US Army Corps of Engineers®

Sacramento District

Planning Division

Sutter Basin Pilot Feasibility Report - Environmental Impact Report / Supplemental Environmental Impacts Statement

Butte and Sutter Counties, California

APPENDIX A - ECONOMICS

August 2013

Revised: October 2013

Economic Analysis – Sutter Basin Pilot Feasibility Study	
Project Name:	Sutter Basin Pilot Feasibility Study—Flood Risk Management Project
Project Briefing:	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 includes the communities of Yuba City, Live Oak, Gridley, Biggs and Sutter with a total urban population of approximately 84,000.
Study Authority:	The authority for USACE to study Flood Risk Management 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).
Purpose and Scope:	The purpose of this document is to present the economic analysis conducted for the Sutter Basin Pilot Feasibility Study. This includes descriptions of the methodologies, assumptions, data and results of both the without and with project conditions. The document presents findings related to flood risk, potential flood damages, and flood risk management benefits. Additionally, this analysis coincides with the planning modernization paradigm of employing sound qualitative analysis guided by professional judgment rather than heavily based quantitative processes during the planning phase of study process. The economic analysis is in accordance with standards, procedures, and guidance of the U.S. Army Corps of Engineers. The Planning Guidance Notebook (ER 1105-2-100) serves as the primary source for evaluation methods. Also, guidance for risk-based analysis was obtained from EM 1110-2-1619 and ER 1105-2-101. Unless otherwise noted, benefits and costs values are expressed in October 2013 prices utilizing the FY14 discount rate of 3.5% and analyzed over a 50-year period of analysis. Economic Modeling was performed using the Corps FRM-PCX certified HEC-FDA (v1.2.5a) model.
Organization of Document:	This document is organized as follows: • Section 1 describes the study area and planning process conducted to date • Section 2 reviews the data used in the analysis and without-project conditions • Section 3 evaluates the final array of alternatives • Section 4 compares the final array of alternatives • Section 5 presents the Other Social Effects analysis • Section 6 discusses the Regional Economic Development impacts • Section 7 summarizes the economic analyses
Authorship:	Economic Risk Analysis Section, (CESPK-PD-WE) Planning Division, Sacramento District U.S. Army Corps of Engineers

1. STUDY BRIEFING

Planning Study. The Sutter Basin Pilot 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 Officer of the Assistant Secretary of the Army for Civil Works, ASA (CW), 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 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. Based on the pilot program principles, the Sutter Basin Pilot Feasibility 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 and quantitative analysis that will be increasingly detailed at each Decision Point or IPR and early screening of alternatives with low likelihood of federal interest.

Table 1. Pilot Study Phases and Associated Decision Points

Pilot Study Phase	Decision Point	Date
Scoping	1 – Federal Interest Determination	Aug 2011
Analysis	2 – Tentatively Selected Plan and Draft Report	March 2013
Review	3 – Civil Works Review Board	Fall 2013
Confirmation	4 – Chief's Report	*Winter 2013*

**Tentative*

Throughout the planning process, the Sutter Project Delivery Team (PDT) has recorded major milestones in the following documents:

- Appendix I, Measure Screening and Alternative Selection— This Progress Document details the broad array of management measures that were developed based on information from existing reports and studies, as well as public input and professional judgment. This document provides descriptions of the measures evaluated at the Critical Thinking Charette and indicate whether each one was retained or dropped and the reason(s) for screening.
- Appendix II, Draft Alternative Evaluation and Selection of Final Alternatives— This Progress Document is a compilation of a series of memorandums from the following disciplines: economics, civil design, real estate, cost engineering, hydrology, hydraulics, and geotechnical. These documents form the basis for selection of the final array of alternatives.

This documentation is in support of Appendix III, Evaluation and Comparison of the Final Array of Alternatives and Identification of the Recommended Plan. This document includes the description, refinement, evaluation and comparison of the final array of alternatives. For additional detail on the economic methodologies and steps taken in the screening of alternatives from the preliminary array to the draft array of alternatives leading up to the final array, please see the Economic Appendix to Progress Document #2 (included in this report as Attachment 1).

Study Area. The 300 square mile study area is located in Butte and Sutter Counties California. A map showing the location of the study area relative to the watershed is provided in Section 1 of Attachment 1.

A map of the study area topography can be found in the Main Report and the Hydraulic Appendix, which shows elevation ranges from 110 feet to 30 feet. The study area is encircled by federal project levees along the Sutter Bypass, Feather River, Cherokee Canal, Wadsworth Canal and the high ground of the Sutter Buttes. The federal levees are features of the Sacramento River Flood Control Project (SRFCP), authorized by Congress in 1917. The SRFCP incorporated features such as levees, weirs, and pumping facilities into a system of leveed river channels and flood bypass channels to provide Flood Risk Management benefits to the Sacramento Valley.

Population estimates were estimated by overlaying a shapefile of the 2010 US Census population by census block and the Economic Impact Areas (EIA) in GIS. These numbers may differ slightly from the official 2010 Census population estimates by city. Note that the Town of Sutter is not included here as modeling shows very limited flooding for the 0.2% ACE event.

Table 2. Population

Economic Impact Area	Population
Yuba City Urban	67,370
Biggs Urban	1,760
Gridley Urban	6,380
Live Oak Urban	8,360
Sutter County Rural	6,340
Butte County Rural	4,900
Total	**95,110**

The highest risk sources of flooding within the study area are the Sutter Bypass and the Feather River, although flooding can also occurs from the Butte Basin, 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 flood stage. The Sacramento River Flood Control Project levees were often constructed of poor foundation materials such as river dredge spoils that does not meet current engineering standards. These legacy levees are relied upon today to provide FRM for numerous communities within the Sacramento Valley.

Historical Assessment. In 1955, flood waters from a levee breach encompassed a significant portion of the study area inundating 6,000 homes, drowning 38 people, injuring 3,200 individuals, and requiring 600 people to be rescued by helicopter. From 1950 to 2011, extensive flood fighting has occurred during 19 events, and levee failures adjacent to the Sutter Basin took place in 1986 and 1997. Flooding historically has occurred during the months of December through February with air temperatures of 38 to 55°F and water temperatures of 45 to 55°F; temperatures which significantly increase risk of death by exposure.

Recent geotechnical analysis and evaluation of historical performance during past floods indicate the project levees within the study area do not meet USACE levee design standards and are at risk of breach failure at stages less than overtopping. This was evidenced by historical boils and heavy seepage at stages less than authorized design flows. Underseepage failures are sudden and unpredictable, resulting in minimal warning time, and ineffectiveness of evacuation plans. Though, 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 flooding presents a continued threat to public safety, property, and critical infrastructure.

2. REVIEW OF EXISTING CONDITIONS

Floodplain Area and Economic Inventory. 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. Field visits were conducted to collect and validate the base inventory data. Parcels with structures were categorized by land use and grouped into residential, commercial, industrial or public categories. The value of damageable structures was estimated based on depreciated replacement values. The total value of damageable property (structures and contents) within the Sutter Basin study area is estimated at $7 billion (Table 3). Table 4 displays the structural inventory by land use category.

Table 3. Value of Damageable Property
October 2013 Prices (Values in 1,000's)

Economic Impact Area	Structures and Contents				
	Commercial	Industrial	Public	Residential	Total
Biggs	6,700	2,400	0	75,700	**84,800**
Gridley	73,200	52,600	3,600	290,900	**420,300**
Live Oak	26,000	3,800	42,600	324,500	**396,900**
Yuba City	1,070,000	423,800	339,200	3,645,300	**5,478,300**
Rural Butte	4,000	46,400	0	203,200	**253,600**
Rural Sutter	9,100	40,200	18,800	279,000	**347,100**
Total	**1,189,000**	**569,200**	**404,200**	**4,818,600**	**6,981,000**

Table 4. Structural Inventory –Existing Conditions
Number of Structures within 0.2% (1/500) Annual Chance Floodplain

Economic Impact Area	Commercial	Industrial	Public	Residential	Total
Biggs	18	1	0	586	**605**
Gridley	81	7	4	1,931	**2,023**
Live Oak	51	5	23	2,088	**2,167**
Yuba City	872	210	122	18,760	**19,964**
Rural Butte	10	16	0	1,242	**1,268**
Rural Sutter	10	29	8	1,162	**1,209**
Total	**1,042**	**268**	**157**	**25,769**	**27,236**

HEC-FDA Modeling Efforts. For the economic analysis, the existing levees were separated into thirteen levee reaches and a representative breach location was chosen for each reach. When the study area becomes inundated, the floodwaters flow from north to south and then pool in the southern portion of the study area to twenty feet or more. Therefore, a levee breach at the northern section of the Feather River would result in a larger inundation area than a breach at the southern portion, but does not necessarily mean that a northern breach has the highest risk (probability and consequence). Because the levees around the Sutter study area have distinct deficiencies, each has a different probability of failure in any given flood event. The probability of flooding from each source is based on the hydrologic frequency, stage-discharge relationship and geotechnical performance. These parameters serve as inputs into the Corps FRM-PCX certified HEC-FDA model (v1.2.5a).

Without-Project Damages. The main analytical tool used to perform the economic analysis was the Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) software. This program stores the engineering probability data (hydrologic, hydraulic, and geotechnical) and the economic consequence data (structure/content inventory and depth-percent damage curves), and is used to model the flooding problem and potential alternative solutions in the study area. By relating the economic inventory data to the floodplain data, the HEC-FDA software computes economic stage-damage curves. Through integration of the main engineering relationships (exceedance probability-discharge curves, rating curves, and geotechnical levee fragility curves) and the main economic relationship (stage-damage curves), the HEC-FDA software computes project performance statistics and expected annual damages/benefits. The results of the economic modeling are then used as input into the net benefit and benefit-to-cost analyses and may also aid in plan formulation, all of which are performed external to the HEC-FDA software.

Agricultural Damages. ER 1105-2-100, Appendix E, beginning on page E-113 includes specific guidance for studies where the primary damages occur to agricultural crops. Primary damages in this evaluation focus on the crop damage, loss of stored crops, and loss of farm equipment. These damages are directly related, and evaluated with special consideration for the expected time of seasonal flooding as well as the variability associated with crop prices and yields. The identified hydrologic/hydraulic variables, discharge associated with exceedence frequency and conveyance roughness and cross-section geometry, also apply to agricultural studies. Based on empirical analyses conducted for past Corps projects, subject matter expertise from the agricultural economist and professional judgment, the project delivery team expects agricultural damages to total 10-15% of total project damages; amounts which are not expected to drive plan selection. A simplified approach was developed for this study based on stage-damage curves for land use types within the study area and simplifying calculations by utilizing 1,000 ft by 1,000 ft hydraulic model grid elements. For detailed information regarding data collection, assumptions, and methodology see the Memorandum for File titled "Agricultural Damages for Final Alternative Comparison" dated 22 February 2013 (Attachment 2).

Cleanup and Emergency Costs. Depreciated structure and structure content damages measure the cost of replacing damaged portions of structures and structure contents with those of similar use and condition. It does not, however, fully account for all the various costs incurred following a damaging flood event. For the final array of alternatives, four additional categories of damages directly related to structure and structure content damages were considered: cleanup costs, temporary housing and relocation assistance costs and other emergency costs (including repairs to roads, bridges, utilities, etc.). Though these damages categories won't likely drive plan formulation and selection due to their high correlation with structure and content damages, they are justified as legitimate flood damage reduction benefit categories and should not be ignored in the calculation of total project benefits. More detail about these damage categories and methodologies used in the estimation of related damages and benefits can be found in Attachment 3.

The HEC-FDA without project conditions model results (expected annual damages) for structures, contents, automobiles, and agriculture, emergency and cleanup costs are shown, by economic impact area

(EIA) in Table 5. The total study area without project damages are estimated to be approximately $137 million. For more detail about the HEC-FDA modeling and the other standard damage categories, see Attachment 1.

Table 5. Expected Annual Damages—Without Project Condition
October 2013 Prices (Values in $1,000s), 3.75 Discount Rate

Economic Impact Area	Damage Category							
	Agriculture	Autos	Cleanup & Emergency	Commercial	Industrial	Public	Residential	Total
Biggs	4	89	252	81	30	0	495	**951**
Gridley	5	179	520	1,012	300	49	987	**3,052**
Live Oak	9	243	734	327	53	471	1,456	**3,293**
Yuba City	250	4,235	13,639	15,700	6,433	4,267	26,405	**70,929**
Rural Butte	1,902	136	351	52	264	0	770	**3,475**
Rural Sutter	16,460	1,956	7,384	1,126	5,741	3,432	18,742	**54,841**
Total	**18,630**	**6,838**	**22,880**	**18,298**	**12,821**	**8,219**	**48,855**	**136,541**

<u>Without Project Performance.</u> In addition to damages estimates, HEC-FDA reports flood risk in terms of project performance. Three statistical measures are provided, in accordance with ER 1105-2-101, to describe performance risk in probabilistic terms. These include annual exceedance probability, long-term risk, and assurance by event.

- Annual exceedance probability measures the chance of having a damaging flood in any given year.
- Long-term risk provides the probability of having one or more damaging floods over a period of time.
- Assurance is the probability that a target stage will not be exceeded during the occurrence of a specified flood.

The worst project performance statistics may not necessarily be associated with the breach location producing the largest economic damages. For example, an impact area may be subject to flooding from two different rivers. River A might have a higher likelihood of flooding than River B but River B’s associated floodplain (consequence) may be larger and cause more damages. If that is the case, then project performance (likelihood of flooding) is not the primary dictator in consequence. Nevertheless, if a proposed project alleviates River B’s floodplain, the project performance is still limited by River A’s performance. For the Yuba City economic impact area, performance is dictated by an index point along the Sutter Bypass. However, the associated floodplain does not significantly impact Yuba City until the 0.2% ACE whereas a break along the Feather River poses imminent damages due to its associated consequence (floodplain) even though it statistically has a higher performance when compared to the Sutter Bypass. Project performance statistics for each area under without project conditions is displayed in Table 6. Some project performance statistics have been updated slightly for the final array based on revisions to existing TOL stages.

Table 6. Project Performance by Economic Impact Area—Without Project Condition

Economic Impact Area	Breach Location	Annual Exceedance Probability		Long Term Risk			Assurance by Event				
		Median	Expected	10-yr period	30-yr period	50-yr period	10%	2%	1%	0.4%	0.20%
Biggs	F9.0R	0.07	0.08	55%	91%	98%	82%	61%	58%	44%	32%
Gridley	F9.0R	0.07	0.08	55%	91%	98%	82%	61%	58%	44%	32%
Live Oak	F9.0R	0.07	0.08	55%	91%	98%	82%	61%	58%	44%	32%
Yuba City	F5.0R	0.04	0.04	33%	70%	86%	85%	67%	60%	40%	22%
Rural Butte	F9.0R	0.07	0.08	55%	91%	98%	82%	61%	58%	44%	32%
Rural Sutter	S4.0L	0.45	0.52	99%	99%	99%	33%	30%	22%	11%	6%

Future Population Growth and Development. A discussion regarding future population growth, wise use of floodplains (EO 11988) and residual risk can be found in Chapter 4 below. Population growth and future development were considered, but were not included in the economic damage analysis, as it would have little impact on project benefits and would not change NED identification, the recommended plan or economic feasibility. Factors that led to the future without project condition assumptions used for this study from a planning and economic standpoint were: 1) CA Senate Bill 5 will limit future development in the study area under future without project conditions given that the study area would not have 0.5% ACE ("200yr") level of flood protection. According to current USACE floodplain modeling, this area would be within the 0.5% ACE ("200yr") without project floodplain. 2) Given #1 above, any development that did take place would likely occur above the mean 0.5% ACE "200yr" WSEL, meaning very infrequent damaging flooding which would be discounted to present values. The result is low equivalent annual damages which would not significantly impact plan selection or project benefits. 3) Within USACE, a greater emphasis is now being placed upon wise use of floodplains and the potential to induce development by building an FRM project (EO11988). For purposes of justifying this pilot project economically, it is not prudent to "count on" benefits associated with future floodplain development to increase the project's net benefits or BCR.

3. ALTERNATIVE EVALUATION

Plan Formulation and Description of Alternatives. 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 Recommended plan best satisfies the objectives as well as the Federal interests, which are consistent with the Federal Water Resources Council's Principles and Guidance (P&G) and the Planning guidance Notebook (ER-1105-2-100). What follows is a brief timeline of the planning process leading up to the final array of alternatives. More detail can be found in Progress Document #1.

(1) Management Measures (Critical Thinking Charette): A broad array of management measures was developed based on information from existing reports and studies, as well as public input and professional judgment. Following the initial screening of measures, the team identified four themes (strategies) for plan formulation (1- Consequence Management Focused on Public Safety, 2-Urban FRM, 3-Maximize Existing System with FRM Focus, and 4-Ecosystem Restoration Focus). These themes were used to establish a preliminary array of conceptual alternatives by grouping measures according to the primary focus of each theme.

(2) Preliminary Array of Alternative: Each alternative was further developed and quantities, costs and economic benefits were estimated at a reconnaissance level. The use of these results was solely to screen out those preliminary alternatives that did not appear economically justified even in the most favorable conditions.

(3) Refinement of Draft Array of Alternatives (Value Engineering Study): The remaining alternatives were furthered refined. 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 of draft alternatives. The draft array of alternatives were then evaluated in further detail, and screened to a final array of alternatives. See Attachment 1 of this report for the economic documentation used in support of Appendix II, Draft Alternative Evaluation and Selection of Final Alternatives, for more detail.

(4) Final Array of Alternatives: The final array of alternatives carried forward for final comparison include:
   - Alternative SB-1: No Action
   - Alternative SB-7: Fix-in-place the Feather River, Sunset Weir to Laurel Avenue
   - Alternative SB-8: Fix-in-place the Feather River, Thermalito to Laurel Avenue

Climate Change: A climate change analysis was completed for the draft array of alternatives to ensure that the relative ranking of alternatives was not particularly sensitive to climate change. The results of the analysis confirmed the insensitivity to Alternative rankings based on NED Equivalent Annual Net Benefits and a detailed writeup of the analysis and results can be found in the Hydrology Appendix.

With-Project Modeling Results. Benefits were determined by incorporating increments of levee fixes into the HEC-FDA model that represent various with-project improvements. Under with-project conditions, levee fragility curves were not used and it was assumed levees would not fail until the WSEL reached 0.1ft above the top of levee. Flood risk management benefits (Table 8) equal the difference between the without project damages (Table 5) and the with-project residual damages (Table 7).

Table 7. Expected Annual Damages—Alternative Conditions
October 2013 Prices (Values in $1,000s), 3.75 Discount Rate

Alternative	Economic Impact Area						Total
	Biggs	Gridley	Live Oak	Yuba City	Rural Butte	Rural Sutter	
SB-1: No Action	951	3,052	3,293	70,929	3,475	54,841	136,541
SB-7: Fix-in-place Feather River, Sunset Weir to Laurel Avenue	951	3,052	3,293	10,491	3,475	36,496	57,758
SB-8: Fix-in-place Feather River, Thermalito to Laurel Avenue	352	452	529	10,483	1,558	36,141	49,515

Table 8. Annual Benefits—Alternative Conditions
October 2013 Prices (Values in $1,000s), 3.75 Discount Rate

Alternative	Economic Impact Area						Total
	Biggs	Gridley	Live Oak	Yuba City	Rural Butte	Rural Sutter	
SB-1: No Action	-	-	-	-	-	-	-
SB-7: Fix-in-place Feather River, Sunset Weir to Laurel Avenue	-	-	-	60,438	-	18,345	78,783
SB-8: Fix-in-place Feather River, Thermalito to Laurel Avenue	599	2,600	2,764	60,446	1,917	18,700	87,026

Probability Distribution of Damages Reduced. In accordance with ER 1105-2-101, flood damages reduced were determined as mean values and by probability exceeded. Table 9 shows the benefits for each alternative for a probability distribution and expected value. The damage reduced column represents the expected benefits for each alternative, while the probability damage reduced indicate the confidence of benefits exceeding the indicated amount. For example, Alternative SB-7 has expected benefits of $64 million at the 50% confidence interval, and 75% confidence that benefits will be equal to or greater than $43 million. The range in probability distribution of damages reduced is indicative of the uncertainty in the benefits estimates, which incorporates all the uncertainties in hydrology, hydraulics, geotechnical and economics in the HEC-FDA model. The uncertainty in damages reduced is a critical component when selecting an optimal plan during the plan formulation process. Professional judgment guides the determination of an alternative meeting a reasonable level of confidence regarding positive net benefits.

Table 9a. Probability Distribution of Damages Reduced—Study Area October 2013 Prices (Values in $1,000s), 3.75 Discount Rate

Alternative	Annual Damages			Probability Damage Reduced		
	Without Project	With Project	Damage Reduced	75%	50%	25%
SB-1: No Action	136,541	136,541	0	0	0	0
SB-7: Fix-in-place Feather River, Sunset Weir to Laurel Avenue	136,541	57,758	78,783	43,111	63,972	108,792
SB-8: Fix-in-place Feather River, Thermalito to Laurel Avenue	136,541	49,515	87,026	46,299	72,113	120,350

Table 9b. Project Performance by Economic Impact Area—Alternative SB-7

Economic Impact Area	Breach Location	Annual Exceedance Probability		Long Term Risk			Assurance by Event				
		Median	Expected	10-yr period	30-yr period	50-yr period	10%	2%	1%	0.4%	0.20%
Biggs	F9.0R	0.070	0.080	55%	91%	98%	82%	61%	58%	44%	32%
Gridley	F9.0R	0.070	0.080	55%	91%	98%	82%	61%	58%	44%	32%
Live Oak	F9.0R	0.070	0.080	55%	91%	98%	82%	61%	58%	44%	32%
Yuba City	F5.0R	0.002	0.003	2%	6%	10%	99%	99%	99%	82%	55%
Rural Butte	F9.0R	0.070	0.080	55%	91%	98%	82%	61%	58%	44%	32%
Rural Sutter	S4.0L	0.450	0.520	99%	99%	99%	33%	30%	22%	11%	6%

Table 9b. Project Performance by Economic Impact Area—Alternative SB-8

Economic Impact Area	Breach Location	Annual Exceedance Probability		Long Term Risk			Assurance by Event				
		Median	Expected	10-yr period	30-yr period	50-yr period	10%	2%	1%	0.4%	0.20%
Biggs	F9.0R	0.002	0.002	2%	7%	11%	99%	99%	97%	81%	64%
Gridley	F9.0R	0.002	0.002	2%	7%	11%	99%	99%	97%	81%	64%
Live Oak	F9.0R	0.002	0.002	2%	7%	11%	99%	99%	97%	81%	64%
Yuba City	F5.0R	0.002	0.003	2%	6%	10%	99%	99%	99%	82%	55%
Rural Butte	F9.0R	0.002	0.002	2%	7%	11%	99%	99%	97%	81%	64%
Rural Sutter	S4.0L	0.450	0.520	99%	99%	99%	33%	30%	22%	11%	6%

4. ALTERNATIVE COMPARISON

Net Benefit Analysis. Economic feasibility and project efficiency are determined through a benefit-cost analysis. For a project to be feasible, benefits must exceed costs and the most efficient alternative is one that maximizes net benefits (annual benefits minus annual costs). The identification of such alternative is referred to the National Economic Development Plan (NED). Table 10 summarizes the net benefit analysis of the final array of alternatives using probability reduced damages at varying confidence intervals in terms of benefits and costs (25%, 50% and 75%), while Table 11 shows the net benefit analysis using the mean computed benefits and cost at an 80% confidence level[1] per standard USACE practice. While the varying confidence intervals in Table 10 do not show the full range of possible Net Benefits and BCR's, it does show the most likely range and meets the intent of ER-1105-2-101. For a more detailed breakdown of costs and interest during construction calculations, please see Attachment 5. With $61 million in equivalent annual net benefits, SB-7 is identified as the NED plan.

Table 10. Net Benefits[2] (Varying Confidence Intervals)—Final Array of Alternatives October 2013 Prices (Values in $Millions), 3.5% Discount Rate

Category	Alternative						
	SB-1: No Action	SB-7: Fix-in-place Feather River, Sunset Weir to Laurel Avenue			SB-8: Fix-in-place Feather River, Thermalito to Laurel Avenue		
		Low	Mid	High	Low	Mid	High
Total First Costs[1]		355	370	386	632	659	688
Sunk PED (-)		0	0	0	0	0	0
Interest During Construction (+)		34	36	37	88	92	96
Subtotal		***389***	***406***	***423***	***720***	***751***	***784***
Interest and Amortization		17	17	18	31	32	33
OMRR&R		0.28	0.28	0.28	0.45	0.45	0.45
Annual Cost		17	17	18	31	32	33
Annual Benefits		43	64	109	46	72	120
Net Benefits[2]		**34**	**54**	**79**	**23**	**47**	**74**
Benefit to Cost Ratio[2]		**2.9**	**4.1**	**5.5**	**1.7**	**2.4**	**3.3**

[1] Cultural resources data recovery costs ($1.6 million for SB-7 and $3.0 million for SB-8) are not included in economic costs per Corps policy (ER 1105-2-100, Appendix e, paragraph E-63.f.(5)).
[2] Net Benefits and Benefit to Cost Ratios are a result of Monte Carlo simulations using triangular distributions of annual benefit and annual costs confidence intervals as inputs.

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[1] Standard practice in Corps Feasibility Studies.
[2] Net Benefits and Benefit to Cost Ratios are a result of Monte Carlo simulations using triangular distributions of annual benefit and annual costs confidence intervals as inputs.

Table 11. Net Benefits (Mean, Standard Corps Practice)—Final Array of Alternatives October 2013 Prices (Values in $Millions), 3.5% Discount Rate

Category	Alternative		
	SB-1: No Action	SB-7: Fix-in-place Feather River, Sunset Weir to Laurel Avenue	SB-8: Fix-in-place Feather River, Thermalito to Laurel Avenue
Total First Costs[1]		390	686
Sunk PED (-)		0	0
Interest During Construction (+)		38	94
Subtotal		***428***	***780***
Interest and Amortization		18	33
OMRR&R		0.28	0.45
Annual Cost		18	33
Annual Benefits		79	87
Net Benefits		**61**	**54**
Benefit to Cost Ratio		**4.4**	**2.6**
Benefit to Cost Ratio (@ 7%)		***2.3***	***1.3***

[1] Cultural resources data recovery costs ($1.6 million for SB-7 and $3.0 million for SB-8) are not included in economic costs per Corps policy (ER 1105-2-100, Appendix e, paragraph E-63.f.(5)).

Residual Floodplains: Residual 1% ACE floodplains[3] for the final array of alternatives are shown in figures below. These floodplains represent composite floodplains for all breaches that have less than a 90% level of assurance to pass the 1% ACE flood event. While this floodplain is larger than would likely be seen in a single flood/breach event, it is meant to represent the relative residual risk for the area from all remaining breach locations. Composite floodplains are for presentation only and were not used in the calculation of economic damages and benefits. SB-7 reduces adverse flooding effects but benefits are primarily centered on Yuba City. The alternative features do not address the significant flooding risk in the communities of Biggs, Gridley, and Live Oak. SB-8 reduces the residual risk for these northern communities.

[3] 1% floodplains are based on the inundation from any levee having less than 90% assurance. The assurance estimate was based on geotechnical, hydraulic, and hydrologic uncertainty.

