant.

Property Damages vs. Critical Infrastructure Damages

Priority is in favor of Property Damages.

Critical infrastructure relates to overall health and welfare of public that is derived from the continued operation of these regional facilities. To some extent, it also impacts life safety (e.g. hospitals, fire protection, etc.). But, the Corps makes its decisions based on economics of damages. The project must be economically justified. Primary drivers of the system are based on National Economic Development (NED) decisions using the other factors as modifiers to enhance the NED.

Life Safety vs. Critical Infrastructure Damages

Priority is in favor of Life Safety.

Both are modifiers of property damage (NED decision), but life safety is a more important modifier.

Sub-attributes under Residual Risks

Minimize Growth Inducement vs. Design Capacity Exceedance

Priority is in favor of Design Capacity Exceedance.

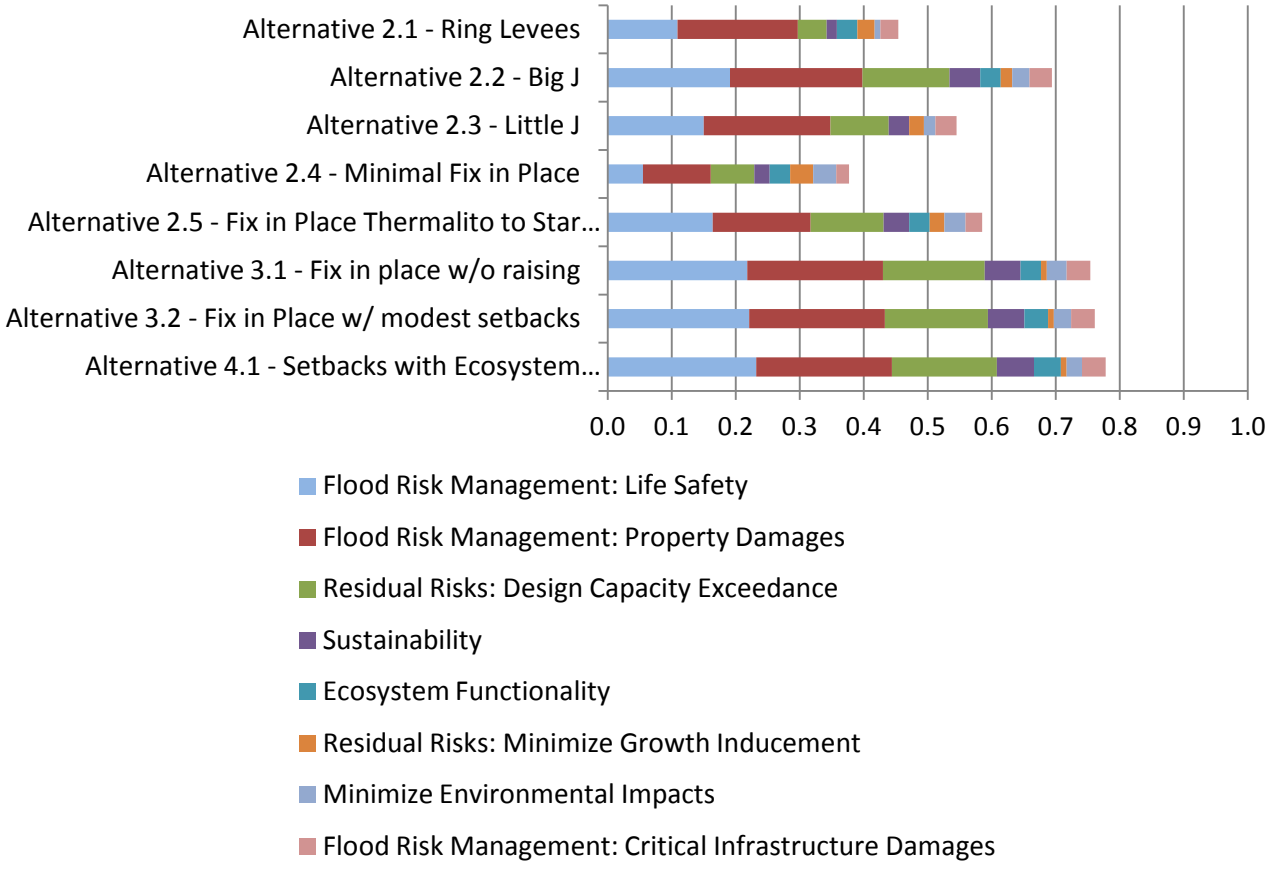
Unwise use of land includes growth inducement. Unprotected life and property is that which remains in areas that are outside the protected areas within the project boundaries. "If you build it, they will

come", but this can be controlled by zoning and floodplain ordinances. It does little good to address a problem in the short term that becomes a bigger problem in the long term. The long term effects represented by the damage caused by an event above and beyond the design capacity should be more important. SB 5 would not allow unwise use of floodplain land in urban or urbanizing areas. But if the 1/200 level of flood protection is constructed, there would no longer be a requirement to prevent growth in the area. Within protected areas, added residual risks can also be experienced from added development as well as flood events that exceed the design.

Measure Performance of Baseline Concepts

The project team and stakeholders evaluated the performance of the Baseline Concepts relative to performance attributes described above. The total performance scores reflect the performance rating for each attribute multiplied by its overall priority (weight) expressed using a ratio scale. A total performance score of "1" would indicate the highest level of desired performance (i.e., "ideal" performance). The chart below compares the total performance scores for the Baseline Conceptual Alternatives.

Comparison of Performance



The information below reflects the performance ratings and associated rationale for each attribute.

RING LEVEES ALTERNATIVE (Alternative 2.1)

Cost

The total estimated first cost of this alternative is $582 to 1,248 million. A breakdown of approximate first cost for each ring levee is provided below.

Measure S1 (Biggs Ring Levee): $60 to $129 million
Measure S2 (Gridley Ring Levee): $95 to $204 million
Measure S3 (Live Oak Ring Levee): $82 to $177 million
Measure S4 (Yuba City Ring Levee): $313 to $671 million

Life Safety

This alternative would reduce flood risk for a majority of the concentrated population and property within Yuba City, Live Oak, Gridley, and Biggs. Locations outside of the ring levees (non-urban areas) would not receive flood reduction benefits from the ring levees. However, these areas are relatively low in population density. The ring levee around Yuba City would include a reach of the Feather River levee system. Thus, there would only be one line of protection around Yuba City versus two lines of protection provided by the ring levees of the other communities. A drawback of this alternative is that ring levees would rely on flood gates and other measures at crossings with railroads and roadways that would need to be actively operated in order to be effective. This alternative would also require access to evacuation routes. An evacuation plan would be included as a nonstructural measure for this alternative to address life safety.

Property Damages

This alternative provides flood risk reduction to key urban development areas, thus property damages from flood events would be minimized. The ring levees around the four urbanized communities would reduce the flood risk for much of the property within the study area. However, some agricultural and some rural structures would still be exposed to flood risk. Based on estimated net benefits, Yuba City is the only potentially economically justified increment.

Critical Infrastructure Impacts

Ring levees would reduce flood risk for key regional facilities and other critical infrastructure within the ring levees, but would not reduce the risk of flooding of roadways and railroads outside of the ring levees.

Design Capacity Exceedance

If design capacity was exceeded, the interior of the ring levees would flood rapidly, which could result in loss of life. In addition, the ring levee around Yuba City would include a reach that is part of the

Feather River levee system. Thus, there would be only one line of protection for Yuba City versus two layers from the ring levees of the other three communities.

Minimize Growth Inducement (Wise Use of Floodplain)

This alternative would limit growth of local communities and future regional growth, while allowing in-fill and redevelopment within the existing developed area.

Sustainability

This alternative would require maintenance of pump stations and closure structures to ensure effective continued operation and flood risk management for the ring levees. In addition, this alternative would require maintaining the existing levees within the study area, which are currently at risk of failure due to through-seepage and underseepage. Maintenance of new ring levees would also be required. However, the maintenance requirements of new levees would be less than existing levees because they would be constructed on new foundations and to modern engineering standards.

Ecosystem Functionality

Opportunities may exist for ecosystem restoration near the reaches of levee at Yuba City that would be incorporated into the Yuba City ring levee. There are few opportunities for ecosystem restoration associated with the other ring levee locations. Constructing new ring levees may impact existing functionality.

Minimize Environmental Impacts

This alternative preserves the existing floodplain while minimizing the potential for future growth and associated adverse effects on air quality and other resources. However, this alternative has the potential to conflict with local land use plans. Construction of the ring levees would require multiple railroad crossings as well as crossings of two significant drainage canals in Yuba City. Significant borrow material would be required for construction of the new levees. Direct and indirect impacts associated with this alternative could affect environmentally and culturally sensitive areas. In addition, construction of the levees would occur in urban areas that are more susceptible to air and noise quality impacts. Ring levees would also separate the communities of Yuba City, Live Oak, Gridley, and Biggs from their surrounding supporting areas and would result in aesthetic impacts by disrupting existing viewsheds. Pump stations would have to be operated periodically, which may result in air quality and noise impacts. There may also be HTRW issues associated with new levee alignments.

BIG "J" LEVEE ALTERNATIVE (Alternative 2.2)

Cost

The total estimated first cost of this alternative is $703 to $1,506 million.

Life Safety

This alternative would reduce flood risk to the majority of the population and property within the study area. Areas in the southern portion of the study located below the Big "J" cross-levee would be located within the 1/100 AEP floodplain. No actively operated closures would be necessary to maintain this alternative. All existing evacuation routes would be maintained.

Property Damages

This alternative would capture approximately 93% of total benefits within the study area. However, some agricultural and some rural structures would still be exposed to flood risk. The benefits would be limited by the performance of the Sutter Bypass levees, which have a lower performance than the Feather River levees.

Critical Infrastructure Impacts

This alternative would provide flood risk reduction for hospitals, power plants, and other critical infrastructure within the study area, but would not reduce risk for all critical roadways within study area limits.

Design Capacity Exceedance

If design capacity was exceeded, the evacuation route on westbound Route 20 would be impacted. Flood depths would be greater due to the height of the southern cross levee south of Yuba City. The flood depths within the urbanized area of Yuba City would increase at a faster rate due to changes in the location of floodplain storage. Areas in the southern portion of the study area (below Sutter Bypass levee) would remain at high risk to flooding.

Minimize Growth Inducement (Wise Use of Floodplain)

This alternative reduces flood risk in Yuba City and other communities, which would allow for growth in existing urbanized areas. The cost of complying with the floodplain regulations could limit growth in the study area outside the Big J levee.

Sustainability

This alternative would result in reduced maintenance on the majority of existing levees along the Feather River, which are currently at risk of failure due to through-seepage and underseepage. New cross-levees for this alternative would be constructed on new foundations and to modern engineering standards. In addition to the maintenance required for the existing levees, these new reaches would require additional maintenance.

Ecosystem Functionality

Opportunities exist for ecosystem restoration within the segments of this alternative that include existing levees. There are few opportunities for ecosystem restoration on other segments of this

alternative. Constructing cross-levees may invade existing functioning ecosystems. Preserving existing levees may allow for future ecosystem restoration projects.

Minimize Environmental Impacts

Construction of the new cross levee associated with this alternative would directly impact farmland and potential sensitive habitat areas. Construction impacts would be limited where land disturbance is confined to existing levee footprints. Seepage berms, canal relocations, and land requirements could impact adjacent environmentally sensitive habitats and structures. The alternative would also require crossing two significant drainage culverts in Yuba City and significant borrow material to construct new levee reaches. Construction of cutoff walls could potentially disrupt groundwater flows. Potential HTRW issues exist for new levee alignments. The alternative would include construction of levee reaches in urban areas, which are more susceptible to air and noise quality impacts. These new levee reaches would result in aesthetic impacts by disrupting existing viewsheds. This alternative would also separate the agricultural areas in the southern portion of the study area from the communities located in the northern portion.

LITTLE "J" LEVEE ALTERNATIVE (Alternative 2.3)

Cost

The total estimated first cost of this alternative is $560 to $1,201 million based on a reconnaissance level of detail.

Life Safety

This alternative would reduce flood risk to the majority of the population and property within the study area due to the population density in Yuba City. Areas in the southern portion of the study located below the Little "J" cross-levee would remain at risk of flooding. This alternative would impact the evacuation route on westbound Route 20 and two major drainage areas in Yuba City.

Property Damages

This alternative would capture approximately 93% of total benefits within the study area. However, some agricultural and some rural structures would still be exposed to flood risk.

Critical Infrastructure Impacts

This alternative reduces the risk of flooding for hospitals, power plants, and other critical infrastructure within the study area, but does not reduce risk for certain roadways within project limits.

Design Capacity Exceedance

If design capacity was exceeded, the evacuation route on westbound Route 20 and two major drainage areas in Yuba City would be impacted. Areas in the southern portion of the study area

(below Sutter Bypass levee) would remain at risk to flood. The area north of the Little "J" levee would capture flood waters from the breach resulting in greater depths and faster stage increases.

Minimize Growth Inducement (Wise Use of Floodplain)

This alternative reduces flood risk in Yuba City and other communities, which would allow for growth in existing urbanized areas. It provides limited flood risk reduction in all other parts of the study area, which could limit future growth. It focuses development in areas designated or already developed in lieu of encouraging development scattered through floodplain.

Sustainability

This alternative would result in reduced maintenance on the majority of existing levees along the Feather River, which are currently at risk of failure due to through-seepage and underseepage. New cross-levees for this alternative would be constructed on new foundations and to current engineering standards. In addition to the maintenance required for the existing levees, the new levee reaches would require additional maintenance. This alternative would also require maintenance of pump stations and closure structures to ensure effective continued operation and flood risk management.

Ecosystem Functionality

Opportunities exist for ecosystem restoration within the reaches of this alternative that include existing levees. There are few opportunities for ecosystem restoration on other reaches of this alternative. Constructing cross-levees may invade existing functioning ecosystems. Preserving existing levees may allow for future ecosystem restoration projects.

Minimize Environmental Impacts

Construction of the new cross levee associated with this alternative would directly impact farmland and potential sensitive habitat areas. Construction impacts would be limited if land disturbance is confined to existing levee footprints. Seepage berms, canal relocations, and land requirements could impact adjacent environmentally sensitive habitats and structures. The alternative would also require crossing two significant drainage systems in Yuba City and significant borrow material to construct levee reaches. Construction of cutoff walls could potentially disrupt groundwater flows. Potential HTRW issues exist for new levee alignments. The alternative would include construction of levee reaches near urban areas, which are more susceptible to air and noise quality impacts. These new levee reaches would result in aesthetic impacts by disrupting existing viewsheds. This alternative would also separate the agricultural areas in the southern portion of the study area from the communities located in the northern portion.

MINIMAL FIX-IN-PLACE ALTERNATIVE (Alternative 2.4)

Cost

The total estimated first cost of this alternative is $177 to $381 million based on a reconnaissance level of detail.

Life Safety

This alternative would reduce flood risk to some portions of Yuba City and surrounding areas, but would not reduce flood risk for the communities in the northern study area (Live Oak, Gridley, and Biggs) and some portions of Yuba City. This alternative addresses high life risk areas south of the Yuba River and Feather River confluence and in Yuba City. In the event of flooding, the eastbound SR-20 evacuation route would be accessible, but evacuation routes SR-99 and Westbound SR-20 would be cut off.

Property Damages

This alternative would provide flood risk reduction to approximately half of Yuba City, which includes approximately 77% of the total property within the study area. It would provide some protection to agricultural lands. The alternative would capture approximately 29% of total benefits within the study area. Compared to the other structural alternatives, it would provide the least amount of flood risk reduction and expose the maximum amount of property to potential damage.

Critical Infrastructure Impacts

The alternative would not provide flood risk reduction for all key critical infrastructure (hospitals, power plants) and would not provide flood risk reduction for roadways or railroads within the study area.

Design Capacity Exceedance

Given the limited extent of levee improvements, it is anticipated that design capacity would be exceeded on a frequent basis. In the event of flooding, the eastbound SR-20 evacuation route would be accessible, but evacuation routes SR-99 and Westbound SR-20 would be cut off. The alternative would not result in the ponding issues caused by the cross-levees in the J-levee alternatives.

Minimize Growth Inducement (Wise Use of Floodplain)

This alternative reduces flood risk in approximately half of Yuba City. It does not provide flood risk reduction in all other parts of the study area, which could limit future growth.

Sustainability

Compared to the other structural alternatives, this alternative would result in the minimum amount of existing levees being improved. Thus, maintenance efforts for existing levees would be greater as compared to the other alternatives. It is assumed that new or improved levees constructed to current standards will require less maintenance than existing levees. However, the alternative would not add any additional reaches of levees to be maintained.

Ecosystem Functionality

Opportunities exist for ecosystem restoration along existing levees. Preserving existing levees may allow for future ecosystem restoration projects.

Minimize Environmental Impacts

Construction impacts would be limited if land disturbance is confined to existing levee footprints. Seepage berms, canal relocations, and land requirements could impact adjacent environmentally sensitive habitats and structures. Construction of cutoff walls could potentially disrupt groundwater flows.

FIX-IN-PLACE THERMALITO TO STAR BEND ALTERNATIVE (Alternative 2.5)

Cost

The total estimated first cost of this alternative is $422 to $905 million based on a reconnaissance level of detail.

Life Safety

This alternative would provide a consistent level of flood risk reduction to northern areas and communities within the study area, including Yuba City. It would not provide flood risk reduction from an event in the western portion of the study area. Due to the downstream levee height and its impacts on backwaters, there is an inflection point on improving the levees to address life safety south of Star Bend. This alternative would preserve eastbound SR-20 as an evacuation route, but would cut off SR-20 westbound and SR-113 as evacuation routes.

Property Damages

The alternative would capture approximately 79% of total benefits within the study area. However, some agricultural and some rural structures would still be exposed to flood risk.

Critical Infrastructure Impacts

This alternative would reduce risk for the majority of hospitals, power plants, and other critical infrastructure within the study area, but would not reduce risk for certain roadways.

Design Capacity Exceedance

It is anticipated that design capacity would be exceeded on a frequent basis. However, the levees along the northern segments of the Feather River would be improved and the probability of potential breaches would decrease. This alternative would preserve eastbound SR-20, but would cut off SR-20 westbound and SR-113 as evacuation routes. The alternative would not result in the ponding issues caused by the cross-levees in the J-levee alternatives. However, deep ponding in the southern portion of the study area would exist.

Minimize Growth Inducement (Wise Use of Floodplain)

This alternative would provide flood risk reduction to a significant portion of study area, thus removing flood risk as an obstacle to future regional growth and development in these areas. By reducing risk to the existing urbanized areas, it focuses development in areas designated or already developed in lieu of encouraging development scattered through floodplain.

Sustainability

This alternative would improve reaches of existing levees that currently have issues related to underseepage and through-seepage, thus reducing maintenance requirements. The alternative would not add any additional levees to be maintained. The Sutter Bypass levees and Feather River levees below Star Bend would not be improved and maintenance requirements are anticipated to remain the same.

Ecosystem Functionality

Opportunities exist for ecosystem restoration along existing levees. Preserving existing levees may allow for future ecosystem restoration projects.

Minimize Environmental Impacts

Construction impacts would be limited if land disturbance is confined to existing levee footprints. Seepage berms, canal relocations, and land requirements could impact adjacent environmentally sensitive habitats and structures. Construction of cutoff walls could potentially disrupt groundwater flows.

FIX-IN-PLACE WITHOUT RAISING ALTERNATIVE (Alternative 3.1)

Cost

The total estimated first cost of this alternative is $737 to $1,579 million based on a reconnaissance level of detail.

Life Safety

This alternative would provide flood risk reduction to most of the study area, including Yuba City, Live Oak, Gridley, and Biggs. In comparison to the previous alternatives, it would also reduce flood risk in the southern part of the study area. However, it would not provide flood risk reduction from an event in the western portion of the study area. This alternative would preserve SR-20 and SR-113 as evacuation routes.

Property Damages

The alternative would capture most of the total benefits within the study area. However, some agricultural and some rural structures would still be exposed to flood risk.

Critical Infrastructure Impacts

The alternative would reduce risk for hospitals, power plants, and other critical infrastructure as well as roadways and railroads within the study area.

Design Capacity Exceedance

This alternative would provide flood risk reduction to most of the study area. Flooding from an event that exceeded the design capacity would be similar to the existing (without-project condition). This alternative would preserve SR-20 and SR-113 as evacuation routes.

Minimize Growth Inducement (Wise Use of Floodplain)

This alternative would provide flood risk reduction to a significant portion of study area, thus removing flood risk as an obstacle to future regional growth and development to these areas. However, existing building codes and land use restrictions could limit future growth.

Sustainability

This alternative would improve the majority of reaches of existing levees, thus reducing maintenance requirements. The alternative would not add any additional levees to be maintained.

Ecosystem Functionality

Opportunities exist for ecosystem restoration along existing levees. Preserving existing levees may allow for future ecosystem restoration projects.

Minimize Environmental Impacts

Construction impacts would be limited if land disturbance is confined to existing levee footprints. Seepage berms, canal relocations, and land requirements could impact adjacent environmentally sensitive habitats and structures. Construction of cutoff walls could potentially disrupt groundwater flows.

PRIMARILY FIX-IN-PLACE W/ MODEST SETBACKS ALTERNATIVE (Alternative 3.2)

Cost

The total estimated first cost of this alternative is $882 to 1,900 million based on a reconnaissance level of detail.

Life Safety

This alternative would provide flood risk reduction to most of the study area, including Yuba City, Live Oak, Gridley, and Biggs. It would reduce flood risk in the southern part of the study area, but would not provide flood risk reduction from an event in the western portion of the study area. This

alternative would preserve SR-20 and SR-113 as evacuation routes. Setback levees would reduce the water surface elevation. There would be a marginal factor of safety improvements due to setback levees being built on new foundations.

Property Damages

The alternative would capture almost 100% of total benefits within the study area. However, some agricultural and some rural structures would still be exposed to flood risk.

Critical Infrastructure Impacts

The alternative would reduce risk for hospitals, power plants, and other critical infrastructure as well as roadways and railroads within the study area.

Design Capacity Exceedance

This alternative would provide flood risk reduction to most of the study area. It would not create the ponding issue that would be caused by the cross-levees of the Big "J" and Little "J" alternatives and would provide more area for ponding in the southern portion of the study area. In comparison to the previous alternatives, it would also reduce flood risk in the southern part of the study area. However, it would not provide flood risk reduction from an event in the western portion of the study area. This alternative would preserve SR-20 and SR-113 as evacuation routes. Setback levees would allow levees to withstand erosion during design exceedance better than fixing the existing levees in place.

Minimize Growth Inducement (Wise Use of Floodplain)

This alternative would provide flood risk reduction to a significant portion of study area, thus removing flood risk as an obstacle to future regional growth and development to these areas. However, existing building codes and land use restrictions could limit future growth.

Sustainability

This alternative would improve the majority of reaches of existing levees, thus reducing maintenance requirements. Setback levees would be constructed on new foundations and to latest engineering standards, thus reducing maintenance efforts. Setback levees would have access points and distances to allow maintenance vehicles access.

Ecosystem Functionality

Levee setbacks would create opportunities for restoration of riparian and wetland habitats within the setback areas (approximately 700 acres). A wider river channel would contribute to improvements in fish habitats.

Minimize Environmental Impacts

Construction impacts would be limited if land disturbance is confined to existing levee footprints. Seepage berms, canal relocations, and land requirements could impact adjacent environmentally sensitive habitats and structures. Construction of cutoff walls could potentially disrupt groundwater flows. Where setback levees are proposed, construction may require removal or relocation of structures and include conversion of farmland to upland, riparian or wetland habitats.