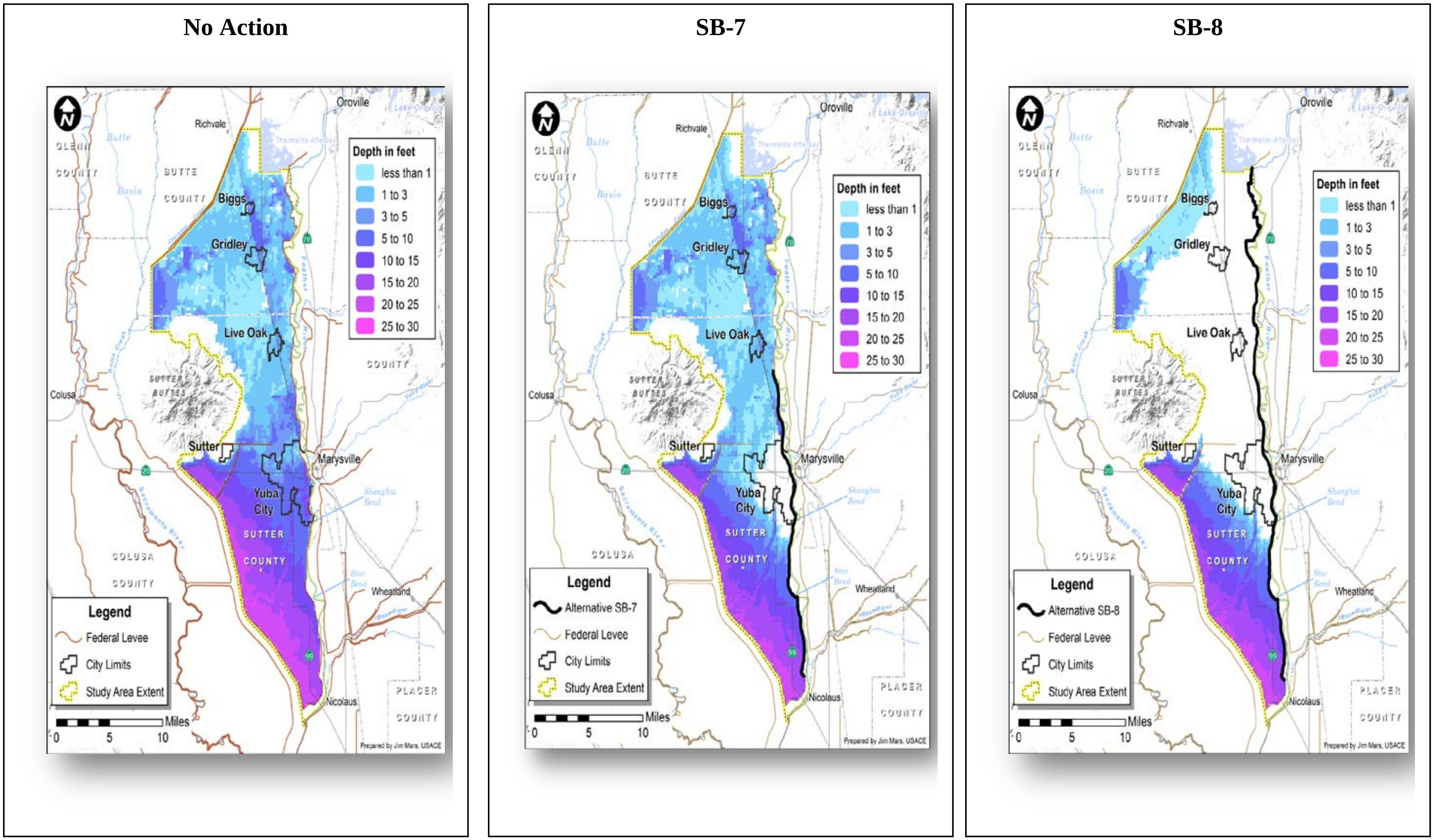
Residual Population at Risk (PAR)[4]: PAR within the 1% ACE floodplain for the No Action Alternative is 94,600. SB-7 reduces the 1% floodplain PAR to 38,200, while SB-8 reduces PAR to approximately 6,600.

Structures within the Residual Floodplains: The number of structures within the residual floodplain for the No Action Alternative is approximately 26,800. SB-7 reduces the structures within the 1% ACE floodplain to 7,600, while SB-8 reduces structures within the floodplain to approximately 1,700 with most of these structures residing on the outskirts of Yuba City and the Rural Sutter, southern part of the basin. For more detail, see Chapter 3 of the main report.

[4] PAR within the 1% ACE floodplain is calculated by overlaying 2010 population by Census block and the residual floodplains. These numbers may differ slightly from the official 2010 Census by city.

Figure 1: 1% ACE Residual Floodplains for the Final Array

(Based on composite floodplains from all potential residual breach locations with less than 90% assurance)



Population growth and Wise Use of Floodplains: Executive Order (EO) 11988 (May 24, 1977) requires a Federal agency, when taking an action, to avoid short and long term adverse effects associated with the occupancy and the modification of a floodplain. The agency must avoid direct and indirect support of floodplain development whenever floodplain siting is involved. In addition, the agency must minimize potential harm to or in the floodplain and explain why the action is proposed. Additional floodplain management guidelines for EO 110988 were also provided in 1978, by the Water Resources Council.

The wise use of floodplains concept, as described in EO 11988, was incorporated as a life safety metric for this study. The metric, "potentially developable floodplains," was used in the pilot study multi-objective planning process for evaluation and screening. This metric approach was based on pilot study objectives of applying qualitative rather than quantitative analysis; use of existing data/inventory; and professional team judgment. In calculating the "potentially developable land" metric for the Sutter Basin, the following areas were excluded.

- Areas that are currently developed.
- Areas that are owned in fee by governments or nonprofit organizations and that are protected for open space purposes.
- Areas with flood depths greater than 3 feet for the FEMA 1% (1/100) Annual Chance Exceedance (ACE) base flood event because constructing buildings to meet FEMA floodplain management requirements is assumed to be cost prohibitive.
- Areas outside the 0.2% (1/500) ACE floodplain boundary to prevent high topographic areas along Sutter Buttes from being included.

Under existing conditions there are approximately 71,000 acres of potentially developable land within the Sutter Basin. SB-7 would result in an additional 16,000 acres of potentially developable floodplain consisting of 5,000 acres in the Yuba City urban area and 11,000 acres in the Sutter County rural area outside of Yuba City. The additional increment to implement SB-8 would result in an additional 12,000 acres of potentially developable floodplain consisting of 500 acres in the urban areas of Yuba City, Biggs, Gridley, and Live Oak; 2,700 acres in the Sutter County rural area; and 8,800 acres in the Butte County rural area.

Development does not occur in the absence of demand. Land use in the basin is primarily dominated by a strong agricultural based economy and uses. This type of land use and economy does not support rapid, urbanized growth or demand. The necessary basin wide public infrastructure (i.e. roadways, water/sewer systems, utilities, etc) do not exist for urban growth, and would require a substantial investment from the State, County, and development community. This type of future investment is not likely due to the lack of demand from consumers (within and outside the basin).

The cities of Biggs, Gridley, Live Oak, and Yuba City are not currently mapped within the FEMA 1% ACE ("100- year") floodplain Despite the lack of floodplain development restrictions, development in Biggs, Gridley, Live Oak, and Yuba City has been modest even during the building boom of the early 2000's. The addition of FRM improvements this study will provide will not change the fundamental drivers of urban growth demand within the Sutter Basin. Lack of market/economic drivers, and development restrictions in place at the local, state, and federal level, will continue to control and limit urbanized development, even with implementation of the improvements to reduce the risk of flooding, such as the local FRWLP and the Sutter Basin project recommended by this report.

The table below presents 2070 population estimates for the Sutter Basin using growth rates developed by the Sacramento Area Council of Governments (SACOG). The population figures do not relate directly to demand for developable acreage. In order to estimate the demand for developable land necessary to accommodate the projected population presented below, the population growth rates were applied to existing developed acreage in each jurisdiction. The projected urban development within each City's Sphere of Influence (SOI) as shown in each General Plan is shown in the Tables 13 and 14

Table 12. Population Projections within the Sutter Basin

Jurisdiction	2010 Population [1]	Projected Population (Year 2070) [2]	
		Med Growth Rate	Est. Population
Yuba City	64,925	2.5%	285,656
Live Oak	8,392	2.6% [3]	39,148
Biggs	1,707	5.2%	35,742
Gridley	6,584	3.5%	51,869
Sutter County	94,737	1.7%	260,482
Butte County	220,000	1.1%	424,123

[1] According to 2010 Census by city and county
[2] Based on Sacramento Area Council of Governments growth rates
[3] City of Live Oak Growth Rate used since SACOG estimate was not available for Live Oak

Table 13. Population Projections within the Sutter Basin – Sutter County

Sutter County Growth Areas[1]	Existing Developed Acreage[2]	Projected New Urban Acreage from 2010-2030[3]	Projected New Urban Acreage from 2010-2070[4]
Yuba City SOI & Employment Corridor	8,965	12,019	30,479
Live Oak SOI	1,165	6,511	11,667[5]
Other (Sutter & Tudor)	2,037	2,939	7,465
Subtotal Sutter County	**12,167**	**21,469**	**49,611**

[1] As indicated in the Sutter County General Plan Draft EIR
[2] Acreage within the City limits are assumed to be fully developed
[3] As indicated in the Sutter County General Plan Draft EIR. Does not subtract out existing development in the SOI
[4] Assumes population projected growth rate of 2.6% also applies to urbanized development
[5] Growth rate of 2.6% applied to new acreage in 2030 (6,511 acres)

Table 14. Population Projections within the Sutter Basin – Butte County

Butte County Growth Areas	Existing Developed Acreage	Projected New Urban Acreage from 2010-2030[3]	Projected New Urban Acreage from 2010-2070[4]
Biggs SOI	414[2]	541[2]	8,524
Gridley SOI	1,300[3]	2,900[3]	8,941
Subtotal Butte County	**5,155**	**3,441**	**17,465**
Total for Sutter & Butte County	**17,322**	**24,910**	**67,076**

1 Does not subtract out existing development in the SOI
2 As indicated in the City of Biggs General Plan
3 Acreage values not included – gross acreage scaled off map in Gridley General Plan
4 Assumes projected growth rate of 5.2% and 3.5% for Biggs and Gridley, respectively, also applies to urbanized development

The data presented in Tables 13-14 indicates that only about 67,000 new acres are projected to be developed by 2070 within the basin, assuming SACOG projected growth rates are maintained beyond 2030. Furthermore, Yuba City accounts for about half of the demand for developable acreage (approx. 30,000 acres). This estimated projected new urban acreage is far less than the Developable Area under the No Action, SB-7, and SB-8 alternatives. Therefore, this data indicates the estimated demand by 2070 for approximately 60,000 acres of developable land – far less than the 71,000 acres projected to be available in the basin under the no-action alternative.

For a more detailed writeup of developable acreages, population growth and wise use of floodplains, please see Attachment 4.

5. OTHER SOCIAL EFFECTS

Purpose and Methodology. This portion of the economic analysis documents the results of the Other Social Effects (OSE) account analysis associated with the Sutter Basin Pilot Feasibility Study. The analysis is intended to provide a portrait of the social landscape of the study area and offer a glimpse as to the vulnerability of the populations that call Sutter Basin their home.

A concern for social effects associated with water resources development and management has long been part of federal water resources planning guidance, appearing as the Social Well-being Account in 1972 *Principles and Standards*, and later as the OSE account in the *Principles and Guidance* (P&G) adopted in 1983 and in the Corps' ER 1105-2-100. However, since the adoption of the P&G there has been a tendency to discount the role and importance of OSE factors in water resources planning. Now, new guidance is being promulgated and implemented—principally EC 1105-2-409 *Planning in Collaborative Environment*—is placing much greater emphasis on the importance of including a broad range of considerations in planning. In addition to NED factors, other considerations, including social factors addressed in the OSE account, are to be used to develop appropriate water resources solutions.

Essentially, the OSE account serves to answer the following question:

> *How are social connectedness, community social capital, and community resiliency likely to change in the absence of a solution to a water resource issue? How are vulnerable populations likely to be affected?*

Metrics:

- Social Connectedness will be measured using Gender, Race & Ethnicity, Age, Rural/Urban Communities, Rentals vs. Homeownership and Occupation.
- Community Social Capital will be measured using Education, Family Structure, Rural vs. Urban Communities and Population Growth.
- Community Resilience will be measured using Income, Political Power, Prestige, Employment Loss, Residential Property, Infrastructure/Lifetime, Family Structure and Medical Services.

This assessment is in accordance with standards, procedures, and guidance of the U.S. Army Corps of Engineers. The *Planning Guidance Notebook* (ER 1105-2-100) serves as the primary source for evaluation methods of flood risk management studies and was used as a reference for this analysis. Additionally, the Institution for Water Resources *Handbook on Applying "Other Social Effects" Factors in Corps of Engineers Water Resources Planning* (IWR 09-R4) served instrumental in conducting the analysis.

This report analyzes the social effects related to the without and with-project conditions. The 1% annual chance exceedance (ACE) floodplain serves as the basis for the analysis of impact.

Historic Digest. The topography of the Sutter Basin is composed primarily of the gentle flatlands of the Sacramento Valley. Prior to the settlement of European populations, the basin was dominated by immense wetlands and riparian forest. The historic habitats of Sutter Basin supported large populations of waterfowl and other wildlife. In the 1830s, European settlers started to cultivate the basing for agricultural use. Other practices included livestock grazing and controlled burns. The late 1800s brought gold miners during the Gold Rush and later cattle drivers that stayed to continue to use the rich soil for agriculture production. This resulted in lower areas and interior valleys being sparsely inhabited by ranchers and farmers. By the 1930s, the majority of the basin was cultivated for agricultural production and cattle grazing. Currently, the basin is a major agricultural center in northern California. Sutter basin is composed of two counties, Sutter and Butte. Both of which are primarily agricultural communities. The *2001 Census of Agriculture* classifies 88% of Sutter County's acreage of being in farms. The five leading crops based are rice, peaches, walnuts, dried plums, and tomatoes. Within the Sutter Basin study area boundary, Sutter County includes two cities (Yuba City and Live Oak), and Butte County includes another two cities (Biggs and Gridley).

Social Profile. A first key step in helping the decision-makers gain a better understanding of the social landscape—e.g., identifying who lives in the study area, who has a stake in the problem or issue and why it is important to them. This fundamental step entails performing a profile of the area in terms of basic social statistics, and to make such presentation of information meaningful by providing useful comparisons and rankings. The preparation of the social profile is not the OSE analysis. Social profiling provides the basic level of understanding about the social conditions, but more in-depth analysis is required to target areas of special concern or relevance to the specifics of the water resources issues. The basic social statistics discussed below are indicators used to portray basic information about the social life and the processes of the area under study. The development of these basic social characteristics (Table 15) present a portrait of the study area.

The 300 square mile study area is home to over 95,110 people. Approximately 88% of the total population abides in one of four incorporated cities. Yuba City makes up the majority of the population with 64,900 individuals. The communities of Live Oak, Gridley and Biggs have 8,400, 6,600, and 1,700 persons, respectively. The remainder of the population of 11,240 individuals reside in the surrounding rural areas of Sutter and Butte Counties. The study has seen a significant increase in population over the last decade. The growth has been primarily centered in Yuba City, which saw its population grow from 36,760 people in 2000 to 60,510 in 2006, a 65% increase.

The median age of the study area is consistent with State and national averages; as is the population over 65. However, the population under 18 years of age is higher in the study are (>28%) compared to State (25%) and national (24%) averages. Education statistics indicate lower levels of attainment. The percent of individuals over 25 with a high school degree (or equivalent) and percent of college graduates are lower than State and national averages.

Variances in race and ethnicity in communities may impose language and cultural barriers that affect ability to cope with natural hazards. The Hispanic presence is evident given they make up at least 28% of the population in each community. Live Oak's population is composed of 48.8% of individuals of Hispanic origin, which is significantly higher than the State average of 37.6% and greatly exceeds the national average of 16.3%.

Median household income for the study area ranges from $36,563 (Gridley) to $48,830 (Yuba City). Both of which are below State ($61,632) and national (52,762) averages. The persons living at or below the poverty level in the study area are 22.7%, 21.4% and 15% for Biggs, Gridley and Yuba City, respectively. All of which are larger than the State (14.4%) and national (14.3%) averages.

The total labor force in the study area is estimated at 40,000, with an unemployment rate of 14.7%, 8.4%, and 9.3% in Biggs, Gridley and Yuba City, respectively. Total private wage or salary workers estimated to be 75% (Biggs), 65% (Gridley) and 69% (Yuba City) with 17% (Biggs), 25% (Gridley) and 20% (Yuba City) of the labor force rated as government workers. Approximately, 7% (Biggs), 11% (Gridley) and 11% (Yuba City) of the labor force was considered to be self-employed, not incorporated. The average wage per job so the study area is between $22,300 to $28,100.

Table 15. Basic Social Characteristics—Sutter Basin Study Area
2010 Census Demographic Data

Basic Social Statistic	Study Area Community				California	National
	Biggs	Gridley	Live Oak	Yuba City		
Population						
Current Population (2010)	1,760	6,380	8,360	67,370	37,254,000	308,746,000
Age						
Median Age	35.1	33.1	31.7	33	35.2	37.2
% 65 and above	10.9%	14.1%	10.7%	11.7%	11.4%	13.0%
% under 18	28.1%	28.7%	30.6%	28.2%	25.0%	24.0%
Race and Ethnicity						
Asian	0.5%	3.7%	11.4%	17.0%	12.8%	4.7%
Black	0.4%	0.5%	1.4%	2.2%	5.8%	12.2%
Hispanic	34.0%	45.6%	48.8%	28.4%	37.6%	16.3%
White	60.5%	46.7%	35.0%	47.4%	40.1%	63.7%
Other	4.6%	3.5%	3.4%	5.0%	3.7%	3.1%
Education						
% HS Graduates	75.1%	64.6%	n/a-	77.6%	80.8%	85.4%
% College Graduates	9.3%	10.1%	n/a-	19.2%	30.2%	28.2%
Income and Poverty Status						
% Unemployed	14.7%	8.4%	n/a-	9.3%	6.5%	5.6%
Median Household Income	$44,485	$36,563	$41,773-	$48,830	$61,632	$52,762
Persons below Poverty (%)	22.7%	21.4%	24.2%-	15.0%	14.4%	14.3%
Housing						
Homeownership Rate	69.4%	57.8%	65.9%	56.9%	55.9%	65.1%
% of Mobile Homes	2.7%	3.6%	n/a-	4.4%	3.9%	6.6%
Quality of Life						
Average Household Size	3.37	3.63	3.88	3.49	3.45	2.58
Language Other than English Spoken at Home	32.6%	43.7%	n/a-	40.1%	43.2%	20.3%
Mean travel time to work (minutes)	26.4	21	n/a-	28	27	25.4

Social Effects Assessment.

Social Vulnerability and Resiliency: Social vulnerability is a term described by the sensitivity of a population to natural hazards, where as resiliency refers to the population's ability to respond to and recover from the impacts of such hazard. The characteristics that are recognized as having an influence on social vulnerability generally include age, gender, race and socioeconomic status. Other characteristics include population segments with special needs or those that lack the normal social safety nets necessary in disaster recovery, such as the physically or mentally challenged, non-English speaking immigrants, transients and seasonal tourists. The quality of human settlements (housing type and construction, infrastructure and lifelines) and the built environment are also important in understanding social vulnerability, especially as these characteristics influence potential economic losses, injuries, and fatalities from natural hazards. Table 16 provides discussion of factors that may dictate vulnerability and ability to cope with natural hazards, along with an assessment as it relates to the Sutter Basin study area.

Table 16. Social Vulnerability and Resiliency Indicators
Assessment of the Sutter Basin Study Area

Indicator	Discussion[1]	Assessment
Income, political power, and prestige	This measure focuses on ability to absorb losses and enhance resilience to hazard impacts. Wealth enables communities to absorb and recover from losses more quickly due to insurance, social safety nets, and entitlement programs.	As a measure, median household income of the study area is less than the State and national average. The communities may be at a disadvantage in recovery efforts.
Gender	Women can have a more difficult time during recovery than men, often due to sector-specific employment, lower wages and family care responsibilities.	Although data is not specifically available concerning the wage rate of male versus female for the study area, it is recognized that a smaller percent of women are employed in the labor force in the study area than in the larger metropolitan city of Sacramento. However, the percent of variation of this factor is quite small.
Race and Ethnicity	Race and ethnicity may impose language and cultural barriers that affect access to post-disaster funding and residential locations in high hazard areas.	It is recognized that the study areas has a significant Hispanic population, which may pose a risk to the resiliency of the community. Of particular note is the fact that between 33-43% of the population speak a language other than English at home.
Age	Extremes of the age spectrum inhibit the movement out of harm's way. Parents lose time and money caring for children when daycare facilities are affected, elderly may have mobility constraints or mobility concerns increasing the burden of care and lack of resilience.	Those over 65 years of age are estimated at 11-14%, which is similar to State and national averages. Those under 5 years of age are estimated at around 8%, which is slightly above State and national averages.
Employment Loss	The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster.	The current unemployment rate of the study area is higher than the State, which indicates that there may be financial issues in dealing with re-establishing housing.
Rural/Urban	Rural residents may be more vulnerable due to lower incomes, and more dependent on locally based resource extraction economies (farming and fishing). High-density areas (urban)	Because 12% of the population reside in the rural areas of the study area, there may be concern in their ability to recover from

	complicate evacuation from harm's way.	natural hazards.
Residential Property	The value, quality, and density of residential construction affect potential losses and recovery. For example, expensive homes are costly to replace, while mobile homes are easily destroyed and less resilient to hazards.	Percentage of mobile homes are similar to State averages, both of which are less than the national average.
Infrastructure and Lifelines	Loss of sewers, bridges, water, communications, and transportation infrastructure may place an insurmountable financial burden on the smaller communities that lack the financial resources to rebuild.	The smaller communities of Biggs, Gridley, and Live Oak are at a greater risk of coping with a natural hazard given their lack of financial resources when compared to the larger urban community of Yuba City.
Renters	People that rent typically do so because they are either transient or do not have the financial resources for home ownership. They often lack access to information about financial aid during recovery. In the most extreme cases, renters lack sufficient shelter options when lodging become uninhabitable or too costly to afford.	Housing rentals range between 30-43% of Sutter Basin's households. The high rental population highlights indications of community cohesion issues. Research indicates that renters do not have the same community pride as owners thereby having more barriers to direct community involvement in redeveloping the community after a natural hazard.
Occupation	Some occupations, especially those involving resource extraction, may be severely impacted by a hazard event. Self-employed fisherman suffer when their means of production is lost and may not have the requisite capital to resume work in a timely fashion and thus will seek alternative employment. Migrant workers engaged in agriculture and low skilled service jobs (housekeeping, childcare, and gardening) may similarly suffer, as disposable income fades and the need for services decline. Immigration status also affects occupational recovery.	Because the study area's industry is primarily driven by agricultural production, many workers may have a difficult time coping with natural hazards.
Family Structure	Families with large numbers of dependents or single-parent households often have limited finances to outsource care for dependents, and thus must juggle work responsibilities and care for family members. All affect the resilience torecover from hazards.	The literature indicates that families having over 4 or more persons have more financial difficulty than those of lesser numbers. Accordingly, community planners need to be aware of pending issues.
Education	Education is strongly linked to socioeconomic status, with higher educational attainment resulting in greater lifetime earnings. Lower education constrains the ability to understand warning information and access to recovery information.	With between 23-35% of Sutter Basin's residents having less than high school education there may be constraints in the ability of those residents to adequately deal with local, state, and federal information requirements surrounding recovery efforts.
Population Growth	Counties experiencing rapid growth lack available quality housing and the social services network may not have had time to adjust to increased populations. New migrants may not speak the language and not be familiar with bureaucracies for obtaining relief or recovery information, all of which increases vulnerability.	Sutter Basin has grown significantly in the past 10 years. A rapid growth rate in population is highly correlated with low community cohesion. The sense of belonging, cooperation, and strong sense of community pride are dynamic factors, which assist in the restoration of the community after a catastrophic event. Due to rapid growth in Yuba City, community bonds and sense of owning community issues may not be as strong as other more slowly growing cities like Biggs, Gridley, and Live Oak.

Medical Services	Health care providers, including physicians, nursing homes, and hospitals are important post-event sources of relief. The lack of proximate medical services will lengthen immediate relief and result in longer recovery from disasters.	Sutter Basin has many medical facilities available to its general population. This indicates very high medical assistance should natural hazard occur. Additionally, the nearby city of Sacramento is equipped to provide some medical assistance to the residents of Sutter Basin.

[1] Source: *Social Vulnerability to Environmental Hazards*. SOCIAL SCIENCE QUARTERLY, Volume 84, Number 2, June 2003.

Environmental Justice: Executive Order 12898 concerning environmental justice provides direction on the analysis of social and economic effects that would be applicable to proposed flood risk management projects. Signed by President Clinton in 1994, EO 12898 (Federal Actions to Address Environmental Justice in Minority and Low-Income Populations) requires that environmental analyses of proposed Federal actions address any disproportionately high and adverse human health or environmental effects on minority and low-income communities. Additionally, EO 13045 (Protection of Children from Environmental Health Risks and Safety Risks) requires Federal agencies to identify, assess, and address disproportionate environmental health and safety risks to children from Federal actions.

(1st Step) According to the guidelines established to assist the Federal and State agencies in examining potential for environmental justice impacts, the first step in conducting an environmental justice analysis is to define minority and low income populations. Based on these guidelines, a minority and low-income population is present in a project study area if:

- The minority population of the affected area exceeds 50 percent or the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.
- The project study area is composed of 50 percent or more people living below the poverty threshold, as defined by the U.S. Census Bureau, or it is significantly greater than the poverty percentage of the general population or other appropriate unit of geographic analysis.

(2nd Step) The second step of an environmental justice analysis requires a finding of a high and adverse impact. The executive orders address the impacts on the demographic, economic, and social factors that could measurably alter the economic condition (i.e., the availability of employment), the accessibility of goods, infrastructure and services, and the quality of life in the area of influence. These types of impacts would be significant to the affected population. More specifically, a proposed project alternative would have a significant socioeconomic impact if it were to result in any of the following effects:

- Long-term increase in population that could not be accommodated by regional infrastructure (i.e., housing, utilities, roads, hospitals and schools) or services (such as police and emergency services)
- A reduction in the availability of affordable housing, which could occur either through a large increase in housing prices or a large decline in the supply of affordable housing
- Long-term displacement of population that could not be accommodated within the region

- Long-term displacement or disruption of local businesses that could not be accommodated within the region
- A loss in community facilities, events, populations, or major industry that would result in an overall loss in community cohesion
- Disruption of emergency services or creation of a public health risk that could not be avoided by the public, especially if it would particularly affect the health and safety of children

(3rd Step) A proposed project alternative would have an environmental justice impact if it were to cause impacts that are disproportionately high and adverse, either directly, indirectly or cumulatively. To make a finding that disproportionately high and adverse effects would likely fall on a minority or low-income population, three conditions must be met simultaneously:

- There must be a minority or low-income population in the impact zone
- A high and adverse impact must exist
- The impact must be disproportionately high and adverse on the minority or low-income population

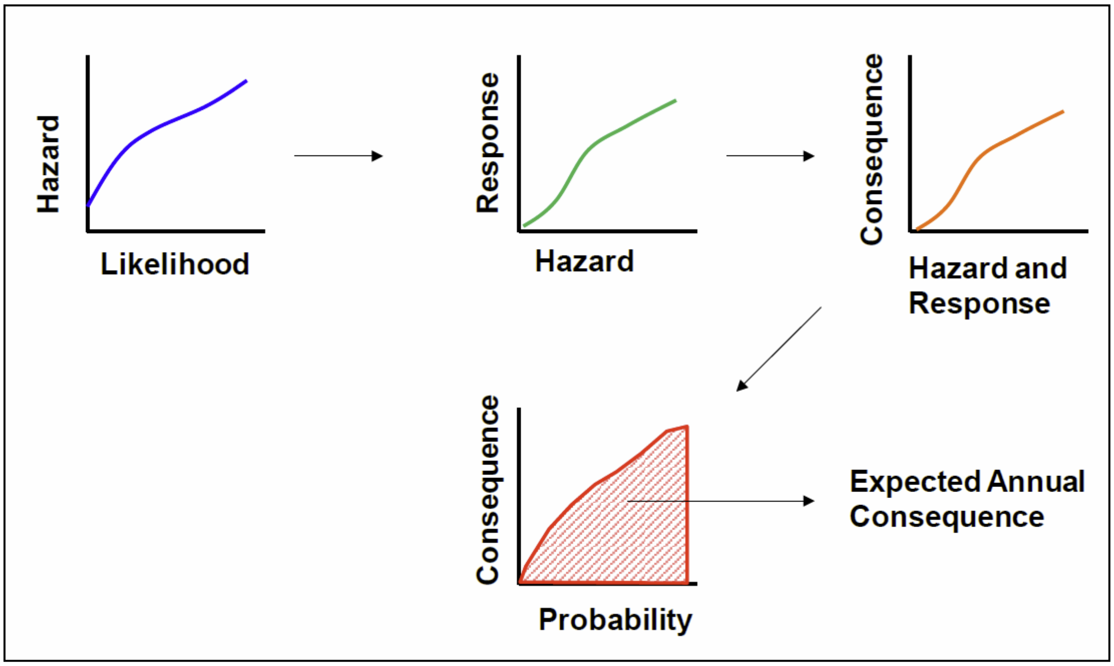
Review of real estate records and discussion with USACE Sacramento District PDT disclosed that the construction of Alternative SB-7 and SB-8 have no major direct impact to residents in the immediate area. Implementing the proposed alternative would have a beneficial impact on the regional economy due to increased expenditures in the regional economy during the construction period. However, increased construction-related traffic, delays, and detours as well as an increased population due to the presence of a construction workforce can result in increased social tension during the construction period. Nevertheless, the conclusion based on the environmental justice criteria, is that there is no highlt adverse impact due to construction of either alternative project.