SETBACKS WITH ECOSYSTEM RESTORATION ALTERNATIVE (Alternative 4.1)

Cost

The total estimated first cost of this alternative is $1,543 to $3,308 million based on a reconnaissance level of detail.

Life Safety

This alternative would provide flood risk reduction to most of the study area, including Yuba City, Live Oak, Gridley, and Biggs. It would reduce flood risk for most of the study area. This alternative would preserve SR-20 and SR-113 as evacuation routes. Setback levees would reduce the water surface elevation. There would be a marginal factor of safety improvement due to setback levees being built on new foundations.

Property Damages

The alternative would capture almost 100% of total benefits within the study area. However, some agricultural and some rural structures would still be exposed to flood risk.

Critical Infrastructure Impacts

The alternative would reduce risk for hospitals, power plants, and other critical infrastructure as well as roadways and railroads within the study area.

Design Capacity Exceedance

This alternative would provide flood risk reduction to most of the study area. It would not create the ponding issue that would be caused by the cross-levees of the Big “J” and Little “J” alternatives and would provide more area for ponding in the southern portion of the study area. In comparison to the previous alternatives, it would also reduce flood risk in the southern part of the study area. However, it would not provide flood risk reduction from an event in the western portion of the study area. This alternative would preserve SR-20 and SR-113 as evacuation routes. Setback levees would allow levees to withstand erosion during design exceedance better than fixing the existing levees in place.

Minimize Growth Inducement (Wise Use of Floodplain)

This alternative would provide flood risk reduction to a significant portion of study area, thus removing flood risk as an obstacle to future regional growth and development to these areas. However, existing building codes and land use restrictions could limit future growth.

Sustainability

This alternative would improve the majority of existing levees, thus reducing maintenance requirements. Setback levees would be constructed on new foundations and to latest engineering standards, thus reducing maintenance efforts. Setback levees would have access points and distances to allow maintenance vehicles access.

Ecosystem Functionality

Levee setbacks would create opportunities for restoration of riparian and wetland habitats within the setback areas (approximately 4,100 acres). A wider river channel would contribute to improvements in fish habitats.

Minimize Environmental Impacts

Construction impacts would be limited if land disturbance is confined to existing levee footprints. Seepage berms, canal relocations, and land requirements could impact adjacent environmentally sensitive habitats and structures. Construction of cutoff walls could potentially disrupt groundwater flows. Where setback levees are proposed, construction may require removal or relocation of structures and include conversion of farmland to upland, riparian, and wetlands habitats.

Compare Value

The cost elements were compared and normalized for the Baseline Conceptual Alternatives using the following table. The table illustrates how cost scores were derived. In this comparison, a lower score is desirable as the project will benefit from lower costs.

Strategies	Cost	Score
Alternative 2.1 - Ring Levees	$853,900,000	0.101
Alternative 2.2 - Big J	$1,070,900,000	0.126
Alternative 2.3 - Little J	$839,200,000	0.099
Alternative 2.4 - Minimal Fix in Place	$267,000,000	0.031
Alternative 2.5 - Fix in Place Thermalito to Star Bend	$651,800,000	0.077
Alternative 3.1 - Fix in place w/o raising	$1,157,400,000	0.136
Alternative 3.2 - Fix in Place w/ modest setbacks	$1,376,900,000	0.162
Alternative 4.1 - Setbacks with Ecosystem Restoration	$2,273,500,000	0.268
TOTAL	**$8,490,600,000**	**1.000**

Once relative scores for performance and cost have been derived, the next step is to synthesize a value index for the Baseline Conceptual Alternatives. The basic equation for value is:

$$Value = \frac{Performance}{Cost + Time}$$

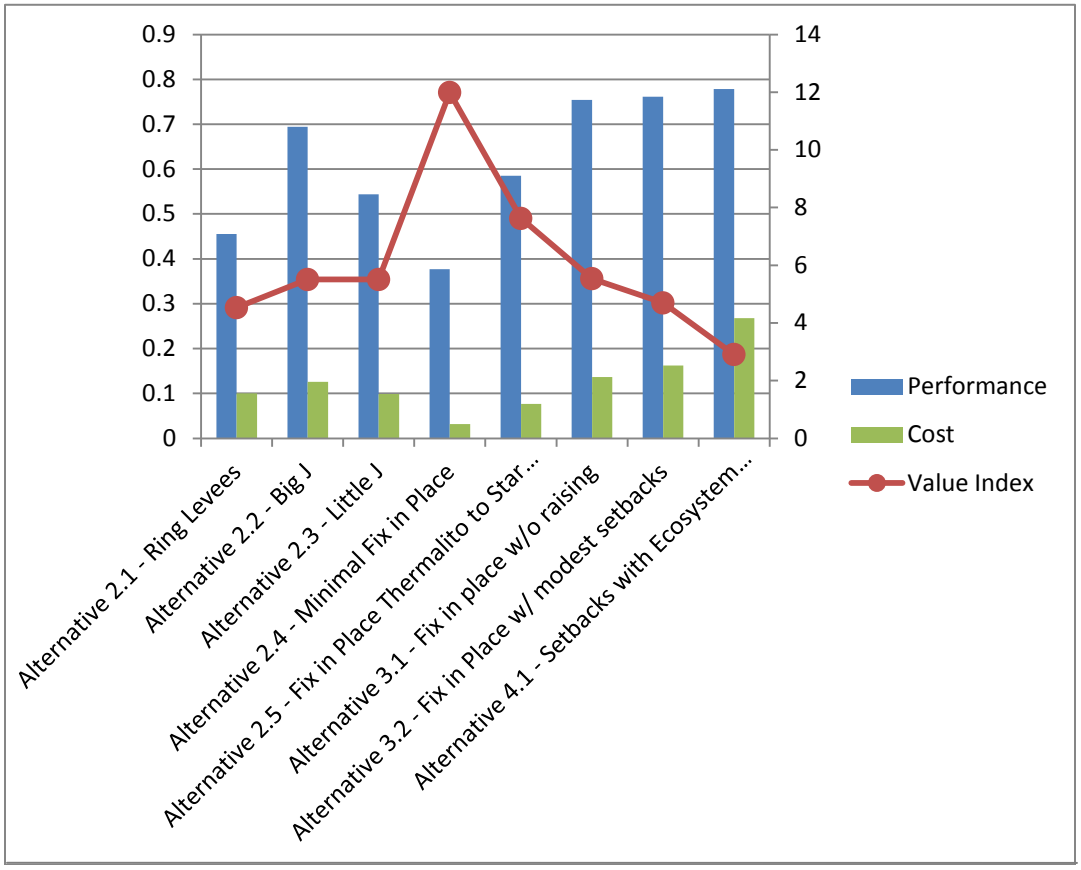
A Value Matrix was prepared which facilitated the comparison of the Baseline Conceptual Alternatives by organizing and summarizing this data into a tabular format. The performance scores for each alternative were divided by the total cost scores for each alternative to derive a value index.

Value Matrix

Baseline Conceptual Alternatives

Strategies	Performance Score	Cost/Time Score	Value Index
Alternative 2.1 - Ring Levees	0.456	0.101	4.529
Alternative 2.2 - Big J	0.694	0.126	5.504
Alternative 2.3 - Little J	0.544	0.099	5.505
Alternative 2.4 - Minimal Fix in Place	0.377	0.031	11.989
Alternative 2.5 - Fix in Place Thermalito to Star Bend	0.585	0.077	7.622
Alternative 3.1 - Fix in place w/o raising	0.754	0.136	5.535
Alternative 3.2 - Fix in Place w/ modest setbacks	0.761	0.162	4.693
Alternative 4.1 - Setbacks with Ecosystem Restoration	0.778	0.268	2.906

Comparison of Value – Baseline Conceptual Alternatives



VALUE ENGINEERING

VALUE ENGINEERING

This section documents the Creativity, Evaluation, and Development phases of the VE Study.

CREATIVE IDEA SPECULATION

The VE team generated and evaluated ideas on how to perform the various project functions using other approaches. All of the ideas that were generated during the Speculation Phase using brainstorming techniques were recorded and are included at the end of this section.

VE CONCEPTS

The ideas that the VE team considered of highest potential for value improvement or further consideration are presented as VE Concepts. Each VE Concept consists of a brief description of the suggested change and a narrative comparing the baseline concept with the VE Concept. Given this study was conducted at an early stage of project development, the VE Concepts generated are of a conceptual nature and focus primarily on optimization of the Baseline Conceptual Alternatives array through either incorporating additional flood risk reduction measures and/or modifying the Conceptual Alternatives per lessons learned during the previous workshop exercises (Function Analysis and Value Metrics). The VE team also identified suggested revisions to the Baseline Conceptual Alternative array through the combination of certain alternatives or the elimination of alternatives from further consideration.

VE CONCEPTS SUMMARY

Summary of VE Concepts

VE Concept No. & Description	Disposition	Disposition Comments
Refinement of Measures		
A-1 Adopt State's floodplain development regulations (wise use of floodplain)	Further Study Needed	PDT to review SB-5 for clarification on regulations. Make part of Without Project Conditions or revise project per regulations. Does it have enough teeth to prevent future development or do additional regulations need to be enacted in the Federal Government preferred plan?
A-2 Establish pre-stage flood fighting areas and equipment	Accept	Add as Measure (NS-9) under each Conceptual Alternative
A-3 Coordinate emergency responses to all floodplain (in lieu of by county)	Accept	Revise NS-6 and NS-7 per VE Concept

VE Concept No. & Description	Disposition	Disposition Comments
A-4 Exempt slurry walls from 408 certification process	Further Study Needed	Local sponsor to propose revision of 408 process to USACE
Modifications to Preliminary Conceptual Alternatives		
M-1 Construct ring levee around Yuba City only in lieu of around other urbanized communities	Accept	Alternative 2.1 to be revised and reevaluated accordingly. PDT to identify non-structural measures required for areas not being provided with ring levees.
M-2 Construct evacuation routes for ring levee alternative	Accept	Yuba City has evacuation routes for the ring levee alternative, but these may need to be upgraded or improved to function as evacuation during failure of the ring levee. Consider high ground refuges may function in lieu of evacuation routes.
M-3 Add S-15 (southern relief feature) to Alternatives 2.2, 2.3, 2.4, 2.5	Accept	Concept to be reviewed as an optional supplemental measure to subject Alternatives
M-4 Add measure for Fix in Place for Sutter Triangle area	Accept / Further Study Needed	PDT to review cost of measure. Consider for optional supplemental measure (S-28) for Alternatives 3.1 and 2.2
M-5 Construct hydraulic elevation control in southern part of basin to prevent certification of southern segment levees to 200 years.	Further Study Needed	Hydraulic control already exists for current levee elevations.

Revise Conceptual Alternatives Array		
R-1 Implement non-structural measures across all structural alternatives in lieu of holding independent non-structural alternative	Already Being Done	PDT to review new Alternative 1.2 (Minimal Fix in Place with Non-Structural Measures) to determine scope of work for non-structural measures to evaluate the new alternative.
R-2 Combine Alternative 3.1 and Alternative 3.2 and evaluate as single alternative	Accept	Modest setbacks become optional separate optimizations of Alternative 3.1.
R-3 Eliminate Alternative 4.1 from future consideration	Accept	Concur.
R-4 Revise Alternative 2.1	Accept	Alternative 2.1 to be revised to ring levee around only Yuba City. PDT to identify non-structural measures required for communities not being provided with ring levees.
R-5 Combine Alternative 2.4 with Alternative 2.1 (Nonstructural)	Accept	PDT to review new alternative (Minimal Fix in Place with Non-Structural Measures) to determine scope of work for non-structural measures to evaluate the new alternative.