Life Safety Evaluation. Methods to calculate economic losses from natural hazards are fundamental to the planning process. However, such losses only capture part of the impact of natural hazards, and alternatives based only on reducing such damages miss a wide range of other important effects. A critical missing element from the current flood damage assessment approach is estimating the potential for loss of life and injury associated with flood events and flood damage reduction interventions. Current methodology has reached high level of sophistication but requires significant technical resources. However, the planning modernization paradigm calls for approaches that employ sound qualitative analysis guided by professional judgment rather than heavily focused high resource consuming quantitative processes.

Economists conducting the Sutter Basin Pilot Feasibility Study decided to make use of the Levee Screening Tool (LST) to facilitate preliminary assessment of the general condition and associated risks of levees in support of loss of life estimation. The LST provides an initial quantitative risk estimate to assist local, state, and Federal stakeholders in identification and prioritization of funding needs for levees of concern. All inputs for the LST will be estimated from readily available data. Estimates of the flood loading are made from information such as design documents, gage records, flood insurance studies, or project specific studies. An assessment of performance is based on results of the routine levee inspection and an engineering assessment of performance related items from the levee inspection checklist based on a review of design documents and other relevant engineering data. Life safety consequences within the study area are estimated from readily available data.

The risk associated with levee segments and systems can be characterized by considering the magnitude and likelihood of a hazard (i.e. loading), the conditional response of the levee given the loading (i.e. performance), and the potential consequences that result from the combination of loading and response. Various loading scenarios may be possible as a result of the types of loading (e.g. flood), operational performance (e.g. gate closure), human intervention (e.g. sandbagging during a flood fight), or outcomes external to the levee system (e.g. upstream reservoir operations or failure of a nearby levee system). Performance of the levee can be described by one of the following inundation scenarios: 1) Breach prior to overtopping, 2) Overtopping with breach, 3) Overtopping without breach, and 4) Component malfunction. Multiple performance modes (e.g. seepage and piping, overtopping, floodwall stability) can influence performance of the levee system and each performance mode can have different consequences depending on the location and severity of a levee breach. Consequences can also be influenced by various factors such as the effectiveness of warnings and evacuations and the depth, velocity, and rate of rise of flooding. The three primary inputs (load, performance, consequences) can be combined using probabilistic methods to obtain a risk estimate represented as a probability distribution of potential consequences. The expected value of risk (i.e. average annual) is often computed from this distribution and used as a point estimate of the risk. Point estimate results are commonly displayed on an f,N chart with the vertical axis representing the annual likelihood of inundation and the horizontal axis representing the average magnitude of consequences. A conceptual representation of the risk framework is provided in Figure 1.

Figure 2. Conceptual Risk Framework



The consequence portion of the LST includes computation that allow for an estimate of loss of life caused by inundation due to breach or overtopping of a levee. Readily available data and information are used along with limited analysis to assess the potential consequences related to a breach prior to overtopping of a levee segment. The consequences section of the LST is subdivided into the categories of general information, evacuation effectiveness, fatality rate computation, and critical infrastructure. For additional information on methodology please see the *Levee Screening Tool: Methodology and Application* (November 2011, RMC-CPD-1).

The computed statistical fatalities under a breach scenario for the without-project condition are estimated to be 388 and 489 for day and night settings, respectively. Table 17 indicates the results of the application of the LST to the estimated population under each alternative scenario. To the approximately 38,300 people at risk under Alternative SB-7, the potential statistical life loss estimate is 157 (day) and 197 (night) statistical lives lost. And to approximately 6,640 people at risk under Alternative SB-8, the potential life loss estimate is 27 (day) and 34 (night). These statistical Life Loss estimates are for a levee breach in an un-strengthened reach during a flood event near the top-of-levee (approximately a 0.5%, 1/200 ACE event) after construction of a given alternative.

Table 17. Statistical Life Loss Estimate

Community	Alternative					
	SB-1		SB-7		SB-8	
	Day	Night	Day	Night	Day	Night
Biggs	6	8	6	8	0	0
Gridley	26	33	26	33	0	0
Live Oak	34	43	34	43	0	0
Yuba City	276	348	47	59	14	18
Rural Butte	20	25	20	25	0	0
Rural Sutter	26	32	24	30	13	16
Total	**388**	**489**	**157**	**197**	**27**	**34**

In addition to life loss evaluation, other metrics were developed to assess the vulnerability of individuals living in the study area. Table 18 describes the metrics used to further evaluate life safety and Table 19 shows their results by alternative.

Table 18. Description of Metrics

Evaluation Metric	Description
Population at Risk (People)	Number of people within the 1% ACE Floodplain based on the 2010 census block GIS data.
Critical Infrastructure (Facilities)	Number of fire stations, police stations, hospitals, senior living facilities, and jails that are of life safety significance.
Evacuation Routes (# of Routes)	Assesses the vulnerability of populations with regards to the number of escape routes available during flood events.
Wise Use of Floodplains (Acres)	Potentially developable land within the 0.2% ACE floodplain. Acres of land with 1% ACE flood depths less than 3 feet.

Table 19. Summary of Life Safety Metrics

Evaluation Metric	Alternative		
	SB-1	SB-7	SB-8
Population at Risk (People)	94,600	38,200	6,600
Critical Infrastructure (Facilities)	28	11	1
Evacuation Routes (# of Routes)	0	1	5
Wise Use of Floodplains (Acres)	71,800	88,200	100,200

Population at Risk. The population at risk of flooding from a 1% ACE flood event is 94,600 for the without project condition (Alternative SB-1). A remaining population of 38,200 and 6,600 are at risk of flooding from Alternative SB-7 and SB-8, respectively. Of special concern is the population over the age of 65 living within the study area since those individuals have been shown to be at higher risk of life loss in flood events. The community of Gridley has above average representation of individuals age 65 or older.

Critical Infrastructure. A significant amount of critical infrastructure is located within the Sutter study area. Critical infrastructure is a term used by governments to describe assets that are essential for the functioning of a society and economy from a national perspective. Most commonly associated with the term are facilities for fire stations, police stations, hospitals, senior living facilities, and prisons. The benefits of Alternative SB-7 are primarily centered around Yuba City and still at risk are 11 of the critical infrastructure in the communities of Biggs, Gridley and Live Oak.

Evacuation Routes. The primary urban centers in the region are Yuba City, Biggs, Gridley, and Live Oak. These communities are all located on or near California State Route 99, which runs north-south through the region. Each community is also relatively close to California State Route 20, a major east-west roadway, which could also be used in an evacuation. Highway 20 takes a generally straight east-west path across the Sacramento River and the Sutter Bypass on its way to Yuba City. The route crosses Highway-99 west of central Yuba City, and runs east through the northern Yuba City to the Feather River, which it crosses on the 10th Street Bridge into Marysville. The Sutter County Evacuation and Mass Shelter/Care Plan identifies Highway 20, 99 and 113 as the primary evacuation routes in the region. These routes are subject to change since these routes are event-specific and official routes are established by the County Sheriff's office during an emergency. The Butte County Office of Emergency Management does not have published evacuation routes at this time, but anticipates Highway 99, 162 and Colusa Highway could be used as conditions allow. During the 1997 event, seven different evacuation zones were established over seven days due to constantly changing conditions and levee breaks[5]. The main evacuation routes used for this flood event were Highway-99 north and Highway-113 south. Highway-20 west and Highway-99 south were used intermittently since all portions of these roads were not accessible at all times during the flood.

Evacuation preparation can be made days in advance for predictably rain events. For example, a 0.2% ACE (1/500 year event) rain storm would be identified by meteorologist and residents could be given notice days in advance. As a significant rain event nears, warnings and evacuation efforts would be

[5] Source: Sutter County Office of Emergency Management.

increased and reiterated. This would allow time for evacuation of immobile residents and other people with special evacuation needs (hospitals, rest homes, jails, elderly individuals, schools) via the established routes. However, none of the historical flooding evacuations in the region have been due to foreseen weather events. Historical flood evacuations in the region have been from levee failures due to underseepage, which is characterized by its unpredictability and sudden occurrence. The result is evacuations after levees have failed and widespread flooding is in progress. The 1955 flood occurred due to a levee break in late December where no prior evacuation notice was given. In the 1997 flood, Yuba City was evacuated and during the evacuation a levee on the east side of the Feather River near Olivehurst (which was not evacuated) broke.

The residual 1% ACE (1/100 year event) resulting from Alternative SB-7 impacts every major urban center and nearly every primary evacuation route in the region. The floodplain is due to potential levee failure upstream of Sunset Weir. All routes out of Biggs, Gridley and Live Oak are impacted by the residual floodplain. The only egress from Yuba City would be Highway 20 east into Marysville, which is a community surrounded by a ring levee. Additionally, heading eastbound entails driving over a four lane bridge that is not expected to adequately handle the additional traffic flow, and may create a bottle neck limiting evacuation.

Wise Use of Floodplains. A determination must be made as to whether the increase in potentially developable floodplain area is acceptable under Corps policy, or can be avoided or mitigated to an acceptable level within a justified cost. It is important to remember that the floodplain metric used in this analysis is a simple index based on physical parameters. The metric does not attempt to forecast future population growth, economic conditions, or government decisions that will constrain future floodplain development. Those factors should be considered in conjunction with the metric.

Without and With-Project Comparison. Corps assessment of beneficial and adverse effects are based on comparison of with-project alternatives to the future without-project alternative condition expected to prevail. The social effects of the alternatives have both direct and indirect effects. Direct effects result immediately from construction of the projects, whereas indirect effects result from the effects of the project on the existing social landscape in the study area. A first step is describing or characterizing the alternatives in terms of descriptors such as magnitude (number of individuals affected), location (concentration of effects), timing and duration (when the effects will start and how long they are expected to last), and associated risks. Table 20 provides a description of the effects of each alternative, including the no action.

Table 20. Characterization of Alternative Effects

	SB-1	SB-7	SB-8
1. ALTERNATIVE DESCRIPTION			
	Alternative SB-1: The No Action provides no physical project constructed by the Federal Government.	Alternative SB-7: The plan is a Feather River fix-in-place levee alternative from Sunset Weir to Laurel Avenue.	Alternative SB-8: The plan is a Feather River fix-in-place levee alternative from Thermalito to Laurel Avenue.
2. OTHER SOCIAL EFFECTS			
Summary	Continued flood risk and consequences in the Sutter Basin including the communities of Yuba City, Live Oak, Gridley, and Biggs.	Flood Warning Emergency Evacuation Plan (FWEEP) mitigation is problematic for types of levee failures and limited evacuation routes. Significant life safety residual risk to the communities of Yuba City, Live Oak, Gridley, and Biggs.	Flood Warning Emergency Evacuation Plan (FWEEP) mitigation is problematic for types of levee failures and limited evacuation routes. Life safety residual risk to the communities of Yuba City, Live Oak, Gridley, and Biggs are significantly reduced.
Population at Risk	Approximately **96,600** individuals are within the 1% ACE floodplain.	**38,200** people remain in the 1% ACE floodplain. (60% of population is removed from the 1% ACE residual floodplain.)	**6,600** people remain in the 1% ACE floodplain. (93% of population is removed from the 1% ACE residual floodplain)
Loss of Life	Potential loss of lives: **Day-388, Night-489**	Potential loss of lives: **Day-157, Night-197**	Potential loss of lives: **Day-27, Night-34**
Critical Infrastructure	**28** structure deemed as critical from a national perspective are at risk from floods.	**11** structures remain at risk from floods.	**1** structure is at risk from floods.
Evacuation Routes	In the event of a flood, no evacuation route is available out of the basin.	Offers **one** problematic route for evacuation during a flood event. A flood warning and evacuation plan would not be as effective and limited.	**5** evacuation routes are available in the event of a flood. A flood warning and evacuation plan would have more robustness and redundancy.
Wise Use of Floodplains	Currently, 71,800 acres of land are potentially available for future development.	88,200 acres would be potentially available for future development.	100,200 acres of land would be potentially available for future development.
Social Vulnerability	The social vulnerability index score (SoVi) indicates the study area to be medium to high vulnerability. The No Action alternative may leave communities unable to cope with the recovery from a flood hazard.	Majority of the community of Yuba City is afforded flood risk reduction, however the communities of Live Oak, Gridley, and Biggs remain at risk of flood hazards and may be unable to cope and recover.	The four existing communities are provided flood risk reduction, and social vulnerability is minimized due to a decrease in the probability of flood hazards occurring.
Residual Risk and Consequences	Residual Risk remains high throughout the study area	Residual Risk for Life Safety is reduced for most of the Yuba City urban area.	Residual Risk for Life Safety is reduced in the high risk communities: Yuba City, Live Oak, Gridley and Biggs.

6. REGIONAL ECONOMIC DEVELOPMENT

Purpose and Methodology. The U.S. Army Corps of Engineers (USACE) *Planning Guidance Notebook* (ER 1105-2-100) states that while National Economic Development and Environmental Quality accounts are required, display of the Regional Economic Development effects are discretionary. The Corps' NED procedures manual affirms that RED benefits are real and legitimate; however, the concern (from a Federal perspective) is that they are often offset by RED costs in other regions. Nevertheless, for the local community these benefits are important and can help them in making their preferred planning decisions.

Although the RED account is often examined in less detail than NED, it remains useful. For example, Hurricane Katrina caused a significant economic hardship to not just the immediate Gulf Coast but for entire counties, watersheds, and the State of Louisiana. Besides the devastating damage to homes (which are often captures by the NED account), hundreds of thousands lost their jobs, property values fell, and tourism and tax revenues declined significantly and moved to other parts of the U.S. In this example, the RED account can provide a better depiction of the overall impact to the region.

The distinction between NED and RED is a matter of perspective, not economics. A non-federal partner may consider the impacts at the state, regional, and local levels to be a true measure of a project's impact or benefit, whereas from the Corps' perspective, this may not constitute a national benefit. Gains in RED to one region may be partially or wholly offset by losses elsewhere in the nation. For example, if a Federal project enables a firm to leave one state to locate in the newly-protected floodplain of another state, the increase in regional income for the project area may come at the expense of the former area's loss. As such, they may not influence the net value of the nation's output of goods and services and should be excluded from NED computations.

RED Concepts. The RED account has been given less emphasis in the Corps' past or current guidance. Perhaps the most extensive statement on RED appeared in the Principles and Guidance earlier version, the Principles and Standards:

> *"Through its effects—both beneficial and adverse—on a region's income, employment, population, economic base, environment, social development and other factors, a plan may exert a significant influence on the course and direction of regional development. The regional development account embraces several types of beneficial effects, such as (a) increased regional income, (b) increased regional employment, (c) population distribution, (d) diversification of regional economic base, and (e) enhancement of environmental conditions of special regional concern."*

Econometric analysis allows for the evaluation of the full range of economic impacts related to specific economic activities (construction and procurement) by calculating the direct, indirect and induced effects of the activities in the specific geographical designation.

- Direct Effects: consist of economic activity contained exclusively within the designated sector. This includes all expenditures made by the companies or organizations in the industry and all employees who work directly for them.
- Indirect Effects: define the creation of additional economic activity that results from linked business, suppliers of goods and services, and provisions of operating inputs.

- Induce Effects: measure the consumption expenditures of direct and indirect sector employees.

Input-output(I/O) models are characterized by their ability to evaluate the effects of industries on each other. Unlike most typical measures of economic activity that examine only the total output of an industry or the final consumption demand provided by a given output, I/O models provide a much more comprehensive view of the interrelated economic impacts. I/O analysis is based on the notion that there is a fundamental relationship between the volume of output of an industry and the volume of the various inputs used to produce that output. Industries are often grouped into production, distribution, transportation, and consumption. Additionally, the I/O model can be used to quantify the multiplier effect. In economics, the multiplier effects refers to the idea that an increase in spending can lead to even greater increase in income and consumption, as monies circulate or multiply through the economy.

Flood Risk Management RED Considerations. There are particular effects for each type of project improvement as they relate to the RED account. The estimation of RED flood-related effects can be very complex. At a minimum, the RED analysis should include a qualitative description of the types of businesses at risk from flooding, particularly those that could have a significant adverse impact (output, employment, etc.) upon the community or regional economies if their operations should be disrupted by flooding and how this would be affected by the recommended project. The potential RED effects to flood risk management projects are summarized in Table 21.

Table 21. Potential RED Effects to Flood Risk Management

RED Factor	Potential RED Effects
Construction	Additional construction related activity and resulting spillovers to suppliers
Revenues	Increased local business revenues as a consequence of reduced flooding, particularly from catastrophic floods
Tax Revenues	Increased income and sales taxes from the direct project and spillover industries
Employment	Short-term increase in construction employment; with catastrophic floods, significant losses in local employment (apart from the debris and repair businesses, which may show temporary gains)
Population Distribution	Disadvantage groups may benefit from the creation of a flood-free zone
Increased Wealth	Potential increase in wealth for floodplain residents as less is spent on damage property, repairs, etc and potential increase in property values.

Regional Economic System Results. A variety of software programs are available to determine the RED impacts for each project. Depending on the level of effort, project purpose, precision requirements and size of the study area, application will most likely vary. The Corps of Engineers' Institute for Water Resources along with the Louis Berger Group has developed a regional economic impact modeling tool called Regional Economic System (RECONS) that provides estimates of regional and national job creation, retention and other economic measures. The expenditures made by the USACE for various services and products generate economic activity that can be measures in jobs, income, sales and gross regional product. RECONS automates calculations and generates estimates of economic measures associated with USACE's annual civil work program spending. RECONS was built by extracting multipliers and other economic measures from more than 1,500 regional economic models that were built specifically for USACE's project locations by the Minnesota IMPLAN Group. These multipliers were then imported into a database and RECONS matches various spending profiles to the matching industry sectors by location to produce economic impact estimates. RECONS will be used as a means to document the performance of direct investment spending of the USACE, as it allows users to evaluate project and program expenditures associated with the annual expenditure.

The economic impacts presented below show the Sutter study area and the State of California's inter-related economic impacts resulting from an infusion of flood reduction construction funds. For this analysis, the study area and the State of California were both used as the geographic designation to assess the overall economic impacts of the construction funds. This places a frame around the economic impacts where the activity is internalized. Leakages (payments made to imports or value added sectors, which do not in turn re-spend the dollars within the area) are not included in the total impacts.

Table 22 serves to demonstrate the complex nature of the Yuba City Metropolitan Statistical Area (MSA) in 2008. There are approximately 64,844 persons employed in the MSA of Yuba City, California providing an output to the national of $8,332,000,000 annually.

Table 22. Regional Profile
Yuba City Metropolitan Statistical Area, California
(Values in Millions, 2013 Dollars)

Industry	Output	Labor Income	GRP	Employment
Accommodations and Food Service	$193	$63	$95	3,507
Administrative and Waste Management Services	$182	$81	$111	2,682
Agriculture, Forestry, Fishing and Hunting	$708	$179	$331	6,260
Arts, Entertainment, and Recreation	$50	$14	$21	753
Construction	$547	$225	$246	3,686
Education	$266	$225	$254	4,491
Finance, Insurance, Real Estate, Rental and Leasing	$510	$113	$355	3,523
Government	$1,220	$871	$1,092	11,767
Health Care and Social Assistance	$603	$340	$391	6,389
Imputed Rents	$688	$90	$437	3,901
Information	$347	$38	$76	603
Management of Companies and Enterprises	$38	$14	$19	233
Manufacturing	$1,131	$154	$236	2,698
Mining	$246	$57	$149	555
Professional, Scientific, and Technical Services	$262	$120	$146	2,421
Retail Trade	$582	$243	$396	7,058
Transportation and Warehousing	$272	$102	$143	2,476
Utilities	$168	$28	$78	201
Wholesale Trade	$320	$122	$209	1,639
Total	**$8,332**	**$3,080**	**$4,786**	**64,844**

The total remaining costs for the project is estimated at 430,000,000 and 691,000,000 for alternative SB-7 and SB-8, respectively. In conducting the regional economic development analysis, the costs needed to be adjusted for two items: (1) interest during construction and (2) purchase of land. Interest during construction is the interest that is paid back to the federal treasury to cover the bond payments made in the construction of the project. These funds are not expended within the region and therefore are not included within the regional analysis. Similarly, the purchase of land, not counting administrative costs, are considered as transfer payments from one party to another and not considered in the analysis.

Table 23 is based on the average annual regional expenditures that are expected over the remaining construction period. The construction schedule for alternative SB-7 is five years and seven years for alternative SB-8. Over that period of construction, a total of $342 million (SB-7) and $629 million (SB-8) is anticipated to be spent in the Sutter Basin study area in order to complete construction effort and place the project beneficial status. The average construction expenditure is the anticipated amount divided by the years of constructions, $68 million (SB-7) and $89 million (SB-8).

Table 23. Input Assumptions
Yuba City Metropolitan Statistical Area, California
(Values in Thousands, 2013 Dollars)

Category	Spending	Spending Amount		Local Percentage Capture		
		SB-7	SB-8	Local	State	National
Aggregate Materials	10%	34,186	62,984	94%	96%	99%
Other Materials	1%	3,419	6,298	100%	100%	100%
Equipment	35%	119,650	220,443	90%	99%	100%
Construction Labor	54%	184,603	340,111	100%	100%	100%
Total	100%	341,857	629,836	-	-	-

Direct expenditures expected for construction of earthen levees are spent primarily in two sectors of the economy, construction labor and equipment. Both account for 89% of the total project expenditures. Local capture rates are computed with RECONS to show where the output from expenditures are realized. As indicated in Table 20, all of the construction labor is expected to occur within the MSA, and 90% of the equipment is expected to be provided from within the study area, and 99% from within the State of California.

Table 21 summarizes the expected economic impacts in terms of monetary output, number of jobs, labor income and gross regional product. USACE is planning on expending approximately $78,000,000 for SB-7 or $99,000,000 for SB-8 on the project. Of this total project expenditure, approximately $75,000,000 for SB-7 or $96,000,000 for SB-8 will be captured within the regional impact area. The rest will be leaked out to the State of California or the nation. The expenditures made by the USACE for various services and products are expected to generate additional economic activity, which can be measured in jobs, income, sales, and gross regional product as summarized in Table 22-24.

Of significant note to the study area is the creation of jobs. Currently, the unemployment rate in the study area (8.4% in Gridley, 9.3% in Yuba City and 14.7% in Biggs) is higher than state (6.5%) and national (5.6%) averages, and the number of jobs gained within the region demonstrates the multiplier effect of this infusion of construction funds for this project.

Table 21. Summary of Economic Impacts
Yuba City Metropolitan Statistical Area, California
(2013 Dollars)

Total Spending		Alternative SB-7			Alternative SB-8		
		Regional	State	National	Regional	State	National
		$389,583,648	$389,583,648	$389,583,648	$696,564,551	$696,564,551	$696,564,551
Direct Impact	Output	$74,773,140	$77,321,802	$77,800,655	$95,494,472	$98,749,426	$99,360,980
	Job	5,421	5,463	5,474	9,693	9,768	9,788
	Labor Income	$52,207,466	$52,884,703	$53,058,423	$66,675,338	$67,540,253	$67,762,115
	GRP	$60,332,499	$61,751,971	$62,020,277	$77,052,002	$78,864,842	$79,207,502
Total Impact	Output	$127,772,992	$155,527,257	$205,466,249	$163,181,784	$198,627,385	$262,405,604
	Job	7,429	8,215	9,605	13,283	14,688	17,173
	Labor Income	$69,479,772	$79,789,624	$95,800,668	$88,734,192	$101,901,137	$122,349,205
	GRP	$91,926,674	$108,402,306	$136,103,550	$117,401,639	$138,443,042	$173,820,929

Table 22. Economic Impacts—Regional Level
Yuba City Metropolitan Statistical Area, California
(2013 Dollars)

Industry Sector		Alternative SB-7				Alternative SB-8			
		Sales	Jobs	Labor Income	GRP	Sales	Jobs	Labor Income	GRP
Direct Effects	Mining and quarrying sand, gravel, clay, & ceramic and refractory minerals	$22,009,401	$124	$11,489,718	$13,332,689	$39,352,187	$223	$20,543,290	$23,838,471
	Wholesale trade businesses	$385,064	$2	$158,569	$295,542	$688,482	$4	$283,517	$528,420
	Transport by rail	$583,568	$2	$179,004	$309,500	$1,043,403	$3	$320,053	$553,377
	Transport by water	$89,119	$0	$35,602	$38,623	$159,342	$0	$63,655	$69,059
	Transport by truck	$12,952,591	$92	$6,595,905	$7,663,482	$23,158,865	$164	$11,793,292	$13,702,088
	Construction of other new nonresidential structures	$4,675,004	$31	$1,612,504	$2,156,066	$8,358,775	$55	$2,883,112	$3,854,985
	Commercial & industrial machinery & equipment rental/leasing	$122,795,785	$403	$30,590,856	$67,491,423	$219,555,391	$721	$54,695,587	$120,672,755
	Labor	$210,375,170	$4,767	$210,375,170	$210,375,170	$376,144,857	$8,523	$376,144,857	$376,144,857
Total Direct Effects		$373,865,699	$5,421	$261,037,328	$301,662,495	$668,461,303	$9,693	$466,727,365	$539,364,015
Secondary Effects		$264,999,257	$2,008	$86,361,532	$157,970,873	$473,811,182	$3,590	$154,411,976	$282,447,457
Total Effects		$638,864,958	$7,429	$347,398,860	$459,633,369	$1,142,272,486	$13,283	$621,139,341	$821,811,471

Table 23. Economic Impacts—State Level
Yuba City Metropolitan Statistical Area, California
(2013 Dollars)

Industry Sector		Alternative SB-7				Alternative SB-8			
		Sales	Jobs	Labor Income	GRP	Sales	Jobs	Labor Income	GRP
Direct Effects	Mining and quarrying sand, gravel, clay, & ceramic and refractory minerals	$22,009,401	$124	$11,489,718	$13,332,689	$39,352,187	$223	$20,543,290	$23,838,471
	Wholesale trade businesses	$572,707	$3	$241,125	$441,650	$1,023,984	$6	$431,124	$789,656
	Transport by rail	$853,694	$3	$264,852	$454,789	$1,526,380	$5	$473,549	$813,149
	Transport by water	$296,773	$1	$118,556	$130,732	$530,622	$1	$211,975	$233,745
	Transport by truck	$12,952,591	$92	$6,595,905	$7,663,482	$23,158,865	$164	$11,793,292	$13,702,088
	Construction of other new nonresidential structures	$4,675,004	$31	$1,612,504	$2,156,066	$8,358,775	$55	$2,883,112	$3,854,985
	Commercial & industrial machinery & equipment rental/leasing	$134,873,671	$443	$33,725,684	$74,205,277	$241,150,310	$792	$60,300,569	$132,676,938
	Labor	$210,375,170	$4,767	$210,375,170	$210,375,170	$376,144,857	$8,523	$376,144,857	$376,144,857
Total Direct Effects		$386,609,009	$5,463	$264,423,514	$308,759,854	$691,245,981	$9,768	$472,781,769	$552,053,892
Secondary Effects		$391,027,274	$2,752	$134,524,604	$233,251,676	$699,145,713	$4,920	$240,526,190	$417,047,405
Total Effects		$777,636,283	$8,215	$398,948,118	$542,011,530	$1,390,391,694	$14,688	$713,307,957	$969,101,296

Table 24. Economic Impacts—National Level
Yuba City Metropolitan Statistical Area, California
(2013 Dollars)

Industry Sector		Alternative SB-7				Alternative SB-8			
		Sales	Jobs	Labor Income	GRP	Sales	Jobs	Labor Income	GRP
Direct Effects	Mining and quarrying sand, gravel, clay, & ceramic and refractory minerals	$22,009,401	$124	$11,489,718	$13,332,689	$39,352,187	$223	$20,543,290	$23,838,471
	Wholesale trade businesses	$580,472	$3	$244,541	$447,695	$1,037,868	$6	$437,233	$800,467
	Transport by rail	$1,110,386	$3	$347,187	$594,122	$1,985,339	$6	$620,760	$1,062,272
	Transport by water	$429,826	$1	$171,710	$191,336	$768,517	$2	$307,011	$342,103
	Transport by truck	$13,667,937	$97	$6,960,184	$8,086,722	$24,437,886	$174	$12,444,613	$14,458,829
	Construction of other new nonresidential structures	$4,675,004	$31	$1,612,504	$2,156,066	$8,358,775	$55	$2,883,112	$3,854,985
	Commercial & industrial machinery & equipment rental/leasing	$136,155,077	$448	$34,091,102	$74,917,585	$243,441,429	$800	$60,953,926	$133,950,525
	Labor	$210,375,170	$4,767	$210,375,170	$210,375,170	$376,144,857	$8,523	$376,144,857	$376,144,857
Total Direct Effects		$389,003,273	$5,474	$265,292,116	$310,101,385	$695,526,857	$9,788	$474,334,804	$554,452,511
Secondary Effects		$638,327,972	$4,130	$213,711,226	$370,416,366	$1,141,312,370	$7,385	$382,109,629	$662,293,992
Total Effects		$1,027,331,245	$9,605	$479,003,341	$680,517,751	$1,836,839,227	$17,173	$856,444,434	$1,216,746,503

7. ECONOMIC SUMMARY

A summary table of the cost benefit analysis, other social effects assessment and the regional economic development benefits is detailed in Table 25.