Revise Conceptual Alternatives Array		
R-6 Eliminate Alternative 2.2 Big J from consideration	Accept	It was recommended that the Big "J" levee be eliminated from further evaluation based on a comparison with the Little “J” levee, which are functionally similar. The Big "J" levee and the Little “J” levee are expected to have similar flood damage benefits. However, the Big “J” levee would be approximately 30% greater in cost based on conceptual cost estimates. Additionally, the benefits associated with the Big “J” levee would be limited by the performance of the Sutter Bypass levees, which have a lower performance than the Feather River levees. The Little “J” levee does not utilize the Sutter Bypass levees and can therefore obtain a higher level of performance. Finally, if the design capacity of the Sutter Bypass reach of the Big “J” levee was exceeded, flood depths would be greater than existing conditions due to the height of the southern cross portion of the “J” levee (south of Yuba City). The flood depths would also increase at a faster rate due to less floodplain storage.

VE CONCEPTS DEVELOPMENT

The following sections include the narrative development of the VE Concepts as they were developed by the VE team. The narratives are provided for the additional information and understanding of the reviewer relative to each idea and are independent of their respective dispositions. After developing the VE Concepts, the VE team reviewed and discussed each VE Concept and developed a consensus relative to its implementation. In some cases, the latter discussion resulted in dispositions of "Further Study Needed" or Rejection of certain concepts altogether. As such, some concepts included below were not implemented into the project's development, but are included for information purposes only. The disposition decision of each VE Concept as determined by the VE Team is provided in the preceding table.

REFINEMENT OF MEASURES

A-1 Adopt State floodplain development regulations (wise use of floodplains). Institute state and local ordinances to avoid floodplain development

The State of California has adopted SB-5 which limits development in areas without 200-year level of protection, and is in accordance with FEMA regulations. The State and local government also have restrictions on floodplain development within Title 24 (California Building code). If the Corps selected plan provides less than 200-year protection to areas with deep flooding depths (e.g. south of Yuba City), the result would be that State law would prevent additional development in the deeper portions of the floodplain, allowing the Corps to address the wise use of floodplains directed by E.O. 11988.

A-2 Establish stage flood fighting areas and equipment

One or more secured area will be identified and stocked with appropriate flood fighting supplies, including lighting, flares, and equipment to allow working at night. Stockpiles of geotextile fabric, sand for fill, and rip-rap of various sizes must be available. The following should also be considered:

- A rapid flood fighting response cache including trained local response force capable of containing a levee breach.
- Coordinated communications efforts with California National Guard and local law enforcement must be planned for and accomplished for traffic control during evacuation.
- Coordination with local and state emergency response authorities to evacuate immediate area needs to be in place.
- USACE must assure that these measures have been planned, documented and exercised for this feasibility study.
- Reduce response time hence improve performance level (lower damages and life loss when failure occurs).

A-3 Coordinate emergency responses to all floodplain (in lieu of by county)

Emergency response will include evacuation authority directives. The flood warning system will be coordinated with Butte and Sutter Counties. A coordinated response protocol directed for information dissemination will be developed and exercised between city EMS, county EMS and State EMS offices. Appropriate decision makers will be identified and documented at the city, county, regional, state, and federal levels. Direct lines of communication will be established with decision makers to assure prompt response effort. Response operation orders will be established, and assignments and responsibilities in order to direct residents and non-residents to the most appropriate evacuation routes. USACE will assure the presence and adequacy of local, emergency response plans and assure that coordination has occurred with state and federal counterparts.

A-4 Exempt slurry walls from 408 certification process

Exempting slurry walls from the Section 408 process implies that the modifications would be reviewed under the Section 208 process. The distinction between Section 208 and 408 is that for a project to be modified under 208, it must not change hydraulics or the structural geometry of the levee, and approval of the 208 may be made by the District Engineer, otherwise approval at HQ level is required. The result would be potentially lower costs to the sponsor in form reduced effort of review by the Corps. Changes to the process require changes in USACE policy; the ability to affect change is beyond the scope of the PDT effort, and likely does not affect the selection of alternatives.

MODIFICATIONS TO PRELIMINARY CONCEPTUAL ALTERANTIVES

M-1 Construct Ring Levee around Yuba City 'only' in lieu of around other urbanized communities

Early parametric analysis leads to preliminary conclusion that smaller rings around Biggs, Gridley and Live Oak are not economical in comparison to the ring levee around Yuba City.

M-2 Construct evacuation routes for ring levee alternative

Ring levees are likely to be perceived by the public as 'refuge' areas and are not likely to be evacuated before a mainstem levee break. Therefore, confined populations are trapped within the rings so at least one evacuation route or high-ground 'refuge' should be included within the ring levee alternative. Several measures have been proposed for this purpose including Hwy 99 Causeway which links all the rings, widened ring levees to serve as high-ground 'refuge', elevated 'critical' structures, and various rescue mechanisms. This alternative is unacceptable without this evacuation route as a 'failure' of the ring levee would quickly inundate the ring and the resulting loss of life would be unacceptable.

M-3 Add Measure S-15 (southern relief structure) to Alternatives 2.3, 2.4 & 2.5

The unimproved portions of the levees under these alternatives would still be subject to levee failure, causing deep flooding in the southern portion of the study area. A Relief Structure or Emergency Relief Mechanism could help relieve both stage and duration of deep ponding (20'+).

M-4 Add measure for Fix-in-Place for Sutter Triangle Area

The Right Bank, Wadsworth Canal and Left Bank, Sutter Bypass protect parts of the small town of Sutter. This measure would reduce flood impacts in that area. The area is also subject to flood risks from the Northern Feather River levee breaks. Other measures would address the Feather River Levee Improvements, however, this measure is necessary to protect this area from adjacent levee failures.

M-5 Construct Hydraulic Elevation Control in the Southern part of the basin to prevent/preclude certification of Southern segment levees to 200 years

The southern portion of the basin is agricultural at present and subject to deep flooding. Wise use of the floodplain could be facilitated by improving the levees to less than a 200-year level of protection. State law (SB-5) precludes urbanization in areas where there is less than 200-year level of protection after 2015. Additional local land-use restrictions may also be required to meet this objective.

REVISED CONCEPTUAL ALTERNATIVE ARRAY

R-1 Combine Alternatives 3.1 and 3.2

This new alternative would combine 3.1 (Fix in place without raising) with 3.2 (Primarily fix in place including modest setbacks). The only difference between these two alternatives is the addition of modest setback levees in isolated locations. Therefore, the outputs and the costs of 3.1 and 3.2 are not distinctive enough to warrant carrying them forward as separate alternatives. Any ecosystem restoration opportunities as a result of the setbacks can be considered a first added increment should this new alternative move forward.

R-2 Implement Nonstructural measures across all structural alternatives

A standalone nonstructural alternative does not significantly address project objectives. Therefore, Alternative 1.1 will be modified by combining it with Alternative 2.4. Due to residual risk, nonstructural measures would enhance all project alternatives in achieving objectives and will be added to those alternatives as appropriate. See VE Concept R-5 below.

R-3 Eliminate Alternative 4.1

This alternative is significantly cost ineffective. The additional cost of this alternative compared to combined alternatives 3.1 and 3.2 exceeds the additional restoration benefits. However, if the hydraulic benefits of setting back the Sutter Bypass east levee in combination with other measures upstream and downstream of the study area result in greater system-wide benefits, then this alternative should be revisited.

R-4 Modify Alternative 2.1

Refine Alternative 2.1 by eliminating the individual ring levees around Biggs, Gridley, and Live Oak. The cost of constructing of ring levees around Biggs, Gridley, and Live Oak are significantly greater than the estimated annual benefits could support

The refined alternative consists of constructing a ring levee around Yuba City in combination with nonstructural measures focused on reducing risk in areas outside of the ring levee.

R-5 Combine Alternative 2.4 with Alternative 1.1

USACE policy requires a predominantly nonstructural alternative. This policy requirement could be achieved by adding a new Alternative 1.2 that is a combination of Alternative 2.4 and 1.1.

R-6 Eliminate Alternative 2.2

It was recommended that the Big "J" levee be eliminated from further evaluation based on a comparison with the Little “J” levee, which are functionally similar. The Big "J" levee and the Little “J” levee are expected to have similar flood damage benefits. However, the Big “J” levee would be approximately 30% greater in cost based on conceptual cost estimates. Additionally, the benefits associated with the Big “J” levee would be limited by the performance of the Sutter Bypass levees, which have a lower performance than the Feather River levees. The Little “J” levee does not utilize the Sutter Bypass levees and can therefore obtain a higher level of performance. Finally, if the design capacity of the Sutter Bypass reach of the Big “J” levee was exceeded, flood depths would be greater than existing conditions due to the height of the southern cross portion of the “J” levee (south of Yuba City). The flood depths would also increase at a faster rate due to less floodplain storage.

IDEA EVALUATION

EVALUATION PROCESS

Prior to development the creative ideas were evaluated to determine which ideas would be considered further and developed into VE Concepts. Each idea was evaluated with respect to the functional requirements of the project. Performance, cost, time, and risk were also considered during this evaluation.

Once each idea was discussed, it was given a rating. This is based on a go/no-go approach as indicated by the following rating index. This rating represents the subjective opinion of the VE team regarding the potential benefits of the concepts in order to prioritize them for development. Comments on the VE team's rating rationale are included as well.

1 = Develop	Concept results in performing project functions in a manner that results in increased value potential. Concepts in this rating group were considered relevant to the VE Study's analysis of the Conceptual Alternatives array and level of project development at the time of the study.
2 = Rationale for Rating	Concept is not technically feasible, does not meet project need and purpose, or represents programmatic operations outside of design development. **OR** Concept was considered not relevant to the VE Study and level of project development at the time of the study. Additional information or design development may be required for concept to be fully evaluated. Concepts in this rating group should be considered during later design development stages. Only ideas that were given a rating of 2 include the rationale for the rating.

Ideas rated 1 were developed further and those that were found to have the greatest potential for value improvement for the project were incorporated into the Final Conceptual Alternative Array.

IDEA SUMMARY LIST

Idea No.	Idea Description	Rating	Rating Rationale
1	Construct ring levee around Yuba City only in lieu of around other urbanized communities	1	
2	Extend the minimal fix in place alternative to Star Bend	1	
3	Close the J	2	Technically infeasible
4	Open the J on the southern end	2	Costly without benefit
5	Combine Minimal Fix in Place with ring levees around northern communities	2	Costly without benefit
6	Abandon southern portion of the project and return to natural floodplain	2	Requires further refinement
7	Install sensors in levees to monitor conditions for early warning system	2	Eliminate. Has maintenance issues. Costly
8	Convert SR-20 into causeway to facilitate evacuation	2	Costly
9	Convert SR-113 into causeway	2	Costly
10	Convert SR-99 into causeway	Combine with 24	
11	Extend Sutter Bypass to east	2	Affects beyond the study area, regional, system-wide impacts
12	Convert Cherokee Canal into bypass	2	Costly, affects beyond study area, fish affects
13	Connect Tisdale Bypass to Feather River	2	hydraulically Ineffective, fish passage affects
14	Implement widespread relocations of residences and businesses in project area	2	Costly due to widespread definition
15	Connect East interceptor to Feather River	2	hydraulically Infeasible

Idea No.	Idea Description	Rating	Rating Rationale
16	Construct safe havens / raised islands for area south of Yuba City	2	Consider during project development
17	Institute boat patrols for ring levee alternative	2	Consider during project development
18	Relocate portion of Sutter, CA that is within floodplain	2	
19	Construct structure on Yuba River to create storage	2	Large regional effects
20	Combine Alternative 3.1 and Alternative 3.2 and evaluate as single alternative	1	
21	Combine Alternatives 2.4, 2.5, and 3.1 and evaluate as single alternative	2	Alternatives have distinctiveness and outputs that needs to be demonstrated
22	Add inflatable rubber dam to increase capacity of Oroville	2	Outside of project scope, regional effects, would only provide rare event protection
23	Relocate measure S-24 (Gilsizer Cross Levee) further to north	2	Option of cross-levee alternative, but more costly
24	Construct evacuation routes for ring levee alternative	1	
25	Armor ring levees to resist failure from overtopping	2	Consider during project development
26	Incorporate nonstructural measures to improve Minimal Fix in Place alternative	1	
27	Adopt State's floodplain development regulations (wise use of floodplain). Institute state and local ordinances to avoid floodplain development	1	
28	Establish pre-stage flood fighting areas and equipment	1	
29	Implement housing standards for flood proofing of buildings in floodplain	2	Assumed as part of Without Project conditions
30	Coordinate emergency responses to all floodplain (in lieu of by county)	1	

Idea No.	Idea Description	Rating	Rating Rationale
31	Combine Alternatives 2.2 and 2.3 into single alternative	2	Little J has more significant impacts, residual risks are unique to alternatives
32	Consider removing homes nearest to existing levees	2	Already being considered as measures
33	Incorporate pump stations to enhance flood risk reduction provided by levees	2	Consider during project development
34	Develop plans to implement fuse plugs during flood event	2	Consider during project development
35	Develop plans to breach levees during flood event	2	Consider during project development
36	Consider rapid levee repair measures being developed by ERDC	2	Failures being considered are more significant than rapid repair measures could address
37	Add measure for Fix in Place for Sutter Triangle area	1	
38	Construct setback levee in Yuba City in location of depression (low lying area)	2	Consider during project development, Costly
39	Implement measures to support emergency evacuation (helicopters, trains, etc.)	2	Incorporated into emergency response plan
40	Consider surface berms in areas where development near levees permits	2	Consider during project development
41	Add relief wells	2	Consider during project development
42	Conduct geophysical survey of levees and implement measures to fix underseepage/through-seepage in critical areas only	2	Extent of fixes would be similar to full fix in place
43	Construct hydraulic elevation control in southern part of basin to prevent preclude certification of southern segment levees to 200 years.	1	
44	Convert J alternatives to construct L with gap	2	Hydraulic infeasible, water outflanks it
45	Compartmentalize the basin	2	Consider during future project development,

Idea No.	Idea Description	Rating	Rating Rationale
			optimization option
46	Perform evaluation of existing levees per segment to determine measures in each area	2	Has been completed
47	Allow adaptable fix in place over time to address problem areas as they arise	2	Implementation/phasing strategy of ultimate project solution
48	Exempt slurry walls from 408 certification process	1	
49	Allow slurry walls be constructed wherever needed	Combines with 49	
50	Construct "straight" alignment of offset Feather River levees to reduce O&M	2	Consider as enhancement of S-10, political ramifications need to be considered, new levee is 3 times the cost of fix in place, thus alternative is costly
51	Consider constructing soil cement levees	2	Consider during future project development, optimization option
52	Authorize funds for Sac bank	2	Outside of project scope and addressed by other study
53	Incorporate fuse gates into Ring Levee alternative	2	Design detail
54	Reduce height of northern ring levees to 100 year event	2	Consider during project development
55	Combine ring levee around Biggs and Gridley into single ring	2	Costly, combines "bathtubbing"
56	Elevate structures inside ring levees and promote additional agricultural development outside	2	Costly
57	Transfer ring levees to local authorities	2	Could consider local input to ring levee alignments
58	Use borrow areas from inside ring levees and use for interior storage	2	Could create seepage problems

Idea No.	Idea Description	Rating	Rating Rationale
59	Implement non-structural measures across all structural alternatives in lieu of holding independent non-structural alternative	1	
60	Minimize flood risk reduction measures to areas south of Big J levee to allow agricultural activities under reduced protection	1	
61	Incorporate minimal protection of areas to allow agricultural use without growth inducement	Combine with 61	
62	Fix problem areas identified by PL-8499 program only	1	
63	Add Measure S-15 (Southern Relief Feature) as an option to Alternative 2.2	2	Breach so far south would be self-draining
64	Implement levee overtopping protection in select areas	2	Consider during future project development, considered by current measures
65	Construct transverse hydraulic conveyance measure in lieu of cross-levee	2	Hydraulic infeasible
66	Add S-15 (southern relief feature) to Alternatives 2.3, 2.4, 2.5	1	
67	Expand Gilsizer slough to handle or divert flood waters	2	Hydraulic infeasible
68	Add Measure S-27 (improve upstream fish passage) to Alternatives 3.2	2	Wouldn't change the selection of the measure
69	Include hydraulic control on southern portion of basin into Alternative 3.1 and 3.2	2	Consider during future project development
70	Incorporate additional setback levee locations into Alternative 3.2	2	Consider during future project development
71	Modify Measure S-26 (managed overtopping) to include selective superiority based on geotechnical	2	Design detail

Idea No.	Idea Description	Rating	Rating Rationale
72	Use deep soil mixing in lieu of slurry walls for fix in place measures	2	Design detail
73	Use fly ash slurry in lieu of bentonite slurry for fix in place	2	Design detail
74	Consider structural flood walls in locations of limited ROW	2	Design detail
75	Include Sutter Bypass levee full setback in Alternative 3.1 per CVFPP plan	2	Regional impacts, system-wide effects, relies on others
76	Use relief wells in lieu of levee improvements	2	Design detail
77	Over construct levee crowns to support emergency borrow and safe havens	Combine with 24	
78	Develop evacuation routes to access Sutter Butte during flood event	Combine with 24	
79	Elevate existing roads to serve as interim cross-levees	2	Less expensive to construct adjacent to roads than raise roads
80	Over-widen ring levees	2	Lack of material, costly
81	Allow farming on levees	2	Infeasible and conflicts with policies, only works on over-widened levees
82	Consider secant pile wall for flood wall structures	2	Design detail
83	Use vinyl sheetpile for flood wall structures	2	Design detail
84	Create floatable critical structures	2	Technical infeasible
85	Allow all underground parking structures to flood for storage purposes	2	Technical infeasible
86	Use barges for evacuation of people	2	Technical infeasible
87	Instigate penalties for development in floodplain	2	Programmatic issue
88	Put flood insurance into exchange program that pays for	2	Programmatic issue

Idea No.	Idea Description	Rating	Rating Rationale
	improvements		
89	Elevate all critical structures	2	Included in non-structural measure analysis, modify NS-3 to include critical infrastructure
90	Designate and develop natural floodways within project area	2	hydraulically Infeasible
91	Construct bypass in northern portion of project	2	Previously considered and rejected due to cost and fish passage
92	Construct U levee on northeast side of northern communities	2	hydraulically Infeasible due to topography
93	Upgrade and modification of Tisdale weir	2	Regional impacts, system-wide effects, outside of project/study scope
94	Widen and improve Fremont weir	2	Previously dismissed, Outside of project scope, regional effects, requires improvements by others
95	Install measures to improve fish passage on Sutter Bypass	2	Already being done or considered as measure
96	Install control structure at Feather River and Cherokee Canal bypass	2	Control structure only relevant for bypass channel
97	Eliminate Alternative 4.1 from future consideration	1	
98	Eliminate Alternative 2.1 from consideration	1	
99	Eliminate Alternative 2.4 from consideration	1	
100	Combine and optimize Alternative 2.5, 3.1 and 3.2	2	Alternatives have distinctiveness and outputs that needs to be demonstrated
101	Eliminate Alternative 2.3 from consideration	1	
102	Widen Sutter Bypass south of study area and southern portion of project limits to reduce depths	2	Requires improvements outside of project limits, relies on others to implement, downstream impacts

Idea No.	Idea Description	Rating	Rating Rationale
103	Construct new Feather River bridge south of Star Bend	Combines with 24	
104	Forecast reservoir operations to lower stage downstream	2	Regional considerations, impacts water supply
105	Redirect water by altering existing areas, regrade mining tailings	2	Consider during future project development, already being considered
106	Manage hydraulic flows and characteristics in floodway to reduce impacts from floods	2	Consider during future project development, already being considered
107	Manage vegetation to optimize hydraulic conveyance in channels and maintain ecosystem function	2	Consider during future development

VALUE ANALYSIS OF
OF FINAL ALTERNATIVES ARRAY

VALUE ANALYSIS OF FINAL ALTERNATIVES ARRAY

FINAL ALTERNATIVE ARRAY SUMMARY

The following summarizes the scope of work of the final alternatives.

All Alternatives

- Coordinated flood warning and evacuation system
- Pre-staging equipment and flood fighting areas (Measure NS-9)
- Levees surrounding urban and urbanizing areas should consider SB-5 requirement of 1/200 flood risk reduction
- Consider economic and flood risk reduction justification for setback levee alignments and isolated weak spots as supplemental options where feasible

Primarily Nonstructural with Minimal Levee Improvement Reaches

- Improve Feather River Levees from Sunset Weir to Star Bend
- Implement non-structural measures focused on reducing risk to loss of life
- Prioritize properties based upon annualized economic value and flood risk probability to determine which structures get relocated or flood-proofed (likely focused on critical infrastructure and large industrial properties)
- Some evacuation route or refuge area improvements may be necessary

Yuba City Ring Levee

- Construct ring levee around Yuba City
- Implement non-structural measures focused on reducing risk to loss of life
- Mitigations for induced damages resulting from ponding on north side of ring levee
- Some evacuation route or refuge area improvements may be necessary
- Prioritize properties based upon annualized economic value and flood risk probability to determine which structures get relocated or flood-proofed (likely focused on critical infrastructure and large industrial properties)

Little "J" Levee

- Improve Feather River Levees from Thermalito to Shanghai Bend
- Construct partial southern cross-levee
- Construct levee north of cross-levee on west side of Yuba City
- Assume alignment of southern levee to be identical to southern levee of ring levee alternative. Levee alignment will be based upon flood risk reduction of existing development with possible consideration to accommodate sphere of influence

Fix in Place Feather River from Thermalito to Star Bend

- Improve Feather River Levees from Thermalito to Star Bend
- Includes Star Bend setback levee
- Implement non-structural measures focused on reducing risk to loss of life
- Prioritize properties based upon annualized economic value and flood risk probability to determine which structures get relocated or flood-proofed (likely focused on critical infrastructure and large industrial properties)
- Some evacuation route or refuge area improvements may be necessary

Fix in Place Feather River, Sutter Bypass, and Wadsworth Canal

- Improve Feather River Levees from Thermalito to Sutter Bypass Confluence (southern basin)
- Improve Sutter Bypass East Levee from Wadsworth Canal to the Feather River and the Wadsworth Canal East Levee, East Interceptor to the Sutter Bypass
- Includes Star Bend setback levee
- Includes Northern Feather River setback levee
- Improve Wadsworth Canal South Levee
- Optional Sutter Triangle levee improvement
- Consider economic and flood risk reduction justification for setback levee alignments and isolated weak spots as supplemental options where feasible
- Optional consideration of "full" Sutter Bypass East Levee setback