Table 25. Summary of Analyses

	SB-1	SB-7	SB-8
1. PLAN DESCRIPTION			
	Alternative SB-1: The No Action provides no physical project constructed by the Federal Government.	Alternative SB-7: The plan is a Feather River fix-in-place levee alternative from Sunset Weir to Laurel Avenue.	Alternative SB-8: The plan is a Feather River fix-in-place levee alternative from Thermalito to Laurel Avenue.
2. SUMMARY OF IMPACT ANALYSES			
A. National Economic Development (NED)			
1. Annual Damages	$ 137,000,000	$ 58,000,000	$ 50,000,000
2. Annual Benefits	$ -	$ 79,000,000	$ 87,000,000
3. Total Economic Costs[1]	$ -	$ 390,000,000	$ 686,000,000
a. IDC	$ -	$ 38,000,000	$ 94,000,000
b. O&M	$ -	$ 280,000	$ 450,000
c. Annual Cost	$ -	$ 18,000,000	$ 33,000,000
d. Construction Period		5 years	7 years
4. Annual Net Benefits	$ -	$ 61,000,000	$ 54,000,000
5. Benefit-to-Cost Ratio	-	4.4	2.6
B. Other Social Effects (OSE)			
Population at Risk[2]	Approximately **96,600** individuals are within the 1% ACE floodplain.	**38,200** people remain in the 1% ACE floodplain. (60% of population is removed from the 1% ACE residual floodplain.)	**6,600** people remain in the 1% ACE floodplain. (93% of population is removed from the 1% ACE residual floodplain)
Loss of Life	Potential loss of lives: **Day-388, Night-489**	Potential loss of lives: **Day-157, Night-197**	Potential loss of lives: **Day-27, Night-34**
Critical Infrastructure	**28** structure deemed as critical from a national perspective are at risk from floods.	**11** structures remain at risk from floods.	**1** structure is at risk from floods.
Evacuation Routes	In the event of a flood, no evacuation route is available out of the basin.	Offers **one** problematic route for evacuation during a flood event. A flood warning and evacuation plan would not be as effective and limited.	**5** evacuation routes are available in the event of a flood. A flood warning and evacuation plan would have more robustness and redundancy.
Wise Use of Floodplains	Currently, 71,800 acres of land are potentially available for future development.	88,200 acres would be potentially available for future development.	100,200 acres of land would be potentially available for future development.
Social Vulnerability	The social vulnerability index score (SoVi) indicates the study area to be medium to high vulnerability. The No Action alternative may leave	Majority of the community of Yuba City is afforded flood risk reduction, however the communities of Live Oak, Gridley, and Biggs remain at	The four existing communities are provided flood risk reduction, and social vulnerability is minimized due to a decrease in the probability of

	SB-1	SB-7	SB-8
	communities unable to cope with the recovery from a flood hazard.	risk of flood hazards and may be unable to cope and recover.	flood hazards occurring.
Residual Risk and Consequences	Residual Risk remains high throughout the study area	Residual Risk for Life Safety is reduced for most of the Yuba City urban area.	Residual Risk for Life Safety is reduced in the high risk communities: Yuba City, Live Oak, Gridley and Biggs.
C. Regional Economic Development (RED)—Regional Direct Impacts			
Output	$8,332,000,000	SB-1 + $74,773,000 (5yrs)	SB-1 + $95,494,000 (7yrs)
Job	64,844	SB-1 + 5,344 (5yrs)	SB-1 + 9,556 (7yrs)
Labor Income	$3,080,000,000	SB-1 + $52,207,000 (5yrs)	SB-1 + $66,675,000 (7yrs)
Gross Regional Product	$4,786,000,000	SB-1 + $60,332,000 (5yrs)	SB-1 + $77,052,000 (7yrs)

[1] Cultural resources data recovery costs ($1.6 million for SB-7 and $3.0 million for SB-8) are not included in economic costs per Corps policy (ER 1105-2-100, Appendix e, paragraph E-63.f.(5)).

[2] Population at Risk was calculated by GIS overlays of: 1) composite residual floodplains showing less than 90% assurance for the 1% ACE event, 2) population by census block and 3) Economic Impact Areas. These figures may differ slightly from those presented previously as official Census data in this document.

Attachment 1: Economic Appendix to support Decision Point #2 (September 2012)

1 Overview

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 study area can be found in Figure 1-1.

The study area is essentially encircled by project levees of the Sacramento River Flood Control Project and high ground of the Sutter Buttes. In 1917, the Federal government authorized the Sacramento River Flood Control Project, 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 flood stage.

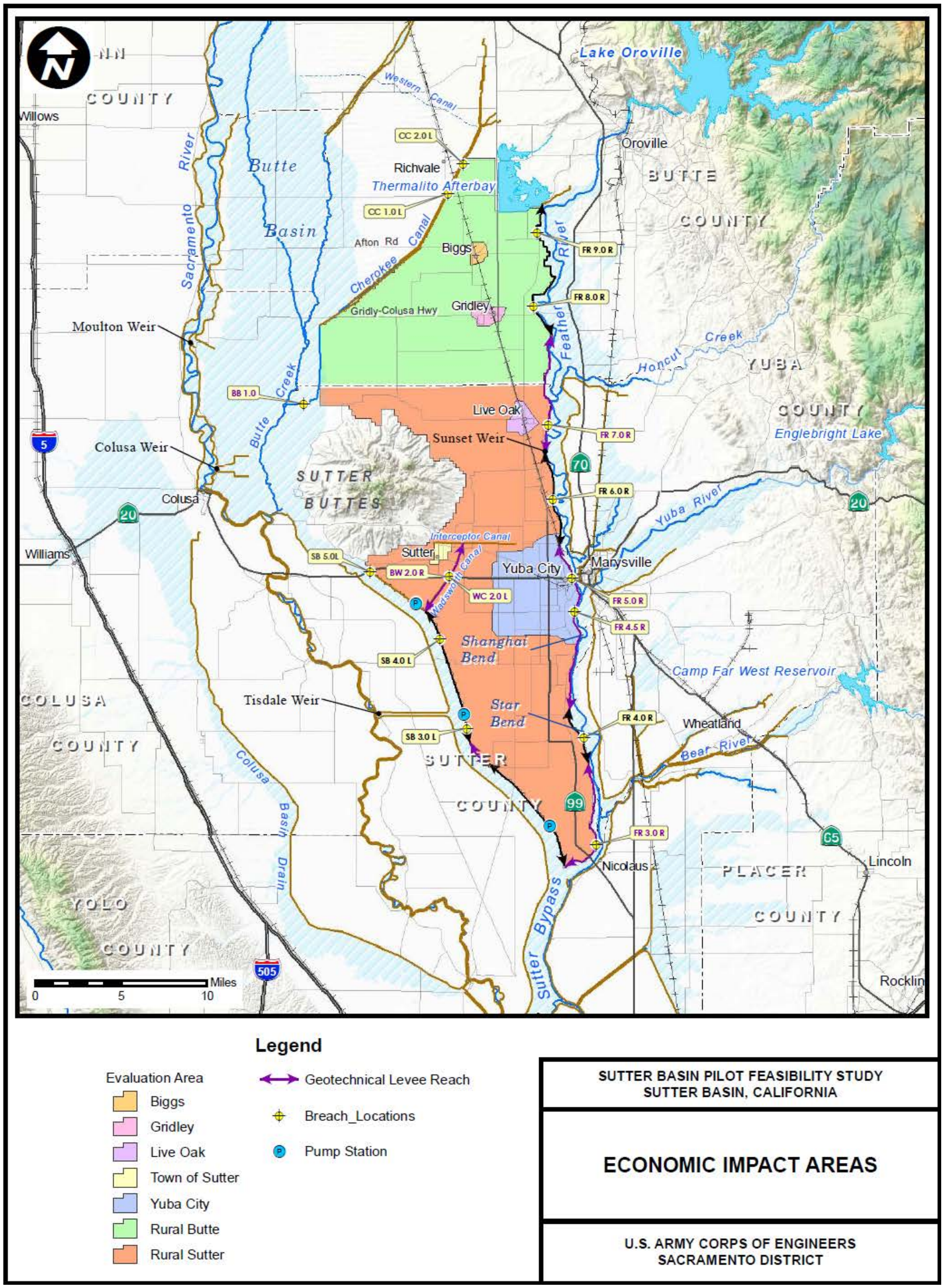
The Sutter Bypass is a flood control channel approximately three quarters of a mile wide, bordered on each side by levees. The bypass is an integral feature of the Sacramento River Flood Control Project's flood bypass system, conveying flood waters from the Butte Basin, Sacramento River, and Feather 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 water from 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 is described by four hydrologic reaches based on tributary inflows: Butte Slough to Wadsworth Canal, Wadsworth Canal to Tisdale Bypass, Tisdale Bypass to Feather River, and 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. The capacity of the East and West Interceptor is limited by levees that are lower than the Wadsworth Canal. As result, inflows to the Wadsworth canal are limited to around 1,500 cfs while excess flows bypass the canal entrance. The design provides resiliency because it reduces the probability that high Wadsworth Canal flows into the Sutter Bypass would combine with high stages in the Sutter Bypass resulting in a possible overtopping failure near the Sutter Bypass and Feather River confluence.

Figure 1-1: Sutter Basin Study Area and Economic Impact Areas



2 Purpose and Scope of Economic Analysis

The purpose of this report is to present the results of the economic analysis performed for the Pilot Feasibility Study of the Sutter Basin. The report documents the existing condition within the study area and proposed alternative plans to improve flood risk management, and designate the tentative National Economic Development (NED) Plan for purposes of estimating federal interest for the Sutter Basin. The report presents findings related to flood risk, potential flood damages and potential flood risk management benefits.

2.1 Methodology

This economic analysis is in accordance with standards, procedures, and guidance of the U.S. Army Corps of Engineers. The Planning Guidance Notebook (ER 1105-2-100, April 2000) serves as the primary source for evaluation methods of flood risk management studies and was used as reference for this analysis. Additional guidance for risk-based analysis was obtained from EM 1110-2-1619, *Engineering and Design – Risk-Based Analysis for Flood Damage Reduction Studies (August 1996)* and ER 1105-2-101, *Planning Risk-Based Analysis of Hydrology/Hydraulics, Geotechnical Stability, and Economics in Flood Damage Reduction Studies (March 1996)*. Economic evaluation was performed over a 50-year period of analysis. All values are presented in October 2011 price levels, and amortization calculations are based on the Fiscal Year 2012 federal discount rate of 4.0 percent as published in Corps of Engineers Economic Guidance Memorandum (EGM).

3 Floodplain Area and Inventory

3.1 Structural Inventory

A structural inventory was completed based on data gathered from assessor's parcel data and on-site inspection of structures within the flood plain. Structures were determined to be within the economic study area by using Geographical Information Systems (GIS) to compare the 0.2% (1/500) Annual Chance Exceedance (ACE) flood plain boundary (plus a buffer) with the spatially referenced assessor parcel numbers (APN). Information from the assessor's parcel database (such as land use, building square footage, address) was supplemented during field visitation for each parcel within the flood plain by adding fields for foundation height, specific business activity (non-residential), building condition, type of construction, and number of units, for example. Where square footage data was not available, the Google Earth measuring tool was used to estimate square footage. Parcels with structures were categorized by land use and grouped into the following structural damage categories:

1) **Single Family Residential** – includes all parcels represented by a single unit such as detached single family homes, individually owned condominiums and townhouses.
2) **Multiple Family Residential** – includes residential parcels with more than one unit such as apartment complexes, duplexes and quadplex units. Each parcel may have multiple structures.
3) **Commercial** – includes retail, office buildings, restaurants, etc.
4) **Industrial** – includes warehouses, light and heavy manufacturing facilities.
5) **Public** – includes both public and semi-public uses such as post offices, fire departments, government buildings, schools and churches.
6) **Agriculture** – Agricultural inventory was developed using assessor's parcel data and land use codes.

All parcels with structures were assigned to one of the listed categories. Single family and multi-family have been grouped together as "Residential" for presentation purposes.

The without-project damages and with-project benefits are based on potential damages to residential structures and contents, non-residential (commercial, industrial and public) structures and contents, automobiles and agriculture. The study area was divided into seven Economic Impact Areas (EIA's) for purposes of this analysis: Gridley, Biggs, Live Oak, Yuba City, Town of Sutter, Rural Butte and Rural Sutter. The delineation of these impact areas can be found in Figure 1-1.

Structure counts (assuming levee breaches) for a 0.2% (1/500) ACE event are presented by EIA in Table 3-1. Note that the Town of Sutter is not inundated by a 0.2% ACE event.

Table 3-1: Structural Inventory –Existing Conditions
Number of Structures within 0.2% (1/500yr) Annual Chance Floodplain if Levee Failures Occurs

Economic Impact Area	Commerical	Industrial	Public	Residential	TOTAL
Biggs	18	1	0	586	**605**
Gridley	81	7	4	1,931	**2,023**
LiveOak	51	5	23	2,088	**2,167**
Yuba City	872	210	122	18,760	**19,964**
Town of Sutter	0	0	0	0	**0**
Rural Butte	10	16	0	1,242	**1,268**
Rural Sutter	10	29	8	1,162	**1,209**
TOTAL	**1,042**	**268**	**157**	**25,769**	**27,236**

3.2 Value of Damageable Property – Structures and Contents

The value of damageable structures was estimated based on depreciated replacement values. The depreciated replacement value of a structure was determined by multiplying the structure’s 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 0.2% (1/500) ACE event is estimated at $6.9 billion. Table 4 displays the total value of damageable property by damage category.

Table 3-2: Value of Damageable Property – Existing Conditions
Within the 0.2% (1/500) Annual Chance Floodplain if Levee Failure Occurs
October 2011 Prices ($1,000's)

Economic Impact Area	Commercial		Industrial		Public		Residential		TOTAL	
	Structures	Contents	Structures	Contents	Structures	Contents	Structures	Contents	Structures	Contents
Biggs	3,780	2,829	1,759	601	0	0	49,747	24,873	**$55,286**	**$28,304**
Gridley	37,534	34,694	36,953	14,942	2,175	1,290	191,168	95,584	**$267,830**	**$146,509**
LiveOak	14,621	11,022	1,389	2,269	31,064	10,984	213,262	106,631	**$260,335**	**$130,906**
Yuba City	585,935	468,893	234,644	183,184	239,100	95,338	2,395,719	1,197,860	**$3,455,399**	**$1,945,276**
Town of Sutter	0	0	0	0	0	0	0	0	**$0**	**$0**
Rural Butte	1,659	2,261	32,091	13,571	0	0	133,513	66,756	**$167,262**	**$82,588**
Rural Sutter	3,585	5,436	24,389	15,246	12,868	5,661	183,350	91,675	**$224,192**	**$118,018**
TOTAL	**$647,114**	**$525,135**	**$331,225**	**$229,814**	**$285,207**	**$113,273**	**$3,166,758**	**$1,583,379**	**$4,430,304**	**$2,451,601**

4 Depth-Damage Relationships

Damages to structures and contents were determined based on depth of flooding relative to the structure's first floor elevation. First floor elevations were determined based upon visual estimates during windshield surveys in the study area. To compute these damages, depth-damage (DD) curves were used. These curves assign loss as a percentage of value for each parcel. The deeper the relative depth, the greater the percentage of value damaged. The sources of the relationships were different depending on land use. For residential structures, the IWR DD curves were used in accordance with EGM-04-01. The non-residential structure DD curves used here were originally developed for the May 1997 "Morganza to the Gulf, Louisiana Feasibility Study." These curves have been used extensively in Sacramento District, including on the American River studies. For Sutter, the long duration versions of the DD curves were used. Depth-damage curves for non-residential contents were taken from the American River Watershed Economic Re-evaluation Report (ERR) expert elicitation for long duration flooding. Depth Damage relationships are shown in the tables below.

Table 4-1: Depth Damage Curves for Residential (Structure and Content)

CATEGORY		DEPTH OF FLOODING ABOVE THE FIRST FLOOR IN FEET							
		-4.0	-1.0	0.0	1	3	5	10	15
1 Story	Structure	0%	3%	13%	23%	40%	53%	73%	80%
	Content	0%	2%	8%	13%	22%	29%	38%	40%
2 Story	Structure	0%	3%	9%	15%	26%	36%	56%	68%
	Content	0%	1%	5%	9%	16%	21%	32%	37%
Split	Structure	0%	6%	7%	9%	17%	29%	63%	84%
	Content	0%	2%	3%	5%	11%	20%	46%	61%
1 Story w/base	Structure	5%	19%	26%	32%	46%	59%	80%	81%
	Content	6%	13%	16%	19%	25%	30%	39%	39%
2 Story w/base	Structure	5%	14%	18%	22%	32%	42%	65%	76%
	Content	5%	10%	12%	14%	18%	22%	34%	49%
Split w/base	Structure	5%	14%	19%	23%	33%	44%	65%	69%
	Content	4%	9%	12%	14%	18%	22%	26%	26%
Mobile Home-Short Duration	Structure	0%	6%	10%	45%	46%	66%	66%	66%
	Content	0%	0%	0%	38%	69%	90%	90%	90%
Mobile Home-Long Duration	Structure	0%	6%	10%	45%	96%	96%	96%	96%
	Content	0%	0%	0%	85%	99%	99%	99%	99%

Table 4-2: Depth Damage Curves for Non-Residential Structures

CATEGORY	DEPTH OF FLOODING ABOVE THE FIRST FLOOR IN FEET						
	-1.0	0	1	3	5	10	15
1 Story Short Duration	0	7	16	28	31	46	50
2 Story Short Duration	0	5	10	18	22	38	38
1 Story Long Duration	0	7	22	31	32	54	86
2 Story Long Duration	0	5	15	22	23	46	80

Table 4-3: Depth Damage Curves for Non-Residential Content 1-story

CATEGORY	DEPTH OF FLOODING ABOVE THE FIRST FLOOR IN FEET						
	-1.0	0	1	3	5	10	15
Food Stores	0	0	78	100	100	100	100
Furniture-Retail	0	0	98	100	100	100	100
Grocery Store	0	0	87	100	100	100	100
Hotel-Full Service	0	0	88	100	100	100	100
Medical	0	0	75	100	100	100	100
Office	0	0	97	100	100	100	100
Restaurant	0	0	91	100	100	100	100
Rest-Fast Food	0	0	88	100	100	100	100
Retail	0	0	80	100	100	100	100
Service-Auto	10	10	74	100	100	100	100
Shopping Centers	0	0	96	100	100	100	100
Heavy	0	0	33	77	100	100	100
Light	0	0	88	99	100	100	100
Warehouse	0	0	84	100	100	100	100
Churches	0	0	73	99	99	99	100
Government	0	0	97	100	100	100	100
Recreation	0	0	98	100	100	100	100
Schools	0	0	88	100	100	100	100
Farms	0	0	56	100	100	100	100

5 Uncertainty and Other Categories

5.1 FLO-2D Grid Cells and Parcel Assignments using GIS

GIS was used to assign centroids to each parcel within the study area and these “points” were then overlaid onto the grid-cells of the FLO-2D model, resulting in the assignment of each parcel (structure) to a specific grid-cell within the hydraulic model. Due to the non-uniform nature of parcel shapes compared to the uniform (i.e. 1000ftx1000ft) nature of the FLO-2D grid-cells, some grid-cells contain zero parcels and other grid-cells have multiple parcels assigned to them. The water surface elevation of the grid-cell now becomes the water surface elevation for all parcels contained therein. Using the grid-cell assignments along with the depths of flooding for the 50% (1/2), 10% (1/10), 4% (1/25), 2% (1/50), 1% (1/100), 0.5% (1/200), 0.2% (1/500) ACE flood events, water surface profiles were developed and imported into HEC-FDA.

5.2 Economic Uncertainty Parameters

Many of the factors that determine flood damages can be represented by a range of values instead of a single number. Errors in measurement, variation in classification and judgment can lead to differences in values. For this study, in accordance with EM 1110-2-1619, uncertainties in the following parameters were considered in the damage estimation:

- Structure Value
- Content Ratio
- Depth-Damage Percentage
- First Floor Elevation (Foundation Height)

Structure values were determined as a function of Marshall& Swift values per square foot, square footage and estimated depreciation. To estimate the mean value of structures, a triangular distribution (minimum, most likely and maximum values) for each of these parameters were set in the model as discussed in detail.

In addition, standard deviations for all 4 variables were used for all land use/structure types within the FDA model and applied during FDA’s Monte Carlo simulation of the Expected Annual Damages. These coefficients of variation were based upon @Risk Monte Carlo simulations for representative structures for each damage category and land use type.

Risk and uncertainty was also included in the Depth Damage Percentages for residential structures and contents that were imported into FDA and applied during the Monte Carlo simulations.

Standard Deviation for foundation heights was set equal to 0.5 feet.

5.3 Other Damage Categories

5.3.1 Agricultural Losses

ER 1105-2-100, Appendix E, beginning on page E-113 includes specific guidance for studies where the primary damages occur to agricultural crops. Primary damages in this evaluation focus on the crop damage, loss of stored crops, and loss of farm equipment. These damages are directly related, and evaluated with special consideration for the expected time of seasonal flooding as well as the variability associated with crop prices and yields. The identified hydrologic/hydraulic variables, discharge associated with exceedence frequency and conveyance roughness and cross-section geometry, also apply to agricultural studies.

Based on empirical analyses conducted for past Corps projects, subject matter expertise from the agricultural economist and professional judgment, the project delivery team expects agricultural damages to total 10-15% of total project damages; amounts which are not expected to drive plan selection. A simplified approach was developed for this study based on stage-damage curves for land use types within the study area and simplifying calculations by utilizing 1,000 ft by 1,000 ft hydraulic model grid elements.

Expected Annual Damages associated with Agricultural land uses will be used in the comparison and screening of refined alternatives for the Sutter Basin Feasibility Study. The final array of alternatives (Tentative Selected Plan, National Economic Development Plan, and Locally Preferred Plan) will be selected from these refined alternatives. The final array of alternatives will be evaluated in further detail in the next phase of the study.

A more detailed writeup of the Agriculture analysis is available upon request in a technical memorandum.

5.3.2 Automobile Losses

Losses to automobiles were determined as a function of the number of vehicles per residence, average value per automobile, estimated percentage of autos removed from area prior to inundation, and depth of flooding above the ground elevation. Depth-damage relationships for autos were taken from EGM 09-04 and modified based on weighted average of distributions of car types (SUV, truck, sedan, sports car, etc) in California. Damages for autos begin once flood depth has reached 0.5 feet, and this damage curve can be seen in Table 5-1. Vehicle counts were estimated using an assumption of 2 vehicles per residential structure. Evacuation (autos moved out of the flooded area) was assumed to be 50%, as used on American River and other Corps studies. Depreciated replacement value of autos was based on a price adjusted Bureau of Labor Statistics average used car value of $8,865[6]. Uncertainty was incorporated using a normal distribution and a standard deviation at 15%.

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[6] $8,865 was derived from taking a value of $7,988 from the 2010 Natomas PAC and adjusting for price level using CPI for used cars and trucks.

Table 5-1: Automobile Depth Damage Function

Damage Category	Depth in Feet													
	-1	0	0.5	1	1.5	2	3	4	5	6	7	8	9	10
	% Damage to Structure/Content													
Automobiles	0	0	3	24	34	43	60	75	86	94	97	99	100	100
Std. Dev	0	0	10	8	7	6	5	3	4	7	7	7	8	8

5.3.3 Emergency Costs, Cleanup Costs, Road Damages and Traffic Disruption

An expert-opinion elicitation panel comprised of professionals having significant, relevant experience in the field of emergency response convened in Sacrament, CA (2009) with the goal of developing estimates of the economic cost associated with various emergency related damage categories (evacuation, debris activities, public services, utilities, etc). Initial model calculations for other district studies, as proportion of structure and content damages, range from 1-3%. Additionally, road damages and traffic-related costs associated with detours and extra time traveled experienced by motorists due to potential flooding in the Sutter Basin was forgone based on prior experiences, which have shown such damage categories to be relatively minimal when compared to structural damages. Nevertheless, it is recognized that in order to detail the magnitude of flooding problems in the Sutter Basin, the economic analyses can be conducted. However, because these damage categories are not expected to drive plan selection, they were omitted from the analysis. If deemed necessary, emergency costs, road damages and traffic disruption analyses can be conducted during refinement of the TSP.

6 Without Project Damages

6.1 HEC-FDA Model

For the Sutter Basin Pilot Feasibility Study, expected annual damages were estimated using the US Army Corps of Engineers, FRM-PCX certified risk-based Monte Carlo simulation program HEC-FDA v. 1.2.5a. Risk is a function of both probability and consequence, and the fact that risk inherently involves chance leads directly to a need to describe and plan for uncertainty. Corps policy has long been to acknowledge risk and uncertainty in anticipating floods and their impacts and to plan accordingly[7]. Historically, that planning relied on analysis of the expected long-term performance of flood-damage reduction measures, application of safety factors and freeboard, designing for worse case scenarios, and other indirect solutions (such as engineering judgment) to compensate for uncertainty. These indirect approaches were necessary because of the lack of technical knowledge of the complex interaction of uncertainties in estimating hydrologic, hydraulic, geotechnical, and economic factors due to the complexities of the mathematics required for doing otherwise. However, with advances in statistical hydrology and the availability of computerized analysis tools (such as HEC-FDA described below), it is now possible to improve the evaluation of uncertainties in the hydrologic, hydraulic, geotechnical, and economic functions. Through this risk analysis, and with careful communication of the results, the public can be better informed about what to expect from flood-damage reduction projects and thus can make more informed decisions. The determination of EAD for a flood reduction study must take into account complex and uncertain hydrologic, hydraulic, geotechnical, and economic information:

- **Hydrologic -** The discharge-frequency function describes the probability of floods equal to or greater than some discharge Q,
- **Hydraulics -** The stage-discharge function describes how high (stage) the flow of water in a river channel might be for a given volume of flow discharge,
- **Geotechnical -** The geotechnical levee failure function describes the levee failure probabilities vs. stages in channel with resultant stages in the floodplain, and
- **Economics -** The stage-damage function describes the amount of damage that might occur given certain floodplain stages.