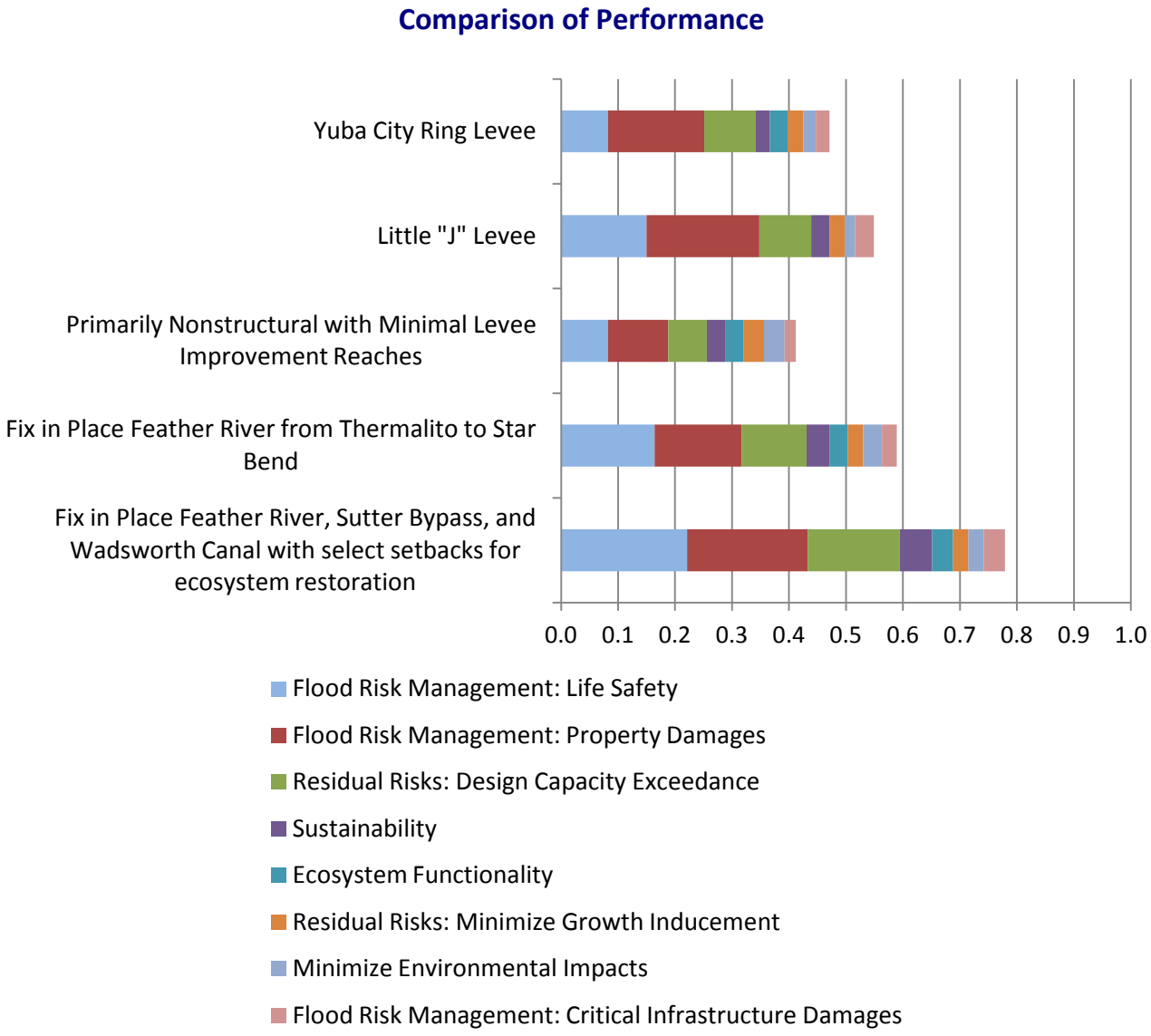
VALUE METRICS

Measure Performance of Final Alternatives

The project team and stakeholders evaluated the performance of the Final Alternatives relative to the performance attributes previously identified.

Compare Performance of Final Alternatives

The total performance scores reflect the performance rating for each attribute multiplied by its overall priority (weight) expressed using a ratio scale. A total performance score of "1" would indicate the highest level of desired performance (i.e., "ideal" performance). The following chart compares the total performance scores for the final alternatives.



The information below reflects the performance ratings and associated rationale for each attribute.

Yuba City Ring Levee

Flood Risk Management: Life Safety
Rating: **3.0**

Rationale: Ring levees protect a majority of the concentrated population and property. Evacuation routes are assumed to be into the areas surrounded by the ring levees, however, it is assumed some measure of evacuation route will be provided. The ring levee around Yuba City is partially part of the Feather River levee system, thus there is only one line of protection (vs. two layers from the ring levees of the other communities). Locations outside of the ring levees are excluded from the additional protection, however, these areas are relatively small in population density. Does not reduce flood risk in areas outside of ring levee (i.e. northern communities of Gridley, Biggs, and Live Oak and southern basin). Ring levees rely on flood gates and other measures at crossings with

railroads and roadways to be actively operated in order to be effective. Pump stations are required to maintain flood protection. Non-structural measures will be implemented to reduce risk to life safety. Any project that relies on the existing levee has a higher life safety risk due to less predictable performance (levees can fail prior to overtopping at any location).

Flood Risk Management: Property Damages
Rating: **7.2**

Rationale: Protects key urban development areas, thus property damages from flood events should be minimized. The ring levees around just Yuba City accounts for protecting 77% of all property values. Some agricultural and some rural structures would still be exposed to flood risk. Captures approximately 72% of total benefits.

Residual Risks: Design Capacity Exceedance
Rating: **4.0**

Rationale: Does not correct deficient flood risk in areas not surrounded by ring levees. Evacuation routes are assumed to be into the areas surrounded by the ring levees, however, it is assumed some measure of evacuation route will be provided. The ring levee around Yuba City is partially part of the Feather River levee system, thus there is only one line of protection (vs. two layers from the ring levees of the other communities). Ring levees may create an exacerbated situation of a catch basin for flood waters when a breach in the levee occurs. Locations outside of the ring levees (non-urban areas) are excluded from the additional protection.

Sustainability
Rating: **3.0**

Rationale: Alternative requires maintenance of pump stations and closure structures to ensure effective continued operation and flood risk management. Ring levees on new alignments would be constructed on new foundations and to modern engineering standards. Requires maintaining existing levees as well as the additional ring levees surrounding Yuba City. Revision to Alternative results in significantly less new ring levees and fewer pump stations and closure structures.

Ecosystem Functionality
Rating: **6.0**

Rationale: Opportunities exist for ecosystem restoration projects on the existing levees at Yuba City where they are combined with the ring levees. There is little opportunity for ecosystem restoration on other portions of the project. Constructing ring levees may invade existing functioning ecosystems. Preserving existing levees may allow future ecosystem restoration projects.

Residual Risks: Minimize Growth Inducement
Rating: **6.0**

Rationale: Limits growth of local communities and future regional growth. The ring levees around northern communities had limited space to allow future development, thus rating did not change when these ring levees were eliminated.

Minimize Environmental Impacts
Rating: **5.0**

Rationale: Preserves the existing floodplain while minimizing the potential for future growth and its adverse effects on air quality and other resources. Conflicts with local land use plans. Protects existing urban development but not areas approved for future growth in local land use plans. Direct impacts from construction could affect environmentally and culturally sensitive areas within the new levee footprint. Ring laves separate the communities from their surrounding supporting areas. Pump stations will have to be operated periodically which may create air quality and noise impacts. Potential HTRW issues on new levee alignments. Construction of levees in urban areas which are more susceptible to air and noise quality impacts. Requires multiple crossings of railroads and crossing two significant drainage culverts in Yuba City. Requires significant borrow material to construct levees. Ring levees would impact the view sheds.

Revision to Alternative results in significantly reduced environmental impacts due to reduced ring levee reaches.

Flood Risk Management: Critical Infrastructure Damages
Rating: **6.0**

Rationale: Ring levees protect medical facilities and other critical infrastructure within the concentrated areas, but do not protect roadways and railroads.

Little "J" Levee

Flood Risk Management: Life Safety
Rating: **5.5**

Rationale: Evacuation route on Westbound Route 20 is cut off. Areas in the southern portion of the project (below Sutter Bypass levee) would remain at risk to flood. Cuts off two major drainage areas in Yuba City.

Flood Risk Management: Property Damages
Rating: **8.4**

Rationale: Captures approximately 84% of total benefits. Ten percent of benefits captured would be agricultural and residual.

Residual Risks: Design Capacity Exceedance
Rating: **4.0**

Rationale: Evacuation route on Westbound Route 20 is cut off. Areas in the southern portion of the project (below Sutter Bypass levee) would remain at risk to flood. Flood depths would be greater (significantly more than 3 feet) and faster due to more concentration of flooding in areas north of Little J levee due to capturing of flood water from upstream levee breach. Cuts off two major drainage areas in Yuba City.

Sustainability
Rating: **4.0**

Rationale: Alternative requires maintenance of pump stations and closure structures to ensure effective continued operation and flood risk management.

Ecosystem Functionality
Rating: **6.0**

Rationale: Opportunities exist for ecosystem restoration projects on the existing levees. There is little opportunity for ecosystem restoration on other portions of the project. Preserving existing levees may allow future ecosystem restoration projects.

Residual Risks: Minimize Growth Inducement
Rating: **6.0**

Rationale: Reduces flood risk to Yuba City and other existing urbanized areas. Focuses development in areas designated or already developed in lieu of encouraging development scattered through floodplain.

Minimize Environmental Impacts
Rating: **4.0**

Rationale: Construction of new cross-levee would directly impact farmland and potential sensitive habitat areas. Construction impacts would be limited if land disturbance is confined to existing levee footprints. Seepage berms, canal relocations, and land requirements could impact adjacent environmentally sensitive habitats and structures. Construction of cutoff walls could potentially disrupt groundwater flows. Potential HTRW issues on new levee alignments. Construction of levees in urban areas that are more susceptible to air and noise quality impacts. Requires crossing two significant drainage systems in Yuba City. Requires significant borrow material to construct levees. New cross-levees may impact view sheds. Separates the agricultural areas in the southern portion of the project.

Flood Risk Management: Critical Infrastructure Damages
Rating: **8.0**

Rationale: Alternative protects all hospitals, power plants, and other critical infrastructure but does not protect certain roadways within project limits.

Primarily Nonstructural with Minimal Levee Improvement Reaches

Flood Risk Management: Life Safety
Rating: **3.0**

Rationale: Reduces flood risk to certain portion of project limits only and would not reduce flood risk to communities in northern area of project limits (Live Oak, Gridley, and Biggs) or portions of Yuba City. Majority of life risk occur in areas south of the Yuba River and Feather River confluence and in Yuba City, which this alternative does address. Cuts off all major evacuation routes (SR-99 and

Westbound SR-20). Eastbound SR-20 evacuation route would remain. Does not create ponding issue caused by cross-levees. Non-structural measures will be implemented to reduce risk to life safety. Any project that relies on the existing levee has a higher life safety risk due to less predictable performance (levees can fail prior to overtopping at any location).

Flood Risk Management: Property Damages
Rating: **4.5**

Rationale: Captures approximately 45% of total benefits. Exposes the maximum amount of property to potential damage. Alternative provides least amount of flood risk reduction to the project. Yuba City includes 77% of total property values in the project limits. Alternative provides flood risk reduction to approximately half of Yuba City, thus achieving some reduction in property damages. Provides some protection to agricultural lands.

Residual Risks: Design Capacity Exceedance
Rating: **3.0**

Rationale: Given limited extent of levee improvements, design capacity is exceeded on a frequent basis. Cuts off all major evacuation routes (SR-99 and Westbound SR-20). Eastbound SR-20 evacuation route would remain. Does not create ponding issue caused by cross-levees, however, deeper ponding in southern portion would occur.

Sustainability
Rating: **4.0**

Rationale: Minimum amount of existing levees are improved, thus maintenance efforts are greater as compared to fixed in place.

Ecosystem Functionality
Rating: **6.0**

Rationale: Opportunities exist for ecosystem restoration projects on the existing levees. There is little opportunity for ecosystem restoration on other portions of project. Preserving existing levees may allow future ecosystem restoration projects.

Residual Risks: Minimize Growth Inducement
Rating: **8.0**

Rationale: Protects Yuba City and other communities, however, provides limited risk reduction in all other areas of the project limits.

Minimize Environmental Impacts
Rating: **8.0**

Rationale: Construction impacts would be limited if land disturbance is confined to existing levee footprints. Seepage berms, canal relocations, and land requirements could impact adjacent environmentally sensitive habitats and structures. Construction of cutoff walls could potentially disrupt groundwater flows.

Flood Risk Management: Critical Infrastructure Damages
Rating: **5.0**

Rationale: Does not provide flood risk reduction for key critical infrastructure (hospitals, power plants) and does not provide flood risk reduction for roadways or railroads within project limits.

Fix in Place Feather River from Thermalito to Star Bend

Flood Risk Management: Life Safety
Rating: **6.0**

Rationale: Provides consistent level of flood risk reduction to northern areas and communities within project limits as well as to Yuba City. Does not provide flood risk reduction from an event in the western portion of project areas. Due to the downstream levee height and its impacts on backwaters, fixing south of Star Bend there is an inflection point on life safety. Cuts off SR-20 Westbound and SR-113 as evacuation routes.

Flood Risk Management: Property Damages
Rating: **6.5**

Rationale: Captures approximately 65% of total benefits. Ten percent of benefits captured would be agricultural and residual.

Residual Risks: Design Capacity Exceedance
Rating: **5.0**

Rationale: Design capacity is exceeded on a frequent basis, however, the levees in northern segments of Feather River would be improved thus the probability of potential breach is reduced. Cuts off all major evacuation routes (SR-99 and Westbound SR-20). Eastbound SR-20 evacuation route would remain. Does not create ponding issue caused by cross-levees, however, some ponding in southern portion would exist.

Sustainability
Rating: **5.0**

Rationale: Improves segments of existing levees, reducing maintenance requirements. Retains Sutter Bypass levees and Feather River levees below Star Bend as they exist.

Ecosystem Functionality
Rating: **6.0**

Rationale: Limited opportunities for ecosystem restoration projects where levees are fixed in place. However, any levee setback options exercised would create opportunities for restoration of riparian and wetland habitats within the setback areas (700 acres). Wider river channel contributes to improvements in fish habitats.

Residual Risks: Minimize Growth Inducement
Rating: **6.0**

Rationale: Provides flood risk reduction to significant portion of study area, thus removing flood risk as an obstacle to future regional growth and development to these areas.

Minimize Environmental Impacts
Rating: **7.5**

Rationale: Construction impacts would be limited if land disturbance is confined to existing levee footprints. Seepage berms, canal relocations, and land requirements could impact adjacent environmentally sensitive habitats and structures. Construction of cutoff walls could potentially disrupt groundwater flows.

Flood Risk Management: Critical Infrastructure Damages
Rating: **6.5**

Rationale: Alternative protects all hospitals, power plants, and other critical infrastructure but does not protect certain roadways within project limits.

Fix in Place Feather River, Sutter Bypass, and Wadsworth Canal with select setbacks for ecosystem restoration

Flood Risk Management: Life Safety
Rating: **8.1**

Rationale: Provides flood risk reduction to the most areas within the project limits. Does not create ponding issue caused by cross-levee of the Little J Alternative. Does not provide flood risk reduction from an event in the western portion of project areas. Protects evacuation routes for SR-20 and SR-113. Reduces flood risk to southern part of project limits. Setbacks reduce the water surface elevation. Marginal factor of safety improvements due to levees built on new foundations.

Flood Risk Management: Property Damages
Rating: **9.0**

Rationale: Captures approximately 90% of total benefits. Ten percent of benefits captured would be agricultural and residual. Some flood stage reduction is possible.

Residual Risks: Design Capacity Exceedance
Rating: **7.1**

Rationale: Provides flood risk reduction to the most areas within the project limits. Does not create ponding issue caused by cross-levee of the Little J Alternative and provides the most area for ponding in southern portion. Does not provide flood risk reduction from an event in the western portion of project areas. Protects evacuation routes for SR-20 and SR-113. Reduces flood risk to southern part of project limits. Setbacks allow levees to withstand erosion during design exceedance better than fixing existing levees.

Sustainability
Rating: **7.1**

Rationale: Improves majority of segments of existing levees, reducing maintenance requirements. Does not add any additional segments of levees to be maintained. Offset segments will be constructed on new foundations and to latest engineering standards, thus reducing maintenance efforts. Offset segments will have access points and distances to allow maintenance vehicles access.

Ecosystem Functionality
Rating: **7.0**

Rationale: Levee setbacks would create opportunities for restoration of riparian and wetland habitats within the setback areas (700 acres). Wider river channel contributes to improvements in fish habitats.

Residual Risks: Minimize Growth Inducement
Rating: **6.0**

Rationale: Provides flood risk reduction to the entire study area, thus removing flood risk as an obstacle to future regional growth and development.

Minimize Environmental Impacts
Rating: **6.0**

Rationale: Same as Alternative 3.1, but where modest setback levees are proposed, construction may require removal or relocation of structures and loss of farmland. Seepage berms, canal relocations, and land requirements could impact adjacent environmentally sensitive habitats and structures. Construction of cutoff walls could potentially disrupt groundwater flows.

Flood Risk Management: Critical Infrastructure Damages
Rating: **9.0**

Rationale: Alternative protects all hospitals, power plants, and other critical infrastructure as well as all roadways and railroads within project limits.

Compare Value

The cost elements were compared and normalized for the Final Alternatives using the table on the following page. This table illustrates how the cost scores were derived. In this comparison, a lower score is desirable as the project will benefit from lower costs.

Strategies	Cost	Score
Yuba City Ring Levees	$482,900,000	0.103
Little "J" Levee	$839,200,000	0.179
Primarily Nonstructural with Minimal Levee Improvement Reaches	$267,000,000	0.057
Fix in Place Feather River from Thermalito to Star Bend	$651,800,000	0.139
Fix in Place Feather River, Sutter Bypass, and Wadsworth Canal with select setbacks for ecosystem restoration	$1,376,900,000	0.294
TOTAL	**$4,688,700,000**	**1.000**

Once relative scores for performance and cost have been derived, the next step is to synthesize a value index for the alternatives. The basic equation for value is:

$$Value = \frac{Performance}{Cost + Time}$$

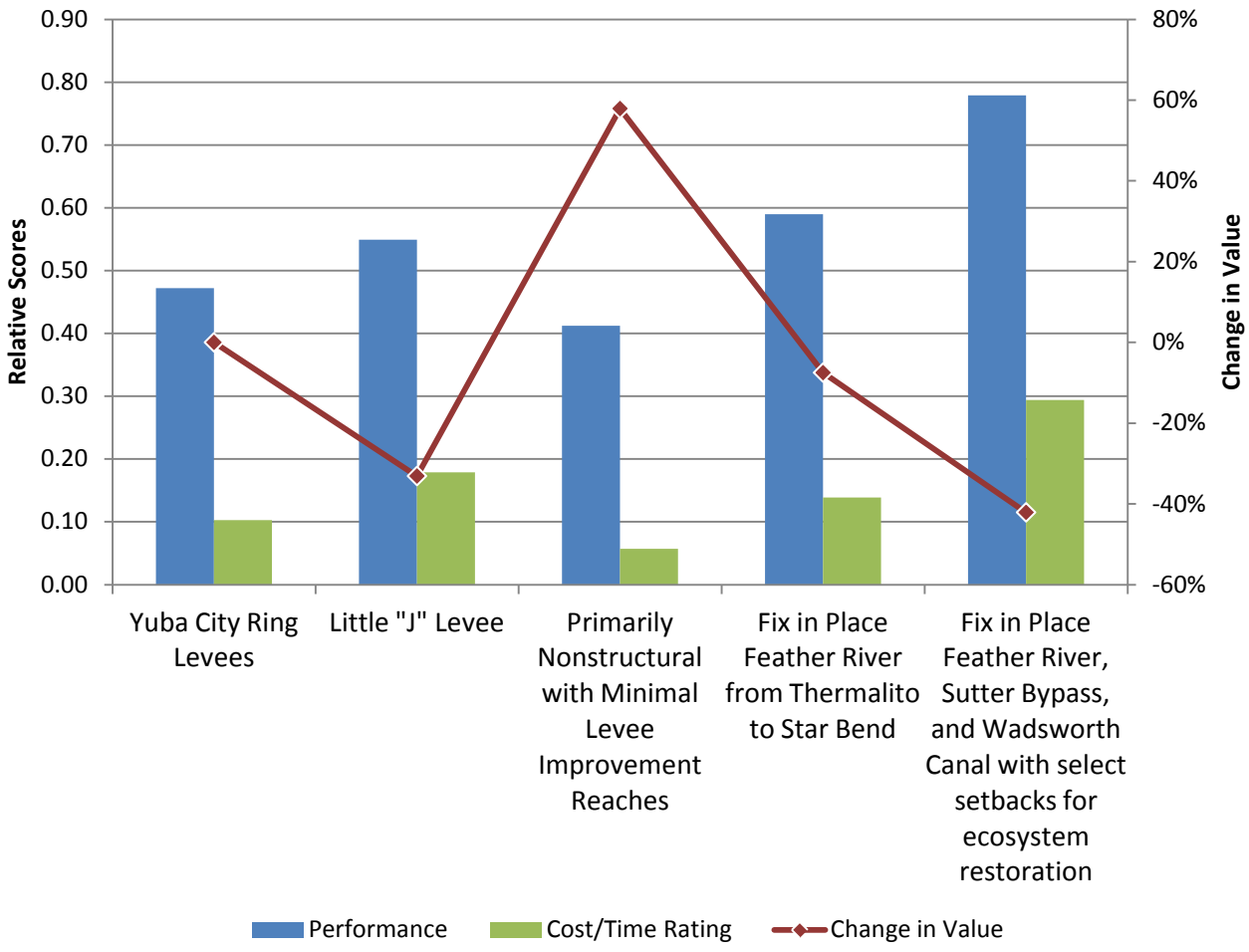
A Value Matrix was prepared which facilitated the comparison of the alternatives by organizing and summarizing this data into a tabular format. The performance scores for each alternative were divided by the total cost/time scores for each alternative to derive a value index.

Value Matrix

Final Conceptual Alternatives

Strategies	Performance Score	Cost/Time Score	Value Index
Yuba City Ring Levees	0.472	0.103	4.585
Little "J" Levee	0.549	0.179	3.066
Primarily Nonstructural with Minimal Levee Improvement Reaches	0.412	0.057	7.242
Fix in Place Feather River from Thermalito to Star Bend	0.590	0.139	4.242
Fix in Place Feather River, Sutter Bypass, and Wadsworth Canal with select setbacks for ecosystem restoration	0.779	0.294	2.654

Comparison of Value – Final Conceptual Alternatives



VALUE ENGINEERING/ PLANNING CHARETTE PROCESS

VALUE ENGINEERING/PLANNING CHARETTE PROCESS

This report section describes the procedures used during the VE study/Planning Charette. It is followed by the workshop agenda and workshop attendance sheets.

A systematic approach was used in the VE study and the key procedures followed were organized into three distinct parts: (1) Pre-Study Preparation, (2) VE Study/Planning Charette Workshop, and (3) Post-Study Procedures.

PRE-STUDY PREPARATION

In preparation for the VE study/Planning Charette, the team leader reviewed critical aspects of the project and areas for improvement with the Project Delivery Team (PDT). In the week prior to the start of the workshop, preliminary performance attributes and requirements and project risks were identified that would later be reviewed and verified during the workshop.

VE STUDY/PLANNING CHARETTE WORKHSOP

The VM job plan was followed to guide the team in the consideration of project functionality and performance, potential schedule issues, high cost areas, and risk factors in the design. These considerations were taken into account in developing alternative solutions for the optimization of project value. The job plan phases are described in order below.

Information Phase

At the beginning of the workshop, a presentation of the project was made by representatives from the PDT. This presentation included an overview of the project and a brief history of the project background and its current status. The workshop attendees were then led through a discussion that included the project's mission (purpose and need) and identification of the project objectives.

Function Phase

Key to the VM process is the function analysis technique used during the Function Phase. Analyzing the functional requirements of a project is essential to assuring an owner that the project has been designed to meet the stated criteria and its need and purpose. The analysis of these functions in terms cost, performance, time, and risk is a primary element in a VE study, and is used to develop alternatives. This procedure is beneficial to the VE team, as it forces the participants to think in terms of functions and their relative value in meeting the project need and purpose. This facilitates a deeper understanding of the project.