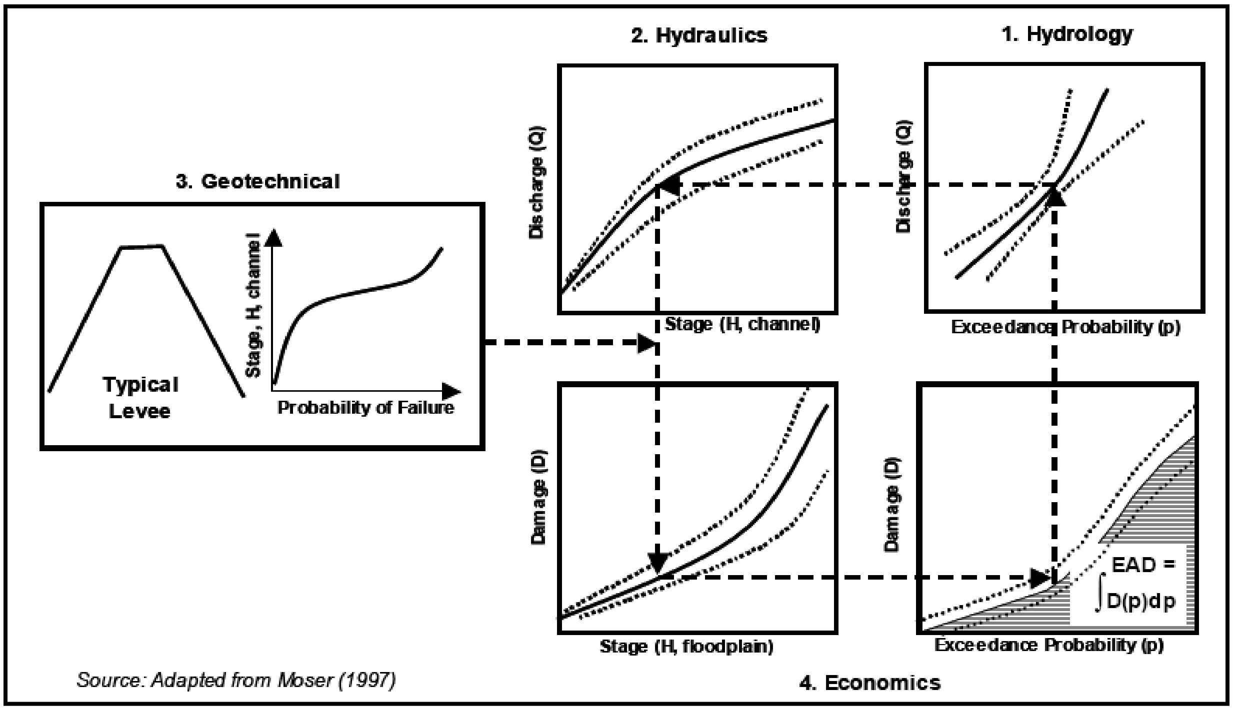
6.2 Estimation of Expected Annual Damages

To find the damage for any given flood frequency, the discharge for that frequency is first located in the discharge-frequency graph (graph #1), then the river channel stage associated with that discharge value is determined in the stage-discharge graph (graph #2). Once the levees fail and water enters the floodplain, the stages (water depths) in the floodplain inundate structures and cause damage (graph #4, left side). HEC-FDA uses a sampling of the curves within the uncertainty bounds of these relationships to generate the probability damage curves used in EAD calculations. By plotting this damage and repeating for process many times, the damage-frequency curve is determined (graph #4, right side). EAD is then computed by finding the area under the flood damage-frequency curve by integration for the without,

[7] In a flood risk management study, risk is defined as the probability of failure during a flood event and the resulting consequence. Uncertainty is the measure of the imprecision of knowledge of variables in a project plan.

interim, and with project conditions. Reductions in EAD attributable to projects are flood reduction benefits. Uncertainties are present for each of the functions discussed above and these are carried forth from one graph to the next, ultimately accumulating in the EAD. These uncertainties are shown in Figure 6-1 as "error bands" located above and below the hydrologic, hydraulic and economics curves.

Figure 6-1: Uncertainty in Discharge, Stage and Damage in Determination of Expected Annual Damages



Some of the important uncertainties specific to the Sutter Basin Feasibility Study include:

- **Hydrologic -** Uncertainty factors include hydrologic data record lengths that are often short or do not exist, precipitation-runoff computational methods that are not precisely known, and imprecise knowledge of the effectiveness of flow regulation.[8]
- **Hydraulics -** Uncertainty arising from the use of simplified models to describe complex hydraulic phenomena, including the lack of detailed geometric data, misalignments of hydraulic structures, debris load, infiltration rates, embankment failures, material variability, and from errors in estimating slope and roughness factors. For all EIA's a standard deviation in stage of 1.5 feet was used. (EM-1110-2-1619 guidance for minimum uncertainty).
- **Geotechnical –** Under without project conditions, levee fragility curves were developed and input into HEC-FDA for each of the 15 levee reaches identified in section 6.3 below.

[8] The hydrologic data record lengths (period of record) are the number of years of a systematic record of peak discharges at a stream gage. This parameter directly influences the uncertainty associated with the frequency-discharge function shown in Figure 6-1 and consequently the project performance statistics. In general, a longer period of record implies less uncertainty associated with this function. The period of record used for the Sutter Basin is 94 years.

- **Economics -** Uncertainty concerning land uses, depth/damage relationships, structure/content values, structure locations, first floor elevations, the amount of debris and mud, flood duration, and warning time and response of floodplain inhabitants (flood fighting).

6.3 Levee Breach and Floodplain Assignments by Economic Impact Area and Event

As mentioned in section 1, the study area is surrounded by project levees and high ground of the Sutter Buttes. For this study, the existing levees were separated into 15 levee reaches and a representative breach location was chosen for each reach. These breach locations can be found in Figure 1-1. When the study area becomes inundated, the floodwaters flow from north to south and then pool up in the southern portion of the Sutter Basin. Therefore, a breach on the northern section of the Feather River would cause a larger inundation area than a breach on the southern portion, but that does not necessarily mean it has the highest risk (probability & consequence).

For without project conditions, each EIA was assigned a dominating breach location which represents the breach where significant flooding starts to occur. A specific breach location was also assigned to each ACE event floodplain for each EIA based on the worst risk for that particular event by EIA. Risk is a function of both probability and consequence. Determining Breach and Floodplain assignments by EIA and event was a two step process:

1. <u>Probability</u> for floodplain assignments was measured in terms of Annual Exceedance Probabilities (AEP) for each breach location. If an ACE event was close to or lower the breach AEP, then that floodplain was “in play” for consideration. For example, if we are trying to determine which 4% ACE floodplains are “in play” and Breach A has an AEP of 0.1, Breach B has an AEP of 0.37 and Breach C has an AEP of 0.01, then Breach A and Breach B would be considered for Step 2 of the process, while flooding from Breach C would not be considered until looking at the 1% ACE floodplain and lower probability events. AEP for this study are highly dependent on levee fragility curves. A summary of Breach AEP’s and associated levee fragility curves are shown in Table 6-1.

2. <u>Consequence</u> for breach and floodplain assignments was determined based on depth and extent of flooding within each EIA. For each ACE event, those floodplains that were determined to be “in-play” during step one were then compared based on the total number of grid cells inundated and the total depth of flooding within each EIA. The “in-play” breach floodplain that caused the highest total depths and/or the highest number of grid cells inundated was chosen to be used in the water surface profile to be used in HEC-FDA calculation of aggregated stage damage functions. Most of the time the breach with the highest cumulative depth and number of grid cells was the same, but in a few cases where it wasn’t, professional judgment was used and usually the breach with the greater inundation extent was chosen.

The dominating breach and breach/floodplain assignments by ACE event for without project conditions are shown in Table 6-2.

Table 6-1: Levee Breach Location AEP's and Associated Probability-Failure Functions

	Feather River F3.0R	Feather River F4.0R	Feather River F4.5R	Feather River F5.0R	Feather River F6.0R	Feather River F7.0R	Feather River F8.0R	Feather River F9.0R	Cherokee Canal CC01L	Cherokee Canal CC02L	Sutter Bypass SB3.0L	Sutter Bypass SB4.0L	Sutter Bypass SB5.0L	Wadsworth Canal W2.0L	Wadsworth Canal W2.0R
WO Project AEP	**0.0399**	**0.0429**	**0.027**	**0.0417**	**0.0417**	**0.023**	**0.0426**	**0.0426**	**0.2246**	**0.2246**	**0.2962**	**0.2954**	**0.0787**	**0.0683**	**0.4217**
ACE Event:															
50% (1/2)	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.13	0.13	0.21	0.21	0.06	0.03	0.45
10% (1/10)	0.13	0.15	0.02	0.14	0.14	0.01	0.08	0.08	0.27	0.27	0.35	0.35	0.15	0.10	0.80
4% (1/25)	0.22	0.24	0.09	0.30	0.30	0.18	0.34	0.34	0.32	0.32	0.45	0.43	0.34	0.27	0.86
2% (1/50)	0.26	0.27	0.12	0.34	0.34	0.28	0.34	0.34	1.00	1.00	0.49	0.49	0.49	0.47	0.90
1% (1/100)	0.28	0.29	0.13	0.35	0.35	0.27	0.34	0.34	1.00	1.00	0.55	0.56	0.66	0.68	0.95
0.5% (1/200)	0.35	0.38	0.22	0.56	0.56	0.48	0.51	0.51	1.00	1.00	0.61	0.63	0.84	0.85	0.99
0.2% (1/500)	0.44	1.00	0.47	0.91	0.91	1.00	1.00	1.00	1.00	1.00	0.67	1.00	0.90	1.00	0.99

Table 6-2: Without Project - Levee Breach & Floodplain Assignments by ACE Event and EIA

EIA	Dominating Index Point (Significant Flooding Starts)	FDA Index Point	Annual Chance Exceedance Event						
			50% (1/2)	10% (1/10)	4% (1/25)	2% (1/50)	1% (1/100)	0.5% (1/200)	0.2% (1/500)
Biggs	F9.0R	F9.0R	None	CC.02	F9.0R	F9.0R	F9.0R	F9.0R	F9.0R
Gridley	F9.0R	F9.0R	None	None	F9.0R	F9.0R	F9.0R	F9.0R	F9.0R
Live Oak	F9.0R	F9.0R	None	None	F9.0R	F9.0R	F9.0R	F9.0R	F7.0R
Yuba City	F5.0R	F5.0R	None	S4.0L	F5.0R	F5.0R	F5.0R	F5.0R	F5.0R
Town of Sutter	None	None	None	None	None	None	None	None	None
Rural Butte	F9.0R	F9.0R	None	CC.02	F9.0R	F9.0R	F9.0R	F9.0R	F9.0R
Rural Sutter	S4.0L	S4.0L	None	S4.0L	F5.0R	F5.0R	F5.0R	F6.0R	F6.0R

6.4 Event Damages

Single-event damages for the 50%, 10%, 4%, 2%, 1%, 0.5% and 0.2% ACE flood events were computed in the HEC-FDA model. Floodplains were based upon existing levee's being breached (the levee was modeled with a hole in it at the breach location), which means that the event damage curve, (prior to levee insertion in FDA) may appear relatively flat with high damages beginning at frequent events. This issue it mitigated by the insertion of a levee height and fragility curve into HEC-FDA. The application of the levee fragility curve in FDA truncates the stage damage curve during EAD calculations for those events where a levee failure or overtopping does not occur. The 4% (1/25) and the 0.2% (1/500) annual chance events damages are presented below in Table 6-3 and represent the damages if a levee breach from the dominating breach location by reach were to occur. These damages can be cross-referenced with Table 6-1 and Table 6-2 above to identify the probability of occurrence. For example, Table 6-3 shows Yuba City damages to be $2.2 billion for the 1/25 chance event and $2.8 billion for the 0.2% annual chance event, but these damages have a 30% and 91% chance of occurrence due to a levee failure respectively. The damages listed here represent probability damages prior to the application of economic uncertainty parameters.

Table 6-3: Without Project Probability-Damage Functions (structure and contents) – by EIA

October 2011 Prices ($1,000's), 4.0% Discount Rate

Economic Impact Area	Commercial		Industrial		Public		Residential		TOTAL	
	4% event	0.2% event	4% event	0.2% event	4% event	0.2% event	4% event	0.2% event	4% event	0.2% event
Biggs	3,149	3,717	756	1,131	0	0	17,427	26,861	**$21,332**	**$31,709**
Gridley	40,214	45,079	12,048	14,323	1,759	1,980	29,423	59,634	**$83,445**	**$121,016**
LiveOak	12,925	16,287	2,246	2,645	17,545	23,521	42,675	107,226	**$75,391**	**$149,679**
Yuba City	629,541	737,631	266,963	300,244	177,653	210,395	1,092,447	1,598,342	**$2,166,603**	**$2,846,613**
Town of Sutter	0	0	0	0	0	0	0	0	**$0**	**$0**
Rural Butte	1,805	1,848	8,115	9,328	0	0	24,985	44,594	**$34,905**	**$55,770**
Rural Sutter	4,711	5,165	14,855	28,149	12,415	13,355	72,040	104,439	**$104,021**	**$151,107**
TOTAL	**$692,345**	**$809,727**	**$304,983**	**$355,819**	**$209,373**	**$249,251**	**$1,278,996**	**$1,941,097**	**$2,485,696**	**$3,355,894**

6.5 Expected Annual Damages – Without Project Conditions

The HEC-FDA without project conditions model results (Expected Annual Damages) for structures, contents, automobiles and agriculture are shown, by EIA, in Table 6-4. Total study area without project expected annual damages are approximately $108 million.

Table 6-4: Expected Annual Damages - Without Project Conditions
October 2011 Prices ($1,000's), 4.0% Discount Rate

EIA	Expected Annual Damages (EAD) by Category ($1,000's)						
	Automobiles	Commercial	Industrial	Public	Residential	Agriculture	TOTAL
Biggs	102	90	30	0	554	4	780
Gridley	201	1,149	341	54	1,094	5	2,844
Live Oak	270	366	59	521	1,569	10	2,795
Yuba City	4,050	14,825	6,081	4,025	24,764	269	54,014
Town of Sutter	0	0	0	0	0	0	0
Rural Butte	154	52	263	0	857	1,316	2,642
Rural Sutter	2,218	1,255	6,391	3,790	20,828	10,910	45,392
TOTAL	6,995	17,737	13,165	8,390	49,666	12,514	108,467

6.6 EAD Future Conditions and Equivalent Annual Damages

The without-project equivalent annual damage reflects the damage value associated with the without-project condition over the period of analysis and under changing hydrology, hydraulic (H&H), and economic conditions in the study area. Essentially, equivalent annual damages are expected annual damages that have been converted to a single present worth value and then amortized over the analysis period using the federally mandated discount rate of 4.0%. Existing conditions represent inventory, H&H and geotechnical performance within the study area currently. 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. For the purposes of the identification of the TSP, economics has assumed that future without-project conditions are equal to existing conditions. Once the TSP is identified, the future conditions within HEC-FDA will be set according to the Future Without-Project Conditions portion of the main report. Because any future without project development would take place outside/above the mean 1% annual chance floodplain boundary/WSEL and because any future damages would be discounted back to present value, the future condition is not expected to impact the plan formulation process significantly.

6.7 Project Performance – Without Project Conditions

In addition to damages estimates, HEC-FDA reports flood risk in terms of project performance. Three statistical measures are provided, in accordance with ER 1105-2-101, to describe performance risk in probabilistic terms. These include annual exceedance probability, long-term risk, and assurance by event.

- Annual exceedance probability measures the chance of having a damaging flood in any given year.
- Long-term risk provides the probability of having one or more damaging floods over a period of time.
- Assurance is the probability that a target stage will not be exceeded during the occurrence of a specified flood.

The worst project performance statistics may not necessarily be associated with the breach location producing the most economic damages (as described in section 6.3). For example, both the Feather River and the Sutter Bypass can cause flooding in the Yuba City EIA. Even though the Feather River (F5.0R) causes more significant annual damages in the area, the project performance is worse for the Sutter Bypass. Because economic consequences are higher for the Feather breach, that's what was used in HEC-FDA, but project performance is still limited by the Sutter Bypass. Project performance statistics for each impact area under without project conditions is displayed in Table 6-5 below.

Table 6-5: Project Performance by EIA - Without Project Conditions

Economic Impact Area	Breach Location	Annual Exceedance Probability		Long-Term Risk			Assurance by Event			
		Median	Expected	10 Year Period	30 Year Period	50 Year Period	10%	2%	1%	0.20%
Biggs	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
Gridley	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
Live Oak	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
Yuba City	S4.0L	0.2482	0.2954	97%	99%	99%	60%	57%	50%	24%
Town of Sutter	None	None	None	None	None	None	None	None	None	None
Rural Butte	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
Rural Sutter	S4.0L	0.2482	0.2954	97%	99%	99%	60%	57%	50%	24%

7 With-Project Damages and Benefits

This section will describe how benefits of flood risk management of the final array of alternatives were estimated. Non-monetary outputs such as environmental measures, which may vary for the final array of alternatives, are not included but may factor in the plan formulation decision process.

Benefits were determined by incorporating increments of levee fixes into the FDA model that represent various with-project improvements. Flood risk management benefits equal the difference between the without project damages and the with-project residual damages.

7.1 Conceptual Alternatives

Many conceptual alternatives were considered during the plan formulation process. See the main report for a detailed description of all conceptual alternatives.

7.2 Refined Array of Alternatives

Economic benefits were estimated for each alternative in the Refined Array. 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 visual inspection of the without and with project floodplains by Hydraulic Design and Economics. Project costs were based on initial parametric project cost estimates (see main report and cost appendix for more detail). These benefits and costs were then compared to screen out those refined alternatives do not appear economically justified even in the most favorable benefit/cost ratio ranges (highest benefit and lowest cost) and/or to compare costs of plans with very similar outputs from a cost effectiveness perspective cost effectiveness. For a more detailed description of this screening, please see the main report. The table below summarizes the findings of the screening. As a result of this screening, only 5 plans (Yuba City Ring Levee, Little J, Minimal Fix-in-Place, Fix in Place Thermalito to Star Bend and Fix-in-Place w/o raising) were carried forward into the Draft Array for identification of the TSP.

Table 7-1: Benefits and Costs for Refined Array of Alternative
October 2011 Prices ($Millions), 4.0% Discount Rate

Alternative	Total First Cost ($Millions)		Annualized Cost ($Millions)		Annual Benefits ($Millions)		Annual Net Benefits ($Millions)		Benefit to Cost Ratio	
	Low	High	Low	High	Low	High	Low	High	Low	High
2.1 - Ring Levees:										
Yuba City	313	671	15	31	12	47	-10	29	0.4	3.2
Gridley	95	204	4	9	1	4	-6	0	0.1	0.9
Live Oak	82	177	4	8	1	3	-5	0	0.1	0.9
Biggs	60	129	3	6	0	1	-5	-2	0.0	0.3
2.2 - Big J	703	1,506	33	70	16	63	-35	26	0.2	1.9
2.3 - Little J	560	1,201	26	56	16	63	-24	32	0.3	2.4
2.4 Minimal Fix in Place	177	381	8	18	5	19	-8	9	0.3	2.3
2.5 Fix in Place Thermalito to Star Bend	422	905	20	42	13	53	-17	29	0.3	2.7
3.1 Fix in Place w/o Raising	737	1,579	34	73	17	68	-36	29	0.2	2.0
3.2 Primarily Fix in Place including modest	882	1,900	41	88	17	68	-48	22	0.2	1.6
4.1 Setbacks with Ecosystem Restoration	1,543	3,308	72	154	17	68	-100	-3	0.1	0.9

7.3 Draft Array of Alternatives – TSP Identification

The draft array of alternatives is listed below. These alternatives were analyzed in more detail to estimate project benefits and identify a TSP. For a detailed description of project measures, please refer to the main report.

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

Maps showing the locations of project features for each alternative can be found in Enclosure 3.

7.3.1 With-Project Levee Breach and Floodplain Assignments by Economic Impact Area and Event

With-Project floodplains and index point assignments were done using the same two-step process described in section 6.3 of this report. Without project floodplains were utilized for the with-project runs. With-project benefits result from the reduction in flood depths/extents as the fixed levee reaches are no longer “in play” during water surface profile creation and floodplain assignments. With-project levee breach and floodplain assignments by event and EIA can be found in Enclosure 4. Table 7-2 summarizes the levee reach fixes and residual breach locations by alternative.

Table 7-2: Levee Reach Fixes by Alternative

Alternative	Fixed Index Points	Residual Index Points
SB-1: No Action		F3, F4, F4.5, F5, F6, F7, F8, F9, S3, S4, CC1, CC2, W2
SB-2: Minimal Fix in Place	F4.5, F5, F6	F3, F4, F7, F8, F9, S3, S4, CC1, CC2, W2
SB-3: Yuba City Ring Levee	F4.5, F5	*F3, F4, F6, F7, F8, F9, S3, S4,* CC1, CC2, W2[9]
SB-4: Little J Levee	F5, F6, F7, F8, F9	*F3, F4, F4.5, S3, S4*[10], CC1, CC2, W2
SB-5: Fix-in-Place, Thermalito to Star Bend	F4.5, F5, F6, F7, F8, F9	F4, F3, S3, S4, CC1, CC2, W2
SB-6: Fix-in-Place, Feather River, Sutter Bypass and Wadsworth Canal	F3, F4, F4.5, F5, F6, F7, F8, F9, S3, S4, W2	CC1, CC2
SB-7: Fix-in-Place, Sunset Weir to Laurel Ave	F4, F4.5, F5, F6, F7, F8, F9	F3, S3, S4, CC1, CC2, W2
SB-8: Fix-in-Place, Thermalito to Laurel Ave	F4, F4.5, F5, F6, F7, F8, F9	F3, S3, S4, CC1, CC2, W2

[9] For Yuba City Economic Impact Area, only the 500 year residual flooding. All other economic impact areas equal the without project depths and damages.
[10] For F3, F4, F4.5, S3 and S4 residual floodplain depths with the Little J Levee in place were used.

7.3.2 Annual Benefits and Residual Damages

The with-project floodplain and levee assignments described above were then input and run in HEC-FDA to determine residual damages and annual benefits. Residual damages can be found in Table 7-3 and annual benefits can be found in Table 7-4.

Table 7-3: Residual Annual Damages by Alternative and EIA
October 2011 Prices ($1,000's), 4.0% Discount Rate

Alternative	Expected Annual Damages (EAD) ($1,000's)							
	Biggs	Gridley	Live Oak	Yuba City	Town of Sutter	Rural Butte	Rural Sutter	TOTAL
SB-1: No Action	780	2,844	2,795	54,014	0	2,642	45,392	108,467
SB-2: Minimal Fix in Place	780	2,844	2,795	14,568	0	2,642	32,058	55,687
SB-3: Yuba City Ring Levee	780	2,844	2,795	2,789	0	2,642	45,392	57,242
SB-4: Little J Levee	171	315	381	10,136	0	1,008	31,416	43,427
SB-5: Fix-in-Place, Thermalito to Star Bend	171	318	381	14,568	0	1,008	32,058	48,504
SB-6: Fix-in-Place, Feather River, Sutter Bypass and Wadsworth	171	318	381	2,752	0	1,008	1,589	6,219
SB-7: Fix-in-Place, Sunset Weir to Laurel Ave	780	2,844	2,795	3,694	0	2,642	27,773	40,528
SB-8: Fix-in-Place, Thermalito to Laurel Ave	171	318	381	3,694	0	1,008	27,773	33,345

Table 7-4: Annual Benefits by Alternative
October 2011 Prices ($1,000's), 4.0% Discount Rate

Alternative	Expected Annual Benefits ($1,000's)							
	Biggs	Gridley	Live Oak	Yuba City	Town of Sutter	Rural Butte	Rural Sutter	TOTAL
SB-1: No Action	0	0	0	0	0	0	0	0
SB-2: Minimal Fix in Place	0	0	0	39,446	0	0	13,334	52,780
SB-3: Yuba City Ring Levee	0	0	0	51,225	0	0	0	51,225
SB-4: Little J Levee	609	2,529	2,414	43,878	0	1,634	13,976	65,040
SB-5: Fix-in-Place, Thermalito to Star Bend	609	2,526	2,414	39,446	0	1,634	13,334	59,963
SB-6: Fix-in-Place, Feather River, Sutter Bypass and Wadsworth Canal	609	2,526	2,414	51,262	0	1,634	43,803	102,248
SB-7: Fix-in-Place, Sunset Weir to Laurel Ave	0	0	0	50,320	0	0	17,619	67,939
SB-8: Fix-in-Place, Thermalito to Laurel Ave	609	2,526	2,414	50,320	0	1,634	17,619	75,122

7.3.3 Probability Distribution of Damages Reduced

In accordance with ER 1105-2-101, flood damages reduced were determined as mean values and by probability exceeded. The table below shows the benefits for each alternative for the 75%, 50% and 25% probability that benefit exceeds indicated value. The damage reduced column represents the mean benefits for each increment and the 75%, 50% and 25% represent the probability that the flood damage reduction benefits exceed the number in that column for that increment. For example, Alternative SB-2 has an average (mean) benefit of $50.3 million, but a 50% chance that benefits could be greater than $38.4 million, 75% confidence that benefits will be equal or greater than $24.3 million and 25% confidence that benefits could exceed $72.7 million. This range is the probability distribution of damages reduced and represents the uncertainty in the benefit estimates and incorporates all the uncertainties in hydrology, hydraulics, geotechnical and economics in the HEC-FDA model. The uncertainty in damages reduced should be considered when selecting an optimal plan during the plan formulation process. Judgment should be used to determine if an alternative meets a reasonable level of confidence regarding positive net benefits and identifying if changes in net benefits from alternative to alternative are significant.

Table 7-5: Probability Distribution of Damages Reduced – TOTAL Study Area
October 2011 Prices ($1,000's), 4% Interest Rate

Alternative	Annual Damages ($1,000's)			Probability Damage Reduced		
	Without Project	With Project	Damage Reduced	75%	50%	25%
SB-1: No Action	95,954	95,954	0	0	0	0
SB-2: Minimal Fix in Place	95,954	45,686	50,268	24,301	38,376	72,685
SB-3: Yuba City Ring Levee	95,954	44,950	51,004	24,851	40,716	71,125
SB-4: Little J Levee	95,954	34,854	61,100	31,497	46,103	86,746
SB-5: Fix-in-Place, Thermalito to Star Bend	95,954	39,128	56,826	28,627	44,861	81,220
SB-6: Fix-in-Place, Feather River, Sutter Bypass and Wadsworth Canal	95,954	4,287	91,667	45,913	73,277	134,087
SB-7: Fix-in-Place, Sunset Weir to Laurel Ave	95,954	31,296	64,658	31,698	51,348	91,999
SB-8: Fix-in-Place, Thermalito to Laurel Ave	95,954	24,739	71,215	36,024	57,834	100,534

7.3.4 Project Performance

As discussed in Section 6.7, project performance for each alternative is identified by the residual index location that has the highest AEP which causes flooding within an EIA. For many alternatives, the with-project AEP may be the same as the without project AEP, even though the annual damages may decrease significantly. For example, the index point which causes flooding within the Yuba City EIA with the worst AEP is from the Sutter Bypass (S4.0L), even though more significant damages come from a breach on the Feather. Because Alternative SB-2 fixes the stretches of levee on the Feather which cause the worst economic consequence flooding in Yuba City (F4.5R, F5.0R and F6.0R), you see a significant annual benefit from fixing those levees. Although project performance (measured by AEP) has not decreased, the overall consequences of flooding are reduced as levee reaches are fixed. The overall/combined likelihood that the area will get flooded is reduced as levee reaches are fixed. This combined chance of flooding is difficult to quantify, so the representative index point is used.