Speculation Phase

The Speculation Phase involves identifying and listing creative ideas. During this phase, the VE team participated in a brainstorming session to identify as many means as possible to provide the necessary project functions. Judgment of the ideas was not permitted in order to generate a broad range of ideas.

The idea list includes all of the ideas suggested during the study. These ideas should be reviewed further by the project team, since they may contain ideas that are worthy of further evaluation and may be used as the design develops. These ideas could also help stimulate additional ideas by others.

Evaluation Phase

The purpose of the Evaluation Phase is to systematically assess the potential impacts of ideas generated during the Speculation Phase relative to their potential for value improvement. Each idea was evaluated in terms of its potential impact to performance, cost, time, and risk. Once each idea is fully evaluated, it is rated on develop/eliminate basis, as set forth in the *Idea Evaluation* section of this report.

Development Phase

During the Development Phase, the highly rated ideas were expanded and developed into VE concepts. The development process included describing the concept in more detail and narrative discussion of the concept's impact on the performance attributes.

Presentation Phase

The VE study/Planning Charette concluded with a presentation of the VE team's assessment of the project and the VE concepts. The presentation provided an opportunity for the project stakeholders to preview the project objectives and performance attributes as well as the VE concepts identified by the VE team and develop an understanding of the rationale behind them.

POST-STUDY PROCEDURES

A Draft VE Study/Planning Charette Report was prepared after the completion of the workshop. This report summarized the activities and results of the VE study. When the draft report was reviewed by the PDT and other stakeholders, the Final VE Study/Planning Charette Report is prepared incorporating any review comments received.

Workshop Agenda
Value Engineering Study and Planning Charette
Sutter Basin Pilot Study – Sutter County, CA

Day 1 – Monday, October 31, 2011; Location: COE-Sacramento District Offices, Room 814 (8th floor)

0800 VE Team Set-up

0830 Introductions; VE Process Overview and Agenda Review,
Information Gathering (Planning Process Steps 1, 2, & 3): Overview of problems, opportunities, objectives and constraints; Discuss future and w/o project conditions; Present conceptual alternatives previously identified; Present risk analysis results

1130 Lunch

1230 Develop/Review Project Purpose & Need Statement

1300 Function Analysis

1400 Analyze Project Performance using Value Metrics

- Define/Review Performance Requirements and Performance Attributes
  Identify attributes that represent those aspects of a project's scope that possess a range of potential values
- Determine Relative Importance of Attributes (Stakeholder voting to determine Attribute priorities)

1600 Adjourn

Day 2 – Tuesday, November 1, 2011; Location: COE-Sacramento District Offices, Room 814 (8th floor)

0830 Present and Discuss FAST Diagram

0900 Evaluation Phase (Planning Process Step 4): Evaluation of previous Conceptual Alternatives based on Performance Attributes

1200 Lunch

1300 Speculation Phase (Planning Process Step 3): Brainstorming of additional alternatives, alternative optimization, value improvements recommendations, and risk reduction/mitigation

1600 Adjourn

Day 3 – Wednesday, November 2, 2011; Location: COE-Sacramento District Offices, Room 814 (8th floor)

0830 Evaluation of Creative Ideas

1130 Lunch

1230 Team Assignments for Development of Alternative Narrative Write-ups

1600 Adjourn

Day 4 – Thursday, November 3, 2011; Location: COE-Sacramento District Offices, Room 814 (8th floor)

0830 VE Alternative Development

1130 Lunch

1230 Re-evaluation of conceptual alternatives and identify final array of alternatives
Planning Process Step 5: Comparison of final array of alternate plans

1600 Adjourn

Day 5 – Friday, November 4, 2011; Location: COE-Sacramento District Offices, Room 814 (8th floor)

0830 Summary of VE Results and Presentation Preparation

1000 Presentation of VE Study Results to all Project Stakeholders
Summary, Wrap-Up, Steps Forward

1200 Adjourn

MEETING ATTENDEES
Value Engineering Study and Planning Charette
Sutter Basin Pilot Study

2011 October/November					NAME	ORGANIZATION	POSITION / RANK	PHONE	EMAIL
31	1	2	3	4					
x	x	x	x	x	Mark Watson	Value Management Strategies, Inc.	VE Team Leader	(816) 206-0067	mark@vms-inc.com
x	x	x	x	x	Ron Tanenbaum	Value Management Strategies, Inc.	VE Team Leader	(858) 204-7942	ron@vms-inc.com
x	x	x	x	x	Mary Diel	USACE - Sacramento District	Value Engineering Officer	(916) 557-6833	mary.r.diel@usace.army.mil
x	x	x	x	x	Robert Vrchoticky	USACE - Sacramento District	Civil Engineer/Cost Engineering	(916) 557-7336	robert.d.vrchoticky@usace.army.mil
x				x	Bill Edgar	Sutter Butte	Executive Director	(916) 392-4909	bedgar@edgarandassociates.com
x	x	x	x	x	Dave Peterson	SBFCA	Consultant	(916) 792-6285	dpeterson@pbieng.com
x	x	x	x	x	Steve Holmstrom	USACE - Sacramento District	Hydrology/PDT	(916) 557-7129	steven.f.holmstrom@usace.army.mil
x	x	x	x	x	Erik James	USACE - Sacramento District	Geotech/PDT	(916) 557-5259	erik.w.james@usace.army.mil
x	x	x	x	x	Matt Davis	USACE - Sacramento District	Environmental	(916) 557-6208	mathew.g.davis@usace.army.mil
x	x	x	x	x	Michael Wright	DWR - FPO	Engineer	(916) 574-1050	mcwright@water.ca.gov
x	x	x	x	x	Michael Musto	DWR - FPO	Engineer	(916) 574-1447	mmusto@water.ca.gov
x	x	x	x	x	Laura Whitney	USACE - Sacramento District	Project Manager	(916) 557-7495	laura.a.whitney@usace.army.mil
x	x	x	x		Gary Bedker	USACE - Sacramento District	Economist	(916) 557-6707	gary.m.bedker@usace.army.mil

2011 October/November					NAME	ORGANIZATION	POSITION / RANK	PHONE	EMAIL
31	1	2	3	4					
x	x	x	x	x	Tri Duong	USACE - Sacramento District	Cost Engineer	(916) 557-7202	tri.h.duong@usace.army.mil
x	x	x	x	x	Shelley McGinnis	USACE - Sacramento District	Planner/Study Manager	(916) 557-5159	shelley.r.mcginnis@usace.army.mil
x				x	Will Hall	USACE - Sacramento District	Sr. Technical Lead/Design Branch	(916) 557-6646	william.hall@usace.army.mil
x	x	x	x	x	Peter Blodgert	USACE - Sacramento District	Study Technical Lead/Hydraulic	(916) 555-7525	peter.j.blodgert@usace.army.mil
x	x	x			John Jordan	USACE - Sacramento District	Economist	(916) 557-7267	john.f.jordan@usace.army.mil
x					Andrea Clark	SBFCA	Counsel	(916) 520-5424	aclark@downeybound.com
x					Lawrence Skaggs	USACE - Sacramento District	Plan Formulation/SPD	(415) 503-6588	lawrence.l.skaggs@usace.army.mil
x	x	x	x	x	Mike Inamine	SBFCA	Director of Engineering	(530) 740-2448	m.inamine@sutterbutteflood.org
x	x	x	x	x	Tung Le	USACE - Sacramento District	Civil Design	(916) 557-6828	tung.le@usace.army.mil
x	x	x	x	x	Boni Bigornia	USACE - South Pacific Division	Senior Civil Engineer	(415) 503-6567	boniface.g.bigornia@usace.army.mil
	x	x	x		Laurie Parker	USACE - Sacramento District	Real Estate	(916) 557-6741	laurie.s.parker@usace.army.mil
		x	x	x	Eric Thaut	USACE - South Pacific Division	Program Manager	(415) 503-6852	eric.w.thaut@usace.army.mil
x	x	x	x	x	Scott Miner	USACE - Sacramento District	Planning/17+1 Advisor	(916) 557-6695	scott.p.miner@usace.army.mil
x				x	Nick Applegate	USACE - Sacramento District	Economist	(916) 557-6711	Nicholas.J.Applegate@usace.army.mil

Value Management Strategies, Inc.

Offices in Escondido and Sacramento, California; Grand Junction, Colorado; Sarasota, Florida; Indianapolis, Indiana Marietta, Georgia; Portland, Oregon; Seattle, Washington; Kansas City, Missouri; and Great Falls, Montana

Value Management Strategies, Inc.

Value Engineering Study/Planning Charette Report

Sutter Basin Pilot Study

U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT

January 2012

Value Management Strategies, Inc.

Value Engineering Study/Planning Charette Report

Sutter Basin Pilot Study

U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT

January 2012

Value Management Strategies, Inc.

Value Engineering Study/Planning Charette Report

Sutter Basin Pilot Study

U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT

January 2012

Value Management Strategies, Inc.

Value Engineering Study/Planning Charette Report

Sutter Basin Pilot Study

U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT

January 2012

Value Management Strategies, Inc.

Value Engineering Study/Planning Charette Report

Sutter Basin Pilot Study

U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT

January 2012

Value Management Strategies, Inc.

Value Engineering Study/Planning Charette Report

Sutter Basin Pilot Study

U.S. ARMY CORPS OF ENGINEERS, SACRAMENTO DISTRICT

January 2012

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

MAY - 7 2013

MEMORANDUM FOR DIRECTOR OF CIVIL WORKS

SUBJECT: Sutter Basin, California – Deviation from the National Economic Development Plan

I am responding to the Army Corps of Engineers (Corps) memorandum dated March 18, 2013, which requests an exception to the policy that requires decision documents to recommend the National Economic Development (NED) Plan. The exception would allow the subject draft feasibility report and draft environmental impact statement to tentatively recommend a Locally Preferred Plan (LPP) for flood risk management improvements. The request indicates that the Sutter Butte Flood Control Agency and the Central Valley Flood Protection Board, as the non-Federal sponsors, support the LPP in lieu of the NED Plan in order to comply with California Government Code requirements for a 200-year level of protection for urban and urbanizing areas by 2025.

Based on the materials provided, the LPP would reduce the vulnerability of a larger population and additional critical infrastructure, reduce economic flood risks to a greater extent, and provide more evacuation routes relative to the NED Plan. The LPP would cost about $290,000,000 more than the NED Plan. As proposed, the non-Federal sponsors would be responsible for the entire extra cost, which would increase the non-Federal cost share from about $148,000,000 for the NED Plan to about $438,000,000 for the LPP. The Federal cost share of initial construction, estimated at $275,000,000, would remain the same for the NED Plan and the LPP.

In addition to the request for an exception, the Corps provided responses on April 17, 2013, to questions my staff raised about the study and the two plans. The responses resolved all but three of those concerns. First, significant population growth during the 50-year period of analysis appears likely and must be explicitly considered in evaluating the public safety aspects of the final alternatives and measures for managing the respective residual risks. Second, the effect of induced development on the public safety aspects of the final alternatives and the residual risks must be assessed. If a reasonable estimate of induced development cannot be achieved, then the analyses should assume full development of areas designated as potentially developable. Areas with temporary restrictions on development should be considered potentially developable unless the Corps can demonstrate that the temporary restrictions would become permanent. Third, the effects of alternatives and their respective induced development and population growth on natural floodplain functions, including the ecological and hydrologic functions, must be assessed.

After reviewing the materials provided, I have decided to grant the requested policy exception, subject to the Corps incorporating the information discussed above into the final decision documents. The documents should be explicit about compliance with EO 11988, particularly the determination of practicable alternatives. The draft feasibility report and draft environmental impact statement may tentatively select the LPP and be released for public review. I concur that the added cost of the LPP relative to the NED Plan, currently estimated at $290,000,000, would be a 100 percent non-Federal cost, with the remainder of the first cost shared 65 percent Federal, 35 percent non-Federal consistent with current policy.

Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)