Project performance statistics for each impact area are displayed by impact area and alternative in the table below.

Table 7-6: Project Performance – With Project Conditions – by EIA

Economic Impact Area	Alternative	Resdiual Breach Location	Annual Exceedance Probability		Long-Term Risk			Assurance by Event			
			Median	Expected	10 Year Period	30 Year Period	50 Year Period	10%	2%	1%	0.20%
Biggs	SB-1: No Action	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
	SB-2: Min FIP	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
	SB-3: Yuba City Ring	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
	SB-4: Little J	F9.0R-fixed	0.0022	0.0022	2%	6%	10%	99%	99%	100%	55%
	SB-5: FIP Therm to Star	F9.0R-fixed	0.0022	0.0022	2%	6%	10%	99%	99%	100%	55%
	SB-6: FIP ALL	F9.0R-fixed	0.0022	0.0022	2%	6%	10%	99%	99%	100%	55%
	SB-7: FIP Sunset to Laurel	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
	SB-8: FIP Themalito to Laurel	F9.0R-fixed	0.0022	0.0022	2%	6%	10%	99%	99%	100%	55%
Gridley	SB-1: No Action	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
	SB-2: Min FIP	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
	SB-3: Yuba City Ring	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
	SB-4: Little J	F9.0R-fixed	0.0022	0.0022	2%	6%	10%	99%	99%	100%	55%
	SB-5: FIP Therm to Star	F9.0R-fixed	0.0022	0.0022	2%	6%	10%	99%	99%	100%	55%
	SB-6: FIP ALL	F9.0R-fixed	0.0022	0.0022	2%	6%	10%	99%	99%	100%	55%
	SB-7: FIP Sunset to Laurel	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
	SB-8: FIP Themalito to Laurel	F9.0R-fixed	0.0022	0.0022	2%	6%	10%	99%	99%	100%	55%
Live Oak	SB-1: No Action	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
	SB-2: Min FIP	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
	SB-3: Yuba City Ring	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
	SB-4: Little J	F9.0R-fixed	0.0022	0.0022	2%	6%	10%	99%	99%	100%	55%
	SB-5: FIP Therm to Star	F9.0R-fixed	0.0022	0.0022	2%	6%	10%	99%	99%	100%	55%
	SB-6: FIP ALL	F9.0R-fixed	0.0022	0.0022	2%	6%	10%	99%	99%	100%	55%
	SB-7: FIP Sunset to Laurel	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
	SB-8: FIP Themalito to Laurel	F9.0R-fixed	0.0022	0.0022	2%	6%	10%	99%	99%	100%	55%
Yuba City	SB-1: No Action	S4.0L	0.2482	0.2954	97%	99%	99%	60%	57%	50%	24%
	SB-2: Min FIP	S4.0L	0.2482	0.2954	97%	99%	99%	60%	57%	50%	24%
	SB-3: Yuba City Ring	F9.0R-fixed	0.0022	0.0022	2%	6%	10%	99%	99%	100%	55%
	SB-4: Little J	S4.0L	0.2482	0.2954	97%	99%	99%	60%	57%	50%	24%
	SB-5: FIP Therm to Star	S4.0L	0.2482	0.2954	97%	99%	99%	60%	57%	50%	24%
	SB-6: FIP ALL	F4_0R-fixed	0.0022	0.0022	2%	7%	11%	99%	99%	99%	55%
	SB-7: FIP Sunset to Laurel	S4.0L	0.2482	0.2954	97%	99%	99%	60%	57%	50%	24%
	SB-8: FIP Themalito to Laurel	S4.0L	0.2482	0.2954	97%	99%	99%	60%	57%	50%	24%
Town of Sutter	ALL	None	None	None	None	None	None	None	None	None	None
Rural Butte	SB-1: No Action	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
	SB-2: Min FIP	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
	SB-3: Yuba City Ring	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
	SB-4: Little J	F9.0R-fixed	0.0022	0.0022	2%	6%	10%	99%	99%	100%	55%
	SB-5: FIP Therm to Star	F9.0R-fixed	0.0022	0.0022	2%	6%	10%	99%	99%	100%	55%
	SB-6: FIP ALL	F9.0R-fixed	0.0022	0.0022	2%	6%	10%	99%	99%	100%	55%
	SB-7: FIP Sunset to Laurel	F9.0R	0.0386	0.0426	35%	73%	89%	89%	60%	56%	19%
	SB-8: FIP Themalito to Laurel	F9.0R-fixed	0.0022	0.0022	2%	6%	10%	99%	99%	100%	55%
Rural Sutter	SB-1: No Action	S4.0L	0.2482	0.2954	97%	99%	99%	60%	57%	50%	24%
	SB-2: Min FIP	S4.0L	0.2482	0.2954	97%	99%	99%	60%	57%	50%	24%
	SB-3: Yuba City Ring	S4.0L	0.2482	0.2954	97%	99%	99%	60%	57%	50%	24%
	SB-4: Little J	S4.0L	0.2482	0.2954	97%	99%	99%	60%	57%	50%	24%
	SB-5: FIP Therm to Star	S4.0L	0.2482	0.2954	97%	99%	99%	60%	57%	50%	24%
	SB-6: FIP ALL	F4_0R-fixed	0.0022	0.0022	2%	7%	11%	99%	99%	99%	55%
	SB-7: FIP Sunset to Laurel	S4.0L	0.2482	0.2954	97%	99%	99%	60%	57%	50%	24%
	SB-8: FIP Themalito to Laurel	S4.0L	0.2482	0.2954	97%	99%	99%	60%	57%	50%	24%

8 Net Benefit Analysis

With benefits calculations complete, annual costs need to be derived to complete the benefit cost analysis. Economic feasibility and project efficiency are determined through benefit cost analysis. For a project or increment to be feasible, benefits must exceed costs and the most efficient alternative is the one that maximizes net benefits (annual benefits minus annual costs). The National Economic Development Plan (NED) is identified as the plan that reasonable optimizes the net benefits.

8.1 Net benefit and BCR uncertainty and ranges

Table 8-1 below summarizes the Net Benefits and Benefit-to-Cost ratio ranges for each of the draft array of alternatives. The low annual benefit represents the 75% confidence (that benefits will exceed the indicated value), the mid represents the 50% and the high annual benefit represents the 25% confidence level. The low annual cost represents the 20% confidence (that costs will be less than the indicated value), the mid annual cost represents the 50% confidence and the high cost represents the 80% confidence. Net Benefit and BCR mean values and ranges were calculated in a Monte-Carlo simulation using a triangular distribution in the annual benefits and the annual costs. The mean Net Benefit and BCR represent the mean result from this Monte Carlo simulation. The low to high range represent the 90% confident range (5%-95%), given our inputs (less than 90% overall because inputs did not represent the 100% range). In other words, we are most confident that Net Benefits and BCR will exceed the low values and become less confident as you move toward the high values, with the best estimate being the mean values.

More detailed costs estimates will be developed for the final array of alternatives.

Table 8-1: Net Benefits and Benefit-to-Cost Ratios – Draft Array of Alternatives in October 2011 Prices ($Million), 4% Interest Rate

Alternative	Total First Cost[1]			IDC[2]	Annualized Cost + O&M[3]			Annual Benefits[4]			Annual Net Benefits[5]			Benefit to Cost Ratio[5]		
	Low (20%)	Mid (50%)	High (80%)	Mid	Low (20%)	Mid (50%)	High (80%)	Low (75%)	Mid (50%)	High (25%)	Low	Mean	High	Low	Mean	High
SB-1: No Action	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
SB-2: Minimal Fix in Place, Sunset Weir to Star Bend	290	319	361	24	14	16	18	24	38	73	14	29	48	1.9	2.9	4.1
SB-3: Yuba City Ring Levee	411	451	507	53	21	23	26	25	41	71	8	23	40	1.3	2.0	2.7
SB-4: Little J Levee	729	798	899	94	37	40	45	31	46	87	-3	14	36	0.9	1.4	1.9
SB-5: Fix-in-Place, Thermalito to Star Bend	549	608	694	72	28	31	35	29	45	81	4	21	41	1.1	1.7	2.3
SB-6: Fix-in-Place, Feather River, Sutter Bypass and Wadsworth Canal	1,018	1,131	1,297	183	53	59	67	46	73	134	-3	25	58	0.9	1.4	2.0
SB-7: Fix-in-Place, Sunset Weir to Laurel Ave	386	423	479	41	19	21	24	32	51	92	18	37	60	1.8	2.8	3.8
SB-8: Fix-in-Place, Thermalito to Laurel Ave	645	713	812	100	33	36	42	36	58	101	7	28	52	1.2	1.8	2.4

1 Cost Range: Min= 20% Mid=50% Max= 80% (confidence costs are less than given value)

2 IDC based on equal annual spending over the following construction schedules: SB-2 = 3years, SB 3 = 5 years, SB-4 = 5 years, SB-5 = 5 years, SB-6 = 7 years, SB-7=4 years, SB-8=6 years

3 First Costs plus IDC amortized over 50 years at 4% plus annual O&M. Annual O&M costs: SB-2 = $195k, SB-3 = $270k, SB-4 = $477k, SB-5 = $360k, SB-6 = $661k, SB-7 = $350k, SB-8 = $500k

4 Benefit Range: Min=75% Mid=50% Max=25% (confidence benefits are greater than given value)

5 Values are a result of Monte Carlo simulations using triangular distributions of annual benefit and annual cost confidence intervals as inputs. Mean=Mean result from simulation.

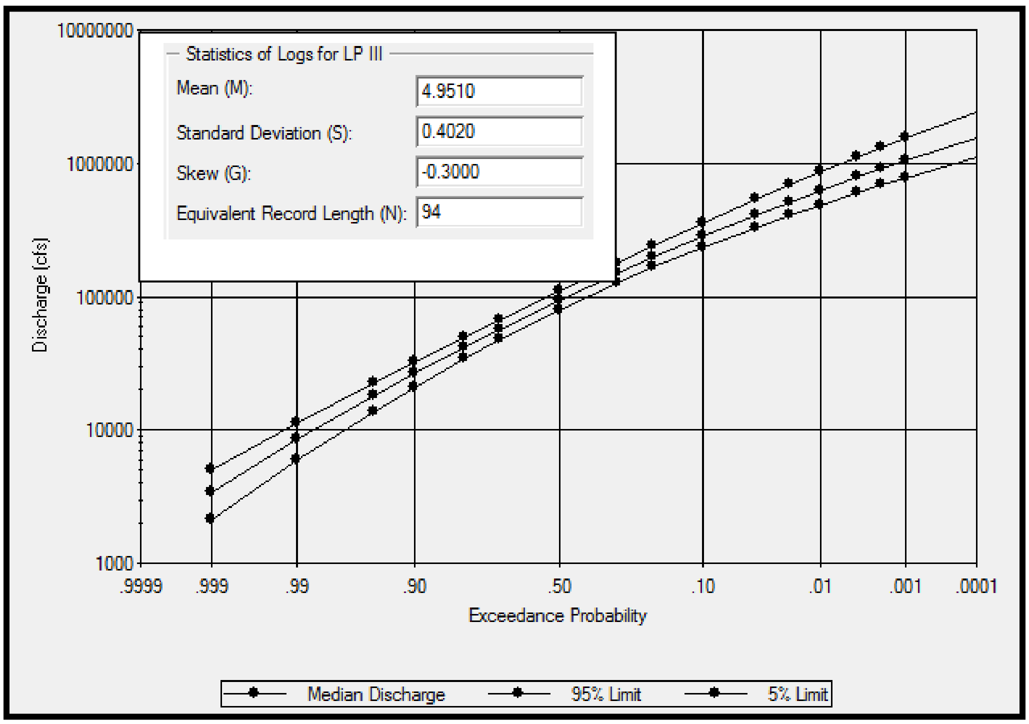
9 Conclusions

The Tentatively Selected Plan will be determined based upon NED and the evaluation of other metrics developed for the Sutter Basin, such as critical infrastructure, life safety and wise use of floodplains. For detailed discussion of these metrics and the identification of the TSP, please refer to the main report.

Enclosure 1 to Attachment 1: Hydrology Inputs

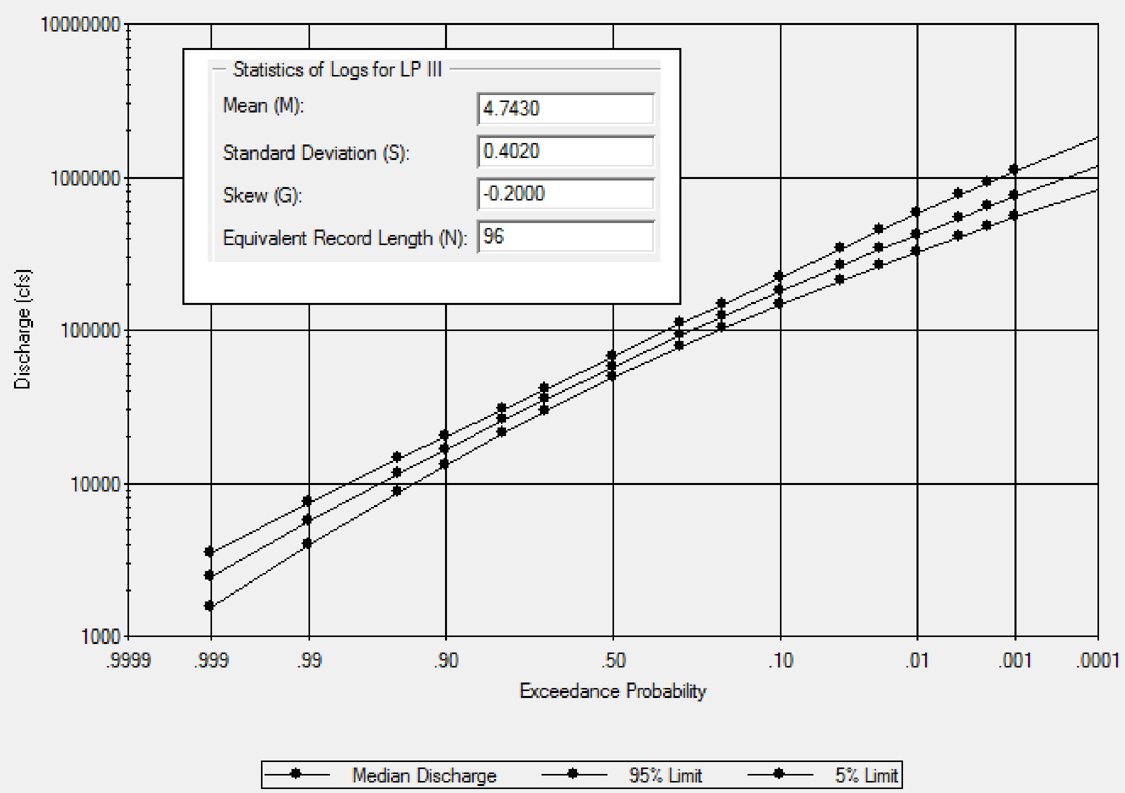
F3.0R, F4.0R, F4.5R (Feather River) – Unregulated Exceedence Probability Curve – Feather River at Shanghai Bend

Exceedance Probability	Discharge (cfs)	Confidence Limit Curves Discharge (cfs)			
		95%	75%	25%	5%
0.9990	3,431	2,129	2,860	4,050	5,022
0.9900	8,477	5,893	7,376	9,630	11,374
0.9500	18,084	13,736	16,265	19,950	22,713
0.9000	26,585	21,023	24,270	28,948	32,438
0.8000	41,672	34,292	38,599	44,822	49,513
0.7000	56,968	47,863	53,152	60,922	66,910
0.5000	93,556	79,914	87,721	99,802	109,677
0.3000	149,787	127,290	139,924	160,751	178,969
0.2000	196,719	165,350	182,781	212,541	239,557
0.1000	282,849	232,753	260,236	309,170	355,625
0.0400	408,885	327,533	371,648	453,221	533,887
0.0200	513,588	403,859	462,966	574,653	687,741
0.0100	626,302	484,207	560,320	706,771	858,035
0.0040	786,874	596,129	697,664	897,011	1,107,553
0.0020	918,331	685,967	809,140	1,054,235	1,316,954
0.0010	1,056,818	779,169	925,797	1,221,087	1,541,860
0.0001	1,569,369	1,114,255	1,352,108	1,847,319	2,405,530



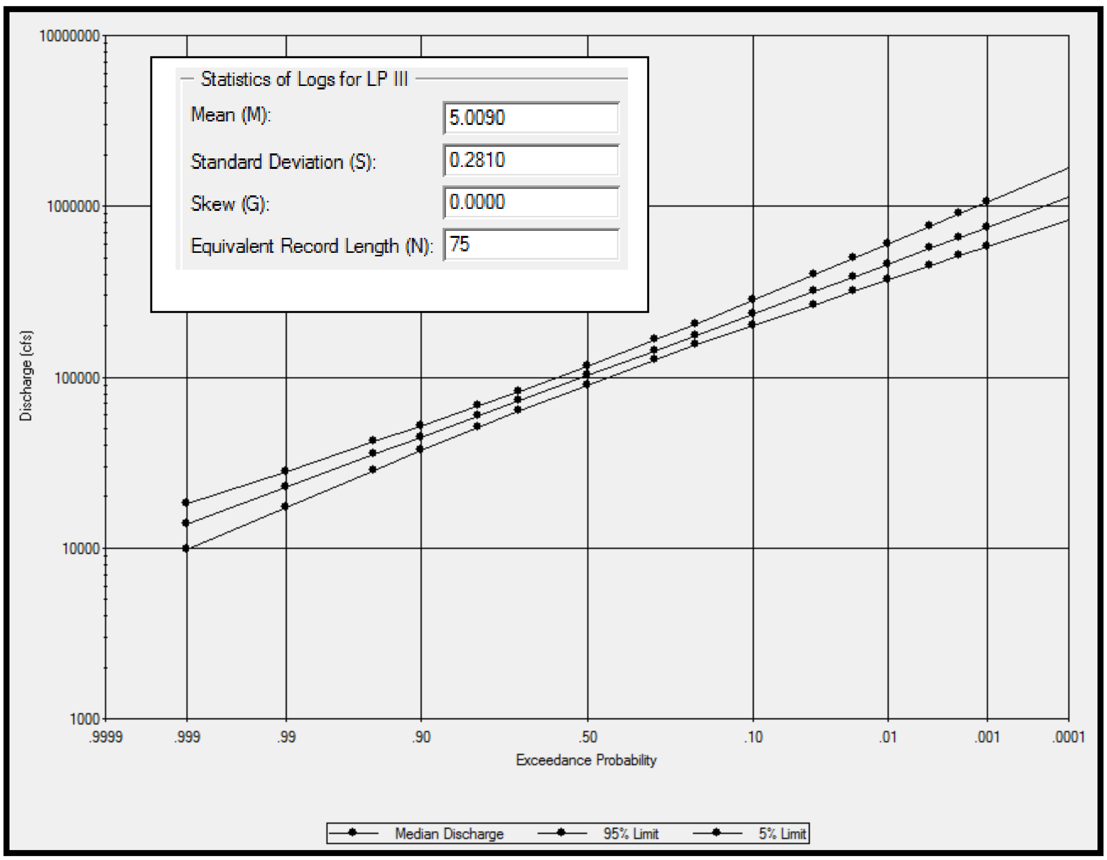
F5.0R, F6.0R, F7.0, F8.0R, F9.0R (Feather River) – Unregulated Exceedence Probability Curve – Feather River at Oroville Dam

Exceedance Probability	Discharge (cfs)	Confidence Limit Curves Discharge (cfs)			
		95%	75%	25%	5%
0.9990	2,429	1,542	2,042	2,846	3,497
0.9900	5,612	3,950	4,906	6,351	7,464
0.9500	11,474	8,766	10,342	12,635	14,352
0.9000	16,595	13,168	15,169	18,050	20,198
0.8000	25,654	21,148	23,778	27,577	30,438
0.7000	34,857	29,323	32,539	37,258	40,886
0.5000	57,065	48,817	53,541	60,829	66,765
0.3000	91,859	78,216	85,885	98,489	109,474
0.2000	121,519	102,333	113,001	131,173	147,620
0.1000	177,343	146,095	163,243	193,740	222,641
0.0400	262,032	209,793	238,117	290,510	342,319
0.0200	334,877	262,816	301,612	375,038	449,478
0.0100	415,639	320,212	371,282	469,821	571,867
0.0040	534,779	402,843	472,973	611,282	758,011
0.0020	635,275	471,052	557,947	731,844	919,343
0.0010	744,324	543,817	649,471	863,739	1,098,199
0.0001	1,172,983	820,544	1,004,075	1,390,541	1,831,466



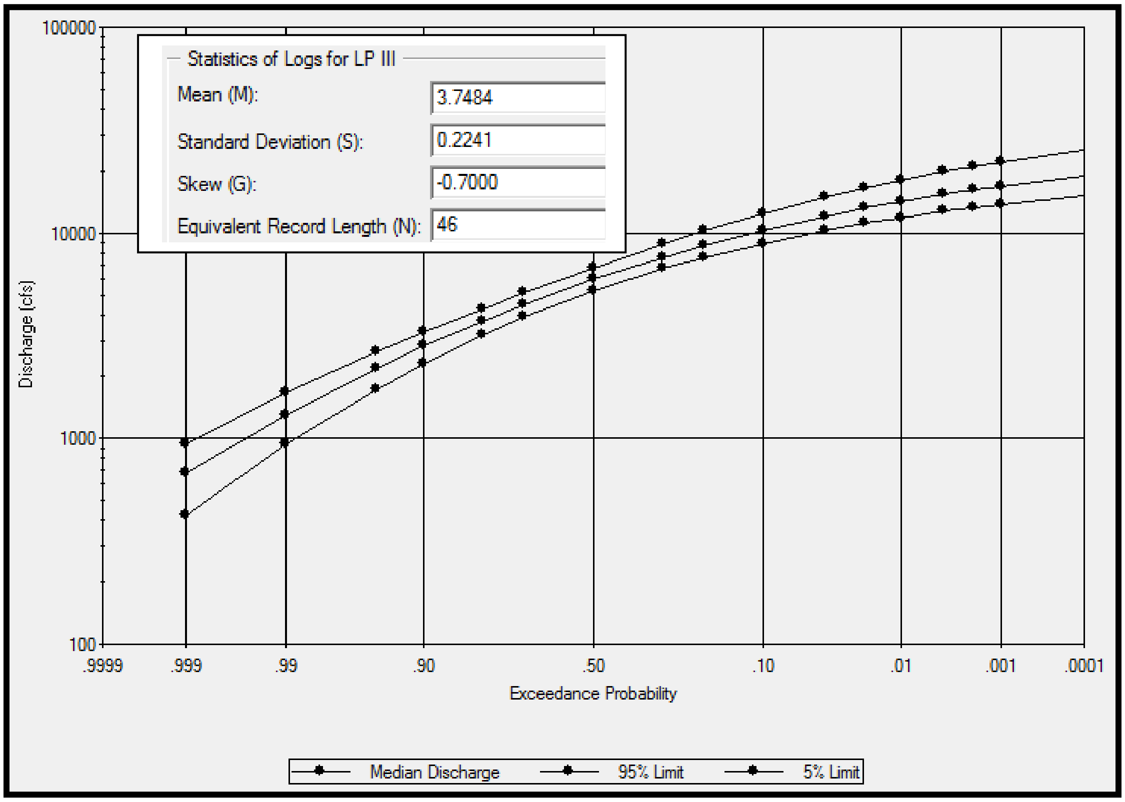
S3.0L, S4.0L, S5.0L (Sutter Bypass) – Unregulated Exceedence Probability Curve – Sacramento River at Ord Ferry

Exceedance Probability	Discharge (cfs)	Confidence Limit Curves Discharge (cfs) 95%	75%	25%	5%
0.9990	13,824	9,847	12,160	15,524	18,015
0.9900	22,662	17,307	20,456	24,873	28,057
0.9500	35,221	28,497	32,478	37,945	41,839
0.9000	44,554	37,064	41,503	47,584	51,928
0.8000	59,225	50,717	55,746	62,710	67,772
0.7000	72,718	63,290	68,832	76,664	82,501
0.5000	102,094	90,185	97,069	107,379	115,575
0.3000	143,336	126,339	135,960	151,430	164,688
0.2000	175,993	153,799	166,212	186,976	205,516
0.1000	233,946	200,725	219,046	251,140	281,218
0.0400	316,915	265,184	293,362	344,759	395,056
0.0200	385,570	316,837	354,012	423,397	493,019
0.0100	459,942	371,503	419,052	509,531	602,269
0.0040	567,847	448,948	512,442	635,935	765,632
0.0020	657,299	511,795	589,145	741,808	904,794
0.0010	753,973	578,578	671,428	857,171	1,058,498
0.0001	1,132,538	831,447	988,918	1,316,405	1,687,293



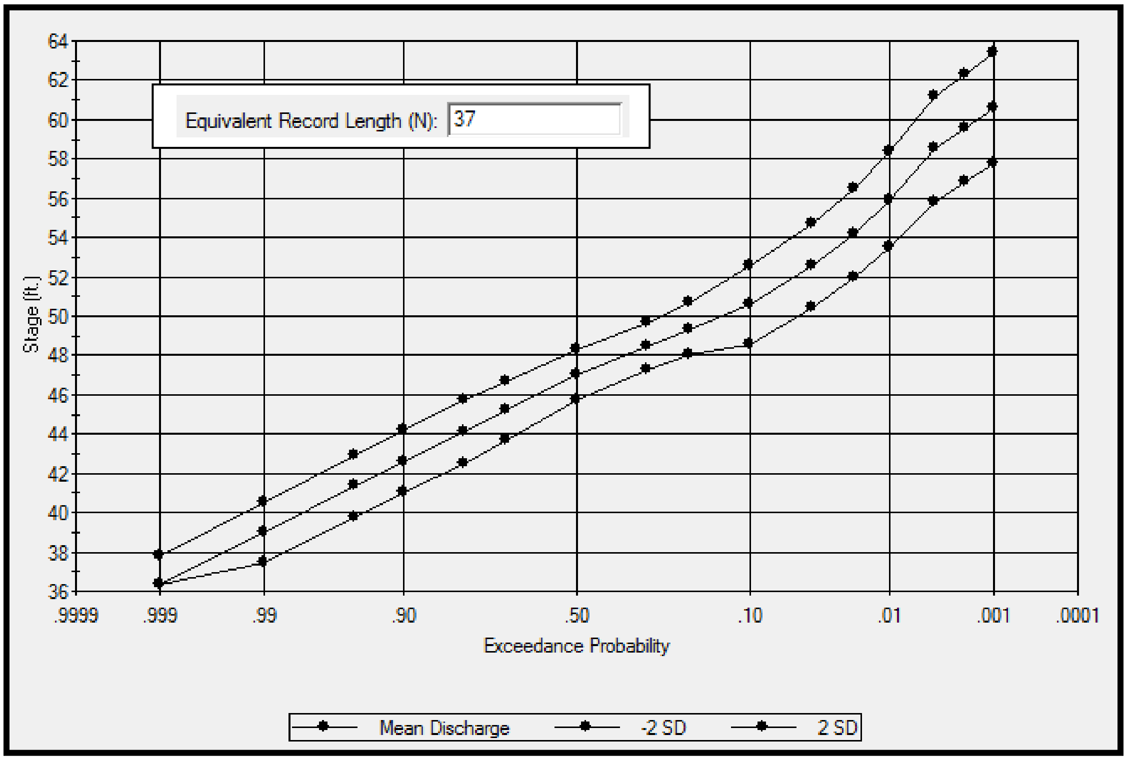
CC.01, CC.02 (Cherokee Canal) – Exceedence Probability Curve – Unregulated Cherokee Canal near Richvale, CA

Exceedance Probability	Discharge (cfs)	Confidence Limit Curves Discharge (cfs) 95%	75%	25%	5%
0.9990	675	424	570	784	943
0.9900	1,305	934	1,153	1,455	1,667
0.9500	2,192	1,725	2,005	2,374	2,628
0.9000	2,816	2,310	2,614	3,013	3,290
0.8000	3,727	3,179	3,506	3,946	4,261
0.7000	4,491	3,905	4,251	4,734	5,096
0.5000	5,948	5,245	5,650	6,265	6,769
0.3000	7,621	6,699	7,217	8,072	8,836
0.2000	8,719	7,611	8,226	9,282	10,266
0.1000	10,318	8,894	9,675	11,073	12,433
0.0400	12,077	10,258	11,246	13,072	14,913
0.0200	13,217	11,122	12,254	14,381	16,565
0.0100	14,229	11,877	13,143	15,552	18,060
0.0040	15,395	12,737	14,161	16,909	19,812
0.0020	16,195	13,320	14,856	17,845	21,030
0.0010	16,908	13,835	15,474	18,683	22,127
0.0001	18,840	15,215	17,139	20,966	25,149



W2.0L, W2.0R – Graphical Probability-Stage Curve – Wadsworth Canal

Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	36.35	36.35	35.62	37.08	37.80
0.9900	38.99	37.48	38.23	39.74	40.50
0.9500	41.34	39.78	40.56	42.12	42.90
0.9000	42.60	41.00	41.80	43.39	44.19
0.8000	44.11	42.49	43.30	44.93	45.74
0.7000	45.21	43.72	44.47	45.95	46.70
0.5000	47.02	45.74	46.38	47.66	48.30
0.3000	48.47	47.28	47.88	49.07	49.67
0.2000	49.35	48.00	48.68	50.02	50.70
0.1000	50.57	48.59	49.58	51.56	52.55
0.0400	52.58	50.43	51.50	53.66	54.73
0.0200	54.22	51.93	53.07	55.37	56.51
0.0100	55.92	53.48	54.70	57.14	58.36
0.0040	58.50	55.84	57.17	59.82	61.15
0.0020	59.58	56.83	58.21	60.95	62.33
0.0010	60.60	57.76	59.18	62.02	63.43



Regulated Transform-Flow Curves by Reach*

ACE Event	Inflow	Ouflow by Reach		
		F3.0R	F4.0R	F4-5.0R
50%	93,556	54,591	69,312	71,106
10%	282,849	150,135	190,157	191,421
4%	408,885	205,191	252,011	253,367
2%	513,588	226,967	277,249	278,979
1%	626,302	238,438	285,044	287,003
0.40%	786,874	296,829	353,748	355,874
0.20%	918,331	395,730	485,616	500,541

ACE Event	Inflow	Ouflow by Reach				
		F5.0R	F6.0R	F7.0R	F8.0R	F9.0R
50%	57,065	49,008	49,008	49,446	53,058	53,058
10%	177,343	107,588	107,588	107,862	99,999	99,999
4%	262,032	151,060	151,060	151,635	149,997	149,997
2%	334,877	158,391	158,391	160,995	150,000	150,000
1%	415,639	160,000	160,000	161,108	150,001	150,001
0.40%	534,779	163,927	163,927	183,101	172,002	172,002
0.20%	635,275	265,514	265,514	290,432	326,100	326,100

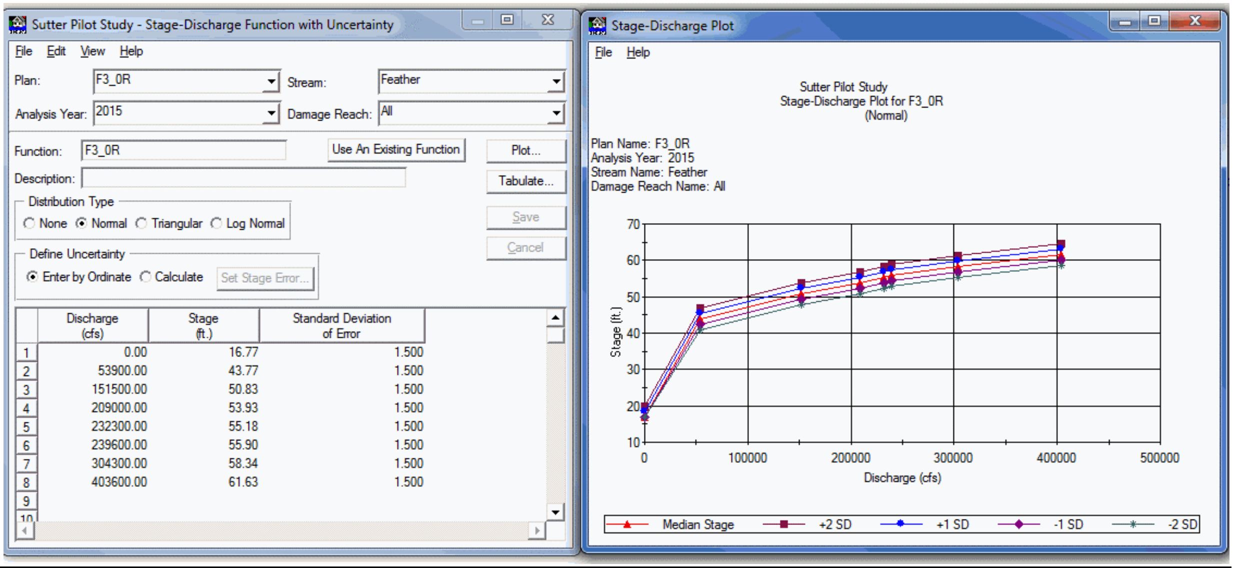
ACE Event	Inflow	Ouflow by Reach		
		S3.0L	S4.0L	S5.0L
50%	102,094	71,238	58,910	57,413
10%	233,946	117,554	103,502	102,011
4%	316,915	141,501	127,476	126,200
2%	385,570	165,863	156,454	155,064
1%	459,942	198,747	185,534	184,198
0.40%	567,847	238,664	228,793	228,195
0.20%	657,299	267,199	251,118	267,153

ACE Event	Inflow	Ouflow by Reach	
		CC.01	CC.02
50%	5,948	5,584	5,584
10%	10,318	9,658	9,658
4%	12,077	11,321	11,321
2%	13,217	12,384	12,384
1%	14,229	13,331	13,331
0.40%	15,395	14,206	14,206
0.20%	16,195	15,286	15,286

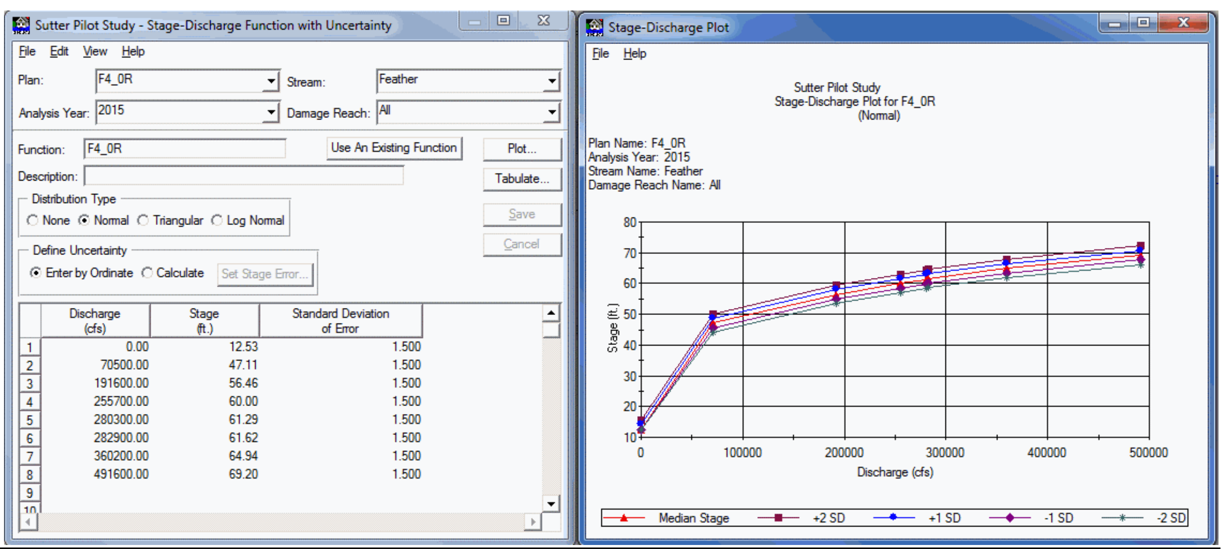
**Note: Inflow values reflect upstream inflows in most cases, while outflows represent the flow at the index location.*

Enclosure 2 to Attachment 1: Hydraulics Inputs

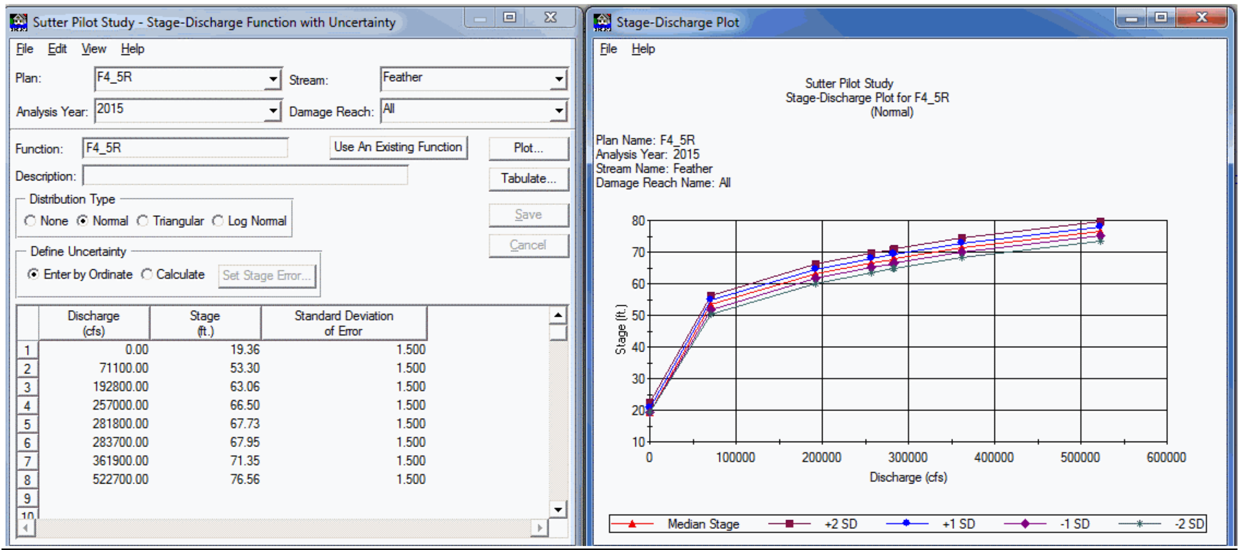
F3.0R



F4.0R

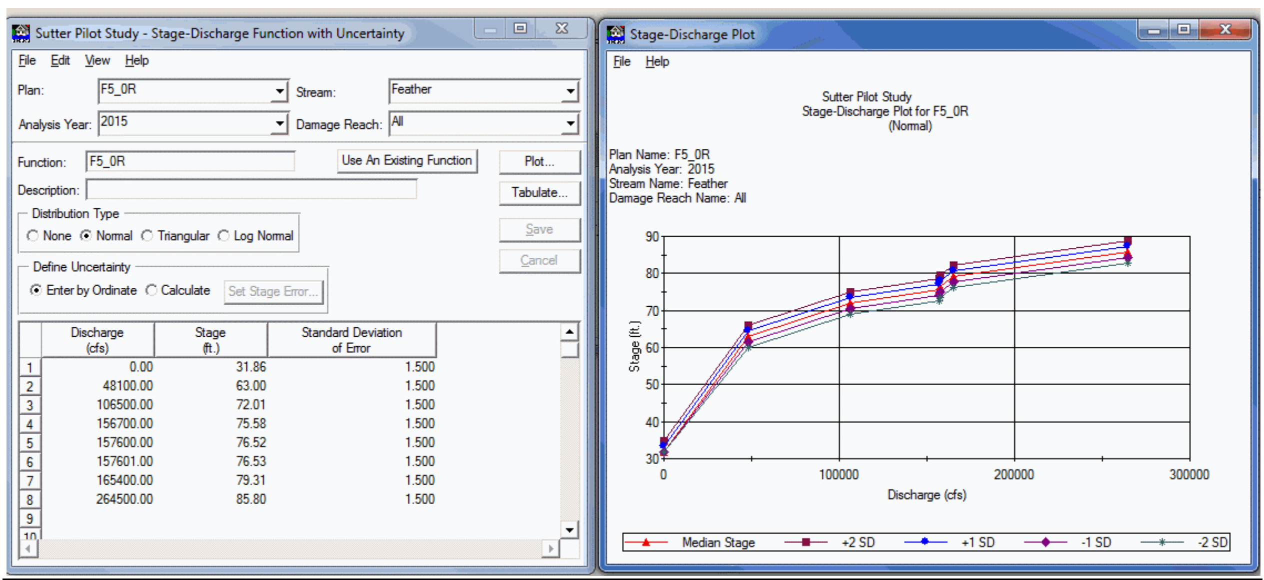


F4.5R



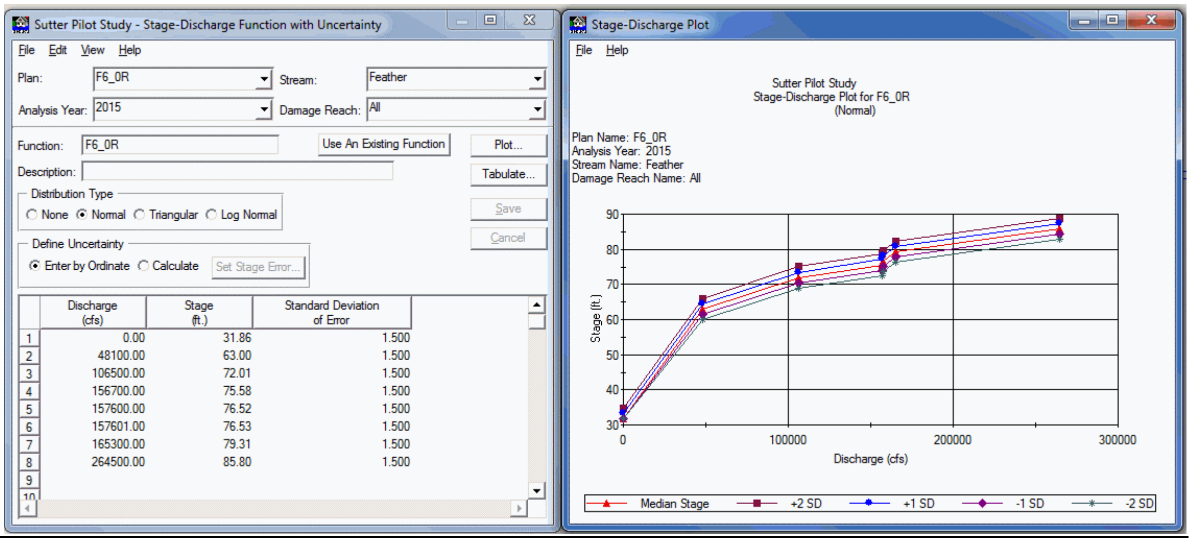
	Discharge (cfs)	Stage (ft.)	Standard Deviation of Error
1	0.00	19.36	1.500
2	71100.00	53.30	1.500
3	192800.00	63.06	1.500
4	257000.00	66.50	1.500
5	281800.00	67.73	1.500
6	283700.00	67.95	1.500
7	361900.00	71.35	1.500
8	522700.00	76.56	1.500
9			

F5.0R



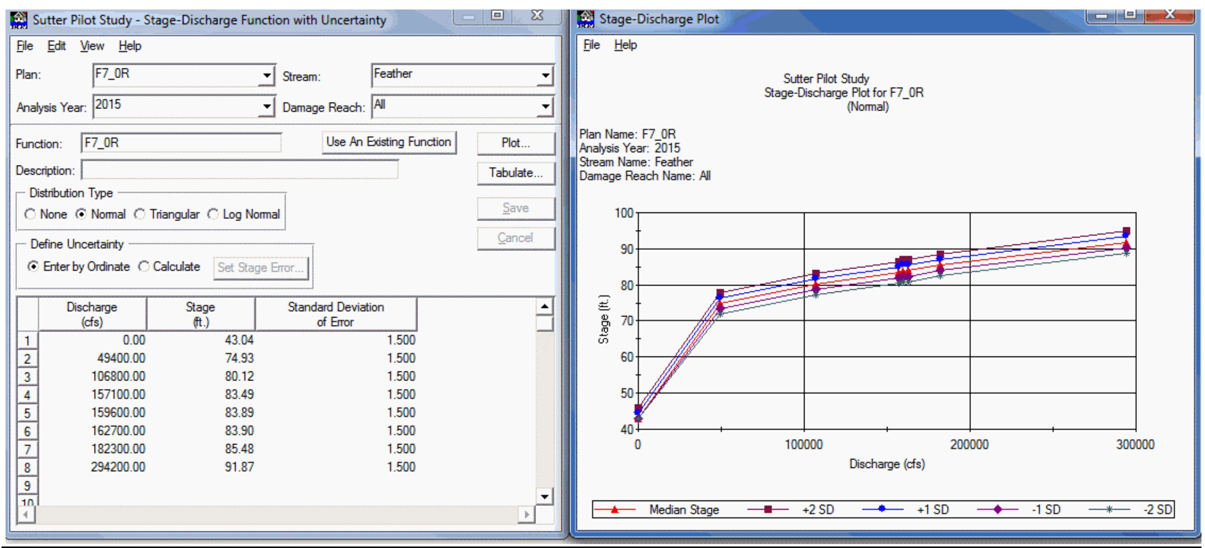
	Discharge (cfs)	Stage (ft.)	Standard Deviation of Error
1	0.00	31.86	1.500
2	48100.00	63.00	1.500
3	106500.00	72.01	1.500
4	156700.00	75.58	1.500
5	157600.00	76.52	1.500
6	157601.00	76.53	1.500
7	165400.00	79.31	1.500
8	264500.00	85.80	1.500
9			

F6.0R



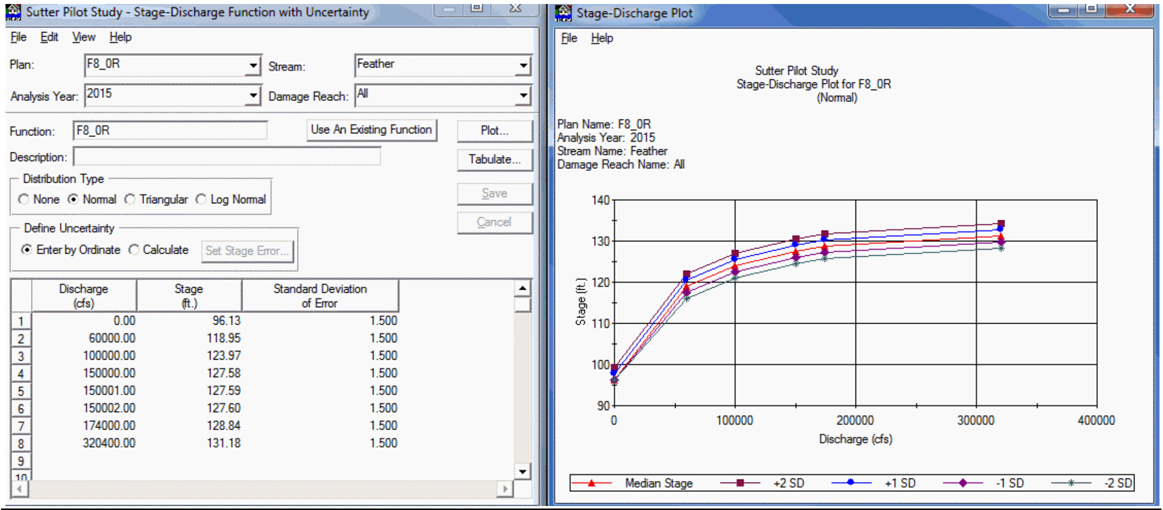
	Discharge (cfs)	Stage (ft.)	Standard Deviation of Error
1	0.00	31.86	1.500
2	48100.00	63.00	1.500
3	106500.00	72.01	1.500
4	156700.00	75.58	1.500
5	157600.00	76.52	1.500
6	157601.00	76.53	1.500
7	165300.00	79.31	1.500
8	264500.00	85.80	1.500
9			
10			

F7.0R

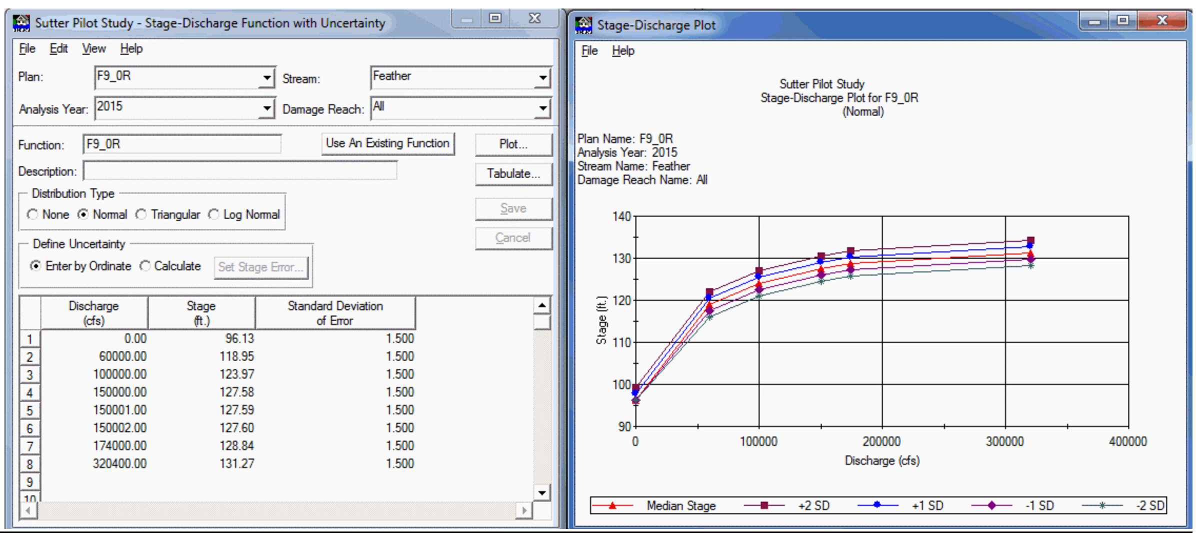


	Discharge (cfs)	Stage (ft.)	Standard Deviation of Error
1	0.00	43.04	1.500
2	49400.00	74.93	1.500
3	106800.00	80.12	1.500
4	157100.00	83.49	1.500
5	159600.00	83.89	1.500
6	162700.00	83.90	1.500
7	182300.00	85.48	1.500
8	294200.00	91.87	1.500
9			
10			

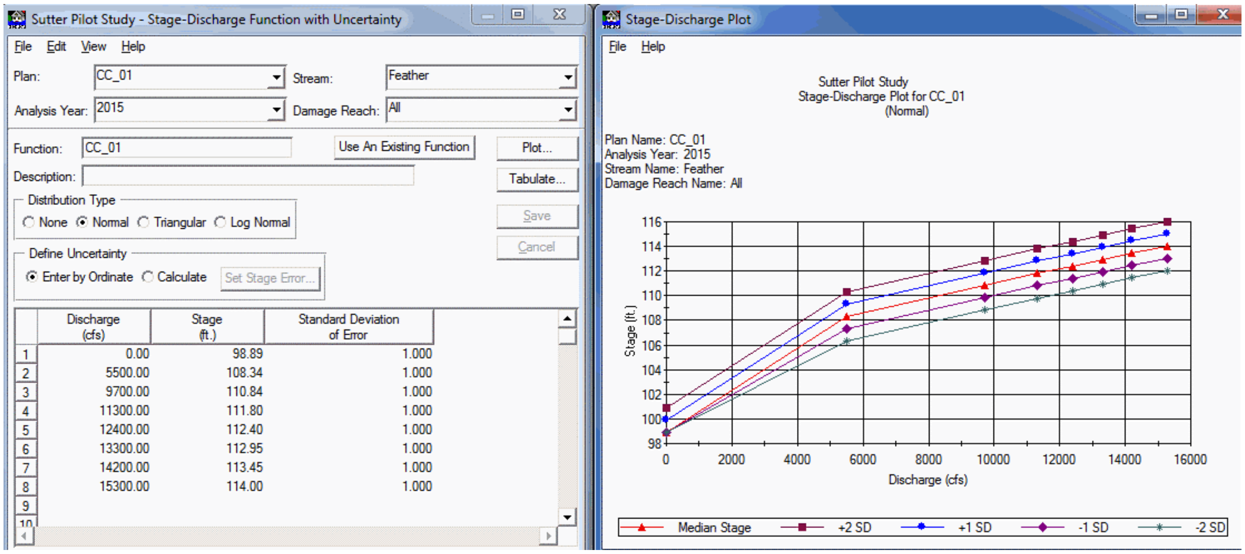
F8.0R


Sutter Pilot Study - Stage-Discharge Function with Uncertainty
File Edit View Help
Plan: F8_0R
Stream: Feather
Analysis Year: 2015
Damage Reach: All
Function: F8_0R
Use An Existing Function
Plot...
Tabulate...
Save
Cancel
Description:
Distribution Type
None Normal Triangular Log Normal
Define Uncertainty
Enter by Ordinate Calculate Set Stage Error...
Discharge (cfs) | Stage (ft.) | Standard Deviation of Error
1 0.00 96.13 1.500
2 60000.00 118.95 1.500
3 100000.00 123.97 1.500
4 150000.00 127.58 1.500
5 150001.00 127.59 1.500
6 150002.00 127.60 1.500
7 174000.00 128.84 1.500
8 320400.00 131.18 1.500
Stage-Discharge Plot
File Help
Sutter Pilot Study
Stage-Discharge Plot for F8_0R
(Normal)
Plan Name: F8_0R
Analysis Year: 2015
Stream Name: Feather
Damage Reach Name: All
Stage (ft.)
Discharge (cfs)
Median Stage
+2 SD
+1 SD
-1 SD
-2 SD

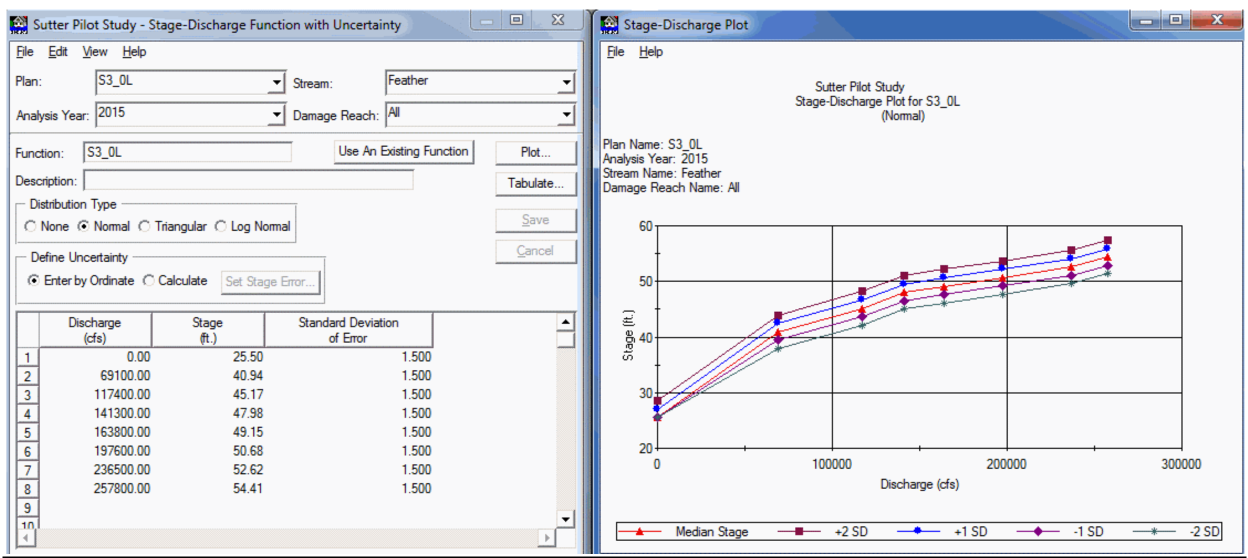
F9.0R


Sutter Pilot Study - Stage-Discharge Function with Uncertainty
File Edit View Help
Plan: F9_0R
Stream: Feather
Analysis Year: 2015
Damage Reach: All
Function: F9_0R
Use An Existing Function
Plot...
Tabulate...
Save
Cancel
Description:
Distribution Type
None Normal Triangular Log Normal
Define Uncertainty
Enter by Ordinate Calculate Set Stage Error...
Discharge (cfs) | Stage (ft.) | Standard Deviation of Error
1 0.00 96.13 1.500
2 60000.00 118.95 1.500
3 100000.00 123.97 1.500
4 150000.00 127.58 1.500
5 150001.00 127.59 1.500
6 150002.00 127.60 1.500
7 174000.00 128.84 1.500
8 320400.00 131.27 1.500
Stage-Discharge Plot
File Help
Sutter Pilot Study
Stage-Discharge Plot for F9_0R
(Normal)
Plan Name: F9_0R
Analysis Year: 2015
Stream Name: Feather
Damage Reach Name: All
Stage (ft.)
Discharge (cfs)
Median Stage
+2 SD
+1 SD
-1 SD
-2 SD

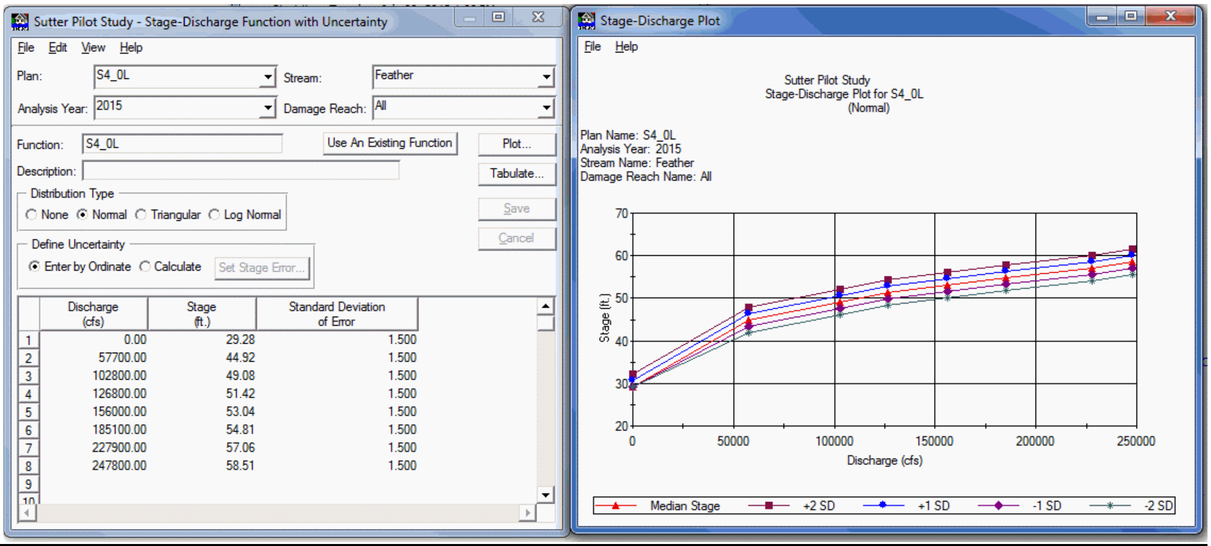
CC.01 & CC.02



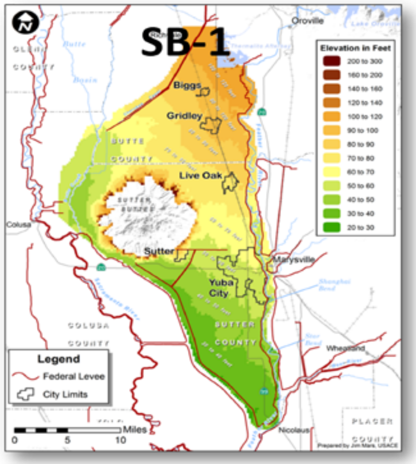
S3.0L



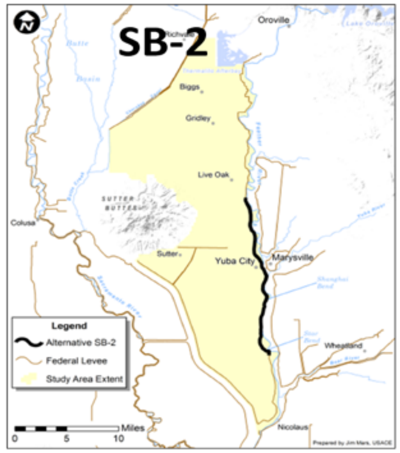
S4.0L


Sutter Pilot Study - Stage-Discharge Function with Uncertainty
File Edit View Help
Plan: S4_0L
Stream: Feather
Analysis Year: 2015
Damage Reach: All
Function: S4_0L
Use An Existing Function
Plot...
Description:
Tabulate...
Distribution Type
None Normal Triangular Log Normal
Save
Cancel
Define Uncertainty
Enter by Ordinate Calculate Set Stage Error...
Discharge (cfs) | Stage (ft.) | Standard Deviation of Error
1 0.00 29.28 1.500
2 57700.00 44.92 1.500
3 102800.00 49.08 1.500
4 126800.00 51.42 1.500
5 156000.00 53.04 1.500
6 185100.00 54.81 1.500
7 227900.00 57.06 1.500
8 247800.00 58.51 1.500
9
10
Stage-Discharge Plot
File Help
Sutter Pilot Study
Stage-Discharge Plot for S4_0L
(Normal)
Plan Name: S4_0L
Analysis Year: 2015
Stream Name: Feather
Damage Reach Name: All
Stage (ft.)
70
60
50
40
30
20
0
50000
100000
150000
200000
250000
Discharge (cfs)
Median Stage
+2 SD
+1 SD
-1 SD
-2 SD

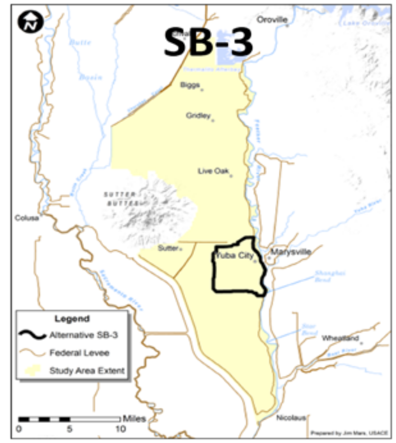
Enclosure 3 to Attachment 1: Draft Array of Alternatives – Maps Showing Project Measures (Levee Reaches)



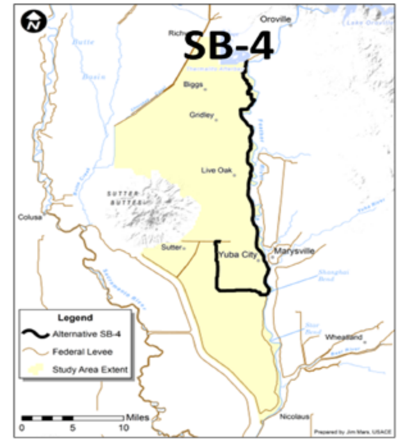
No Action Alternative



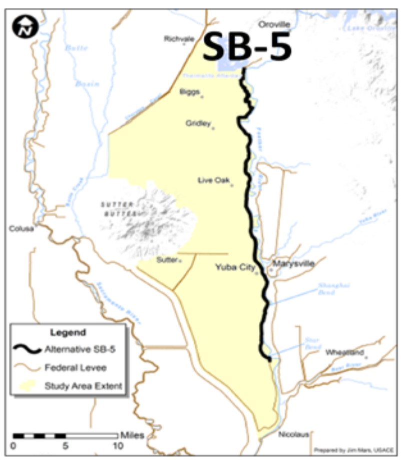
Feather River at Yuba City



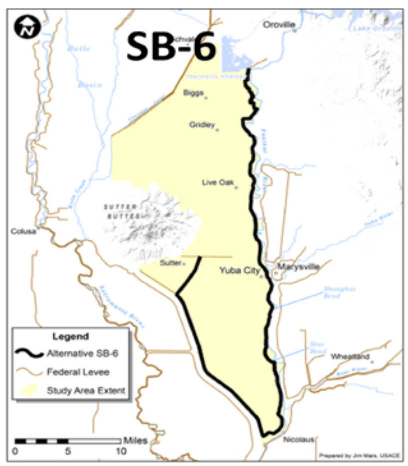
Yuba City Ring Levee



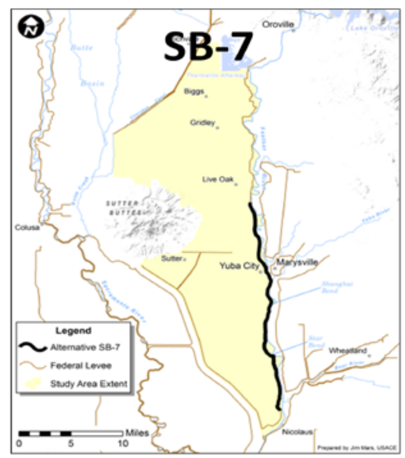
Little "J" Levee



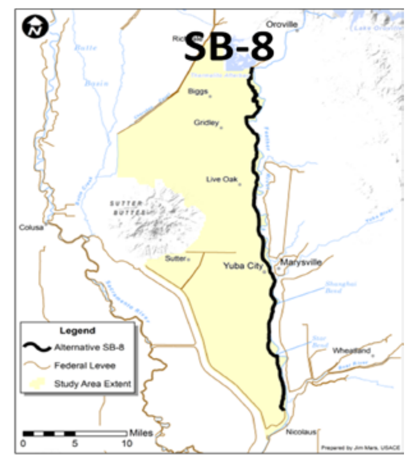
Feather River Thermalito Afterbay to Star Bend



Feather River, Sutter Bypass, and Wadsworth



Feather River Sunset Weir to Laurel Ave



Feather River Thermalito Afterbay to Laurel Ave

Enclosure 4 to Attachment 1: With-Project - Levee Breach & Floodplain Assignments by ACE Event and EIA

Below are the Levee Breach & Floodplain assignments used during HEC-FDA flood damage calculations by Alternative.

SB-1: No Action

EIA	Dominating Index Point (Significant Flooding Starts)	FDA Index Point	Annual Chance Exceedance Event						
			50% (1/2)	10% (1/10)	4% (1/25)	2% (1/50)	1% (1/100)	0.5% (1/200)	0.2% (1/500)
Biggs	F9.0R	F9.0R	None	CC.02	F9.0R	F9.0R	F9.0R	F9.0R	F9.0R
Gridley	F9.0R	F9.0R	None	None	F9.0R	F9.0R	F9.0R	F9.0R	F9.0R
Live Oak	F9.0R	F9.0R	None	None	F9.0R	F9.0R	F9.0R	F9.0R	F7.0R
Yuba City	F5.0R	F5.0R	None	S4.0L	F5.0R	F5.0R	F5.0R	F5.0R	F5.0R
Town of Sutter	None	None	None	None	None	None	None	None	None
Rural Butte	F9.0R	F9.0R	None	CC.02	F9.0R	F9.0R	F9.0R	F9.0R	F9.0R
Rural Sutter	S4.0L	S4.0L	None	S4.0L	F5.0R	F5.0R	F5.0R	F6.0R	F6.0R

SB-2: Minimal Fix-in-Place Feather River Levees-Sunset Weir to Star Bend

EIA	Dominating Index Point (Significant Flooding Starts)	FDA Index Point	Annual Chance Exceedance Event						
			50% (1/2)	10% (1/10)	4% (1/25)	2% (1/50)	1% (1/100)	0.5% (1/200)	0.2% (1/500)
Biggs	F9.0R	F9.0R	None	CC.02	F9.0R	F9.0R	F9.0R	F9.0R	F9.0R
Gridley	F9.0R	F9.0R	None	None	F9.0R	F9.0R	F9.0R	F9.0R	F9.0R
Live Oak	F9.0R	F9.0R	None	None	F9.0R	F9.0R	F9.0R	F9.0R	F7.0R
Yuba City	F4.0R	F4.0R	None	S4.0L	F4.0R	F4.0R	F4.0R	F4.0R	F5.0R
Rural Butte	F9.0R	F9.0R	None	CC.02	F9.0R	F9.0R	F9.0R	F9.0R	F9.0R
Rural Sutter	S4.0L	S4.0L	None	S4.0L	F4.0R	F4.0R	F4.0R	F4.0R	F6.0R

SB-3: Yuba City Ring Levee

EIA	Dominating Index Point (Significant Flooding Starts)	FDA Index Point	Annual Chance Exceedance Event						
			50% (1/2)	10% (1/10)	4% (1/25)	2% (1/50)	1% (1/100)	0.5% (1/200)	0.2% (1/500)
Biggs	F9_0R	F9_0R	None	CC_02	F9_0R	F9_0R	F9_0R	F9_0R	F9_0R
Gridley	F9_0R	F9_0R	None	None	F9_0R	F9_0R	F9_0R	F9_0R	F9_0R
Live Oak	F9_0R	F9_0R	None	None	F9_0R	F9_0R	F9_0R	F9_0R	F7_0R
Yuba City	F5_0R	F5_0R	None	None	None	None	None	None	F5_0R
Rural Butte	F9_0R	F9_0R	None	CC_02	F9_0R	F9_0R	F9_0R	F9_0R	F9_0R
Rural Sutter	S4_0L	S4_0L	None	S4_0L	F5_0R	F5_0R	F5_0R	F6_0R	F6_0R

SB-4: Little J Levee

EIA	Dominating Index Point (Significant Flooding Starts)	FDA Index Point	Annual Chance Exceedance Event						
			50% (1/2)	10% (1/10)	4% (1/25)	2% (1/50)	1% (1/100)	0.5% (1/200)	0.2% (1/500)
Biggs	CC_02	F9_0R*	None	CC_02	CC_02	CC_02	CC_02	CC_02	F9_0R
Gridley	F9_0R	F9_0R	None	None	None	None	None	None	F9_0R
Live Oak	F7_0R	F7_0R	None	None	None	None	None	None	F7_0R
Yuba City	F4_0R	F4_0R	None	S4_0L	F4_0R	F4_5R	F4_5R	F4_5R	F5_0R
Rural Butte	CC_02	F9_0R*	None	CC_02	CC_02	CC_02	CC_02	CC_02	F9_0R
Rural Sutter	S4_0L	S4_0L	None	S4_0L	F4_0R	F4_5R	F4_5R	F4_5R	F6_0R

* Fragility curve adjusted to mimic CC_02 Fragility

SB-5: Fix-in-Place Feather River Levees: Thermalito Afterbay to Star Bend

EIA	Dominating Index Point (Significant Flooding Starts)	FDA Index Point	Annual Chance Exceedance Event						
			50% (1/2)	10% (1/10)	4% (1/25)	2% (1/50)	1% (1/100)	0.5% (1/200)	0.2% (1/500)
Biggs	CC_02	F9_0R*	None	CC_02	CC_02	CC_02	CC_02	CC_02	F9_0R
Gridley	F9_0R	F9_0R	None	None	None	None	None	None	F9_0R
Live Oak	F7_0R	F7_0R	None	None	None	None	None	None	F7_0R
Yuba City	F3_0R	F3_0R	None	S4_0L	F4.0R	F4.0R	F4.0R	F4.0R	F5_0R
Rural Butte	CC_02	F9_0R*	None	CC_02	CC_02	CC_02	CC_02	CC_02	F9_0R
Rural Sutter	S4_0L	S4_0L	None	S4_0L	F4.0R	F4.0R	F4.0R	F4.0R	F6_0R

* Fragility curve adjusted to mimic CC_02 Fragility

SB-6: Fix-in-Place Feather River, Sutter Bypass, & Wadsworth Canal Levees

EIA	Dominating Index Point (Significant Flooding Starts)	FDA Index Point	Annual Chance Exceedance Event						
			50% (1/2)	10% (1/10)	4% (1/25)	2% (1/50)	1% (1/100)	0.5% (1/200)	0.2% (1/500)
Biggs	CC_02	F9_0R*	None	CC_02	CC_02	CC_02	CC_02	CC_02	F9_0R
Gridley	F9_0R	F9_0R	None	None	None	None	None	None	F9_0R
Live Oak	F7_0R	F7_0R	None	None	None	None	None	None	F7_0R
Yuba City	F5_0R	F5_0R	None	None	None	None	None	None	F5_0R
Rural Butte	CC_02	F9_0R*	None	CC_02	CC_02	CC_02	CC_02	CC_02	F9_0R
Rural Sutter	F6_0R	S4_0L	None	None	None	None	None	None	F6_0R

*Fragility adjusted to mimic CC_02 Fragility

SB-7: Fix-in-Place Feather River Levees: Sunset Weir to Laurel Ave.

EIA	Dominating Index Point (Significant Flooding Starts)	FDA Index Point	Annual Chance Exceedance Event						
			50% (1/2)	10% (1/10)	4% (1/25)	2% (1/50)	1% (1/100)	0.5% (1/200)	0.2% (1/500)
Biggs	CC_02	F9_0R	None	CC.02	F9.0R	F9.0R	F9.0R	F9.0R	F9.0R
Gridley	F9_0R	F9_0R	None	None	F9.0R	F9.0R	F9.0R	F9.0R	F9.0R
Live Oak	F7_0R	F7_0R	None	None	F9.0R	F9.0R	F9.0R	F9.0R	F7.0R
Yuba City	F5_0R	F5_0R	None	S4.0L	F3.0R	F3.0R	F3.0R	F3.0R	F5.0R
Rural Butte	CC_02	F9_0R	None	CC.02	F9.0R	F9.0R	F9.0R	F9.0R	F9.0R
Rural Sutter	F6_0R	S4_0L	None	S4.0L	F3.0R	F3.0R	F3.0R	F3.0R	F6.0R

SB-8: Fix-in-Place Feather River Levees: Thermalito Afterbay to Laurel Ave.

EIA	Dominating Index Point (Significant Flooding Starts)	FDA Index Point	Annual Chance Exceedance Event						
			50% (1/2)	10% (1/10)	4% (1/25)	2% (1/50)	1% (1/100)	0.5% (1/200)	0.2% (1/500)
Biggs	CC_02	F9_0R*	None	CC_02	CC_02	CC_02	CC_02	CC_02	F9_0R
Gridley	F9_0R	F9_0R	None	None	None	None	None	None	F9_0R
Live Oak	F7_0R	F7_0R	None	None	None	None	None	None	F7_0R
Yuba City	F5_0R	F5_0R	None	None	None	None	None	None	F5_0R
Rural Butte	CC_02	F9_0R*	None	CC_02	CC_02	CC_02	CC_02	CC_02	F9_0R
Rural Sutter	F6_0R	S4_0L	None	S4.0L	F3.0R	F3.0R	F3.0R	F3.0R	F6.0R

*Fragility adjusted to mimic CC_02 Fragility

Attachment 2: Agricultural Analysis

SUBJECT: Agricultural Damages for Final Alternative Comparison

1. REFERENCES:

a. Recommendation for Transforming the Current Pre-Authorization Study Process, USACE, January 2011.
b. USACE, 1989. Expected Annual Flood Damage Computation, Users Manual, CPD-30 US Army Corps of Engineers Hydrologic Engineering Center, March 1989.
c. DWR, 2004A Butte County Land use Data, DWR Division of Planning and Local Assistance. Arc GIS 04bu.shp file. July through September 2004.
d. DWR, 2004B Sutter County Land use Data, DWR Division of Planning and Local Assistance. Arc GIS 04su.shp file. July through September 2004.

2. PURPOSE:

The purpose of this memorandum is to describe the method used to calculate Expected Annual Damages (EAD) associated with agricultural land uses for the Sutter Basin Pilot Feasibility Study. A map of the study area showing economic evaluation areas is provided in Plate 1. A map of the landuse types within the study area is provided in Plate 2. The approach was based on the pilot study objective of applying qualitative rather than quantitative analysis during plan selection (Reference a).

The values presented for the final alternatives are based on final hydraulic models, final geotechnical fragility curves, and final depth versus agricultural damage curves. The final values also incorporate estimated residual flooding from interior drainage.

Damages for urban, industrial, urban-landscape, and residential were not included in the estimates. These damages are calculated using the USACE FDA model and are not part of this analysis.

3. BACKGROUND:

The Sutter Basin study area is approximately 300 square miles. The probability of flooding varies by geographical location due to variable hydrologic, hydraulic, and geotechnical conditions.

Expected Annual Damages associated with Agricultural land uses will be used in the comparison of final alternatives for the Sutter Basin Feasibility Study. The final alternatives are presented in Plates 3 through 5. The Recommended Plan will be selected from these refined alternatives.

The USACE Flood Damage Assessment (FDA) computer program was considered for calculating agricultural damages. However, a major limitation of the FDA approach is evaluation of multiple sources of flooding within a damage area. One of the major limitations of the approach is that damages are aggregated to a single source index point. This limitation was overcome in the urban economic damage calculation by assigning floodplains to damage areas based on probability and consequence from the various levee breaches. This approach resulted in different floodplain assignments for each damage area (see Economic Appendix for more detailed information). However, the method was considered more detailed, costly, and time consuming than necessary for evaluation of the agricultural related damages. A simplified approach was developed based on stage damage curves for land use types within the study area and simplifying calculations by utilizing 1000ft x 1000ft hydraulic model grid elements.

4. APPROACH:

Estimated annual damages were calculated for agricultural land uses using a grid type analysis of the study area. The damage estimates were calculated using stage- damage relationships for the crop type within each grid element, levee breach inundation maps indicating depths within each grid, and levee performance calculations from HEC-FDA which estimate the probability of a levee breach inundating each grid element.

As described in Institute for Water Resources (IWR) Report 87-R-10, dated October, 1987 flood damage to agriculture is computed and categorized as either direct production investment (DPI) loss, or income loss. Analyses of DPI losses per acre and income losses per acre for each major crop type form the basis for determining total expected damages per acre for each crop. Direct production investment costs are cash and non-cash costs needed to bring the product to market and include pre-harvest costs (e.g., land preparation, fertilizer application, equipment costs, labor costs, seed, planting, etc.). Harvest costs are excluded as it assumed that the product is removed from risk once the product is harvested. DPI losses for each crop type are based on typical monthly production costs incurred during the growing season and the probability of experiencing a flood event during a particular month.

Income losses represent loss of anticipated net income that is expected to be generated from the production on the land. Net income losses per acre for each crop type were calculated based on the four-year average yield and price data from Sutter and Sacramento Counties and subtracting the cash and non-cash costs of production as published in UC Davis Agricultural Economics Crop Production Cost Estimation. The costs are adjusted based on the producer cost index for the appropriate level.

5. AGRICULTURAL DEPTH-DAMAGE CURVES

Agricultural stage-damage curves were developed for each agricultural type within the grid elements of the study area. To evaluate the uncertainty in the results, curves were developed for most likely, low, and high confidence limits.

Input data for the analysis was received from a variety of sources. The input data for Sutter Basin Project includes data collected from literature reviews, UC Davis Agricultural

Economic Crop Budget website, Sutter and Sacramento County Agricultural Commissioner's Annual Crop and Livestock Reports and hydrologic and hydraulic data.

a. Non-Flood Scenario. The status quo is the non-flood scenario. This analysis assumes *ceteris paribus*, or all else equal. This means that aspects not discussed in the analysis were assumed to be the same pre-flood and post-flood.

b. Long term conditions. Average long-term conditions were assumed for all aspects not explicitly discussed.

c. Market prices. Market prices and yields for the study area are based on the County which comprises most of the study area.

d. Budget costs. Budget costs associated with individual crops were received from the UC Davis Crop Budget routine located on the UC Davis, California website and are representations of the costs incurred by producers in the study area.

e. Shortages. No shortages of labor or capital are expected. The quantity of labor and capital demanded and consumed by the flood would be small, relative to the national market. The market has many buyers and sellers and no one firm or consumer should be able to affect prices and quantities in the market.

f. Crop Type. Stage-Damage curves were developed only for crops considered as having significant acres devoted to them. The crops include:

Truck and Specialty Crops – including processing tomatoes
Field Crops – including row crops like corn, and winter forage
Orchard – including Walnuts and Almonds
Alfalfa and Irrigated Pasture
Wine grapes
Rice
Other – including lands irrigated and native pasture and lands that are idle, semi-agricultural, and native vegetation

Other crops or lesser acreages are represented by the surrogate crop/crops representing the general land use category. For example, apples, peaches, and pears are recognized as being grown in the study area but contain a relatively small acreage of the total Orchard Land Class, therefore Walnuts and Almonds making up approximately 90 percent of the Orchard acres are used as surrogates for the acreages of apples, peaches, and pears grown in the area.

g. Producer Price Index. The producer prices paid in the Crop Sector from United States Department of Agriculture (Table 1) was used to adjust costs to current dollars.

Prices Paid by Farmers for Production Items,
Interest, Taxes, and Wages
1990-92 = 100

Year	Price Index
2005	142
2006	150
2007	161
2008	187
2009	181
2010	185
2011	205
2012	220

Source: http://usda.mannlib.cornell.edu/usda/nass/AgriPric/

h. Seasonality. Computationally, the season of the year that the flood occurs greatly impacts the amount of flood damage to the agricultural crop. If flooding occurs early within the year, the producer may be able to re-prepare the seedbed, plant and realize a return on the efforts. Conversely, a flood of substantial proportion occurring at harvest time will most certainly result in complete loss for the entire year.

The probabilities of flooding by month were estimated from seventy-six years of historical peak annual flows. Monthly realizations of peak annual flows were then computed as a percentage of all peak annual flows. These monthly percentages formed the basis for determining the likelihood of a flood occurring in a particular month.

Due to year-to-year variability, flood occurrences may be as much as 4 weeks early or later than the flood occurrence midpoint. These flood occurrence probabilities for the Sutter Basin Project Study area are provided in Table 1. The table indicates the uncertainty within each month:

Table 1 - Monthly Flood Occurrence Probabilities

Month	Probability of Peak Annual Flood Occurring within Given Month		
	Scenario Midpoint	Scenario Beginning	Scenario Ending
January	0.21	0.17	0.31
February	0.31	0.21	0.17
March	0.17	0.31	0.08
April	0.08	0.17	0.01
May	0.00	0.1	0.00
June	0.00	0.00	0.00
July	0.00	0.00	0.00
August	0.00	0.00	0.00
September	0.00	0.00	0.00
October	0.00	0.00	0.01
November	0.04	0.01	0.17
December	0.17	0.04	0.21

Farm budgets provide costs that are incurred on a monthly production cycle for each respective crop. These monthly costs are used in a spreadsheet and accumulated throughout the production cycle to show the costs of production that is at risk for any particular month of assumed flooding. Multiplying the direct production costs and the value of crop at risk for each month times the monthly probability provided the probable damages expected if a flood event occurred in any particular month.

Farm budgets were obtained from the University of California at Davis and are available at http://coststudies.ucdavis.edu/. All crop budgets used in the agricultural model are found on this site. Specific crop budgets are chosen by the analyst based on the proximity to the study area and the irrigation practice that is prevalent. The farm budgets are updated periodically by UC Davis and display a comprehensive library of budget data that is readily used. US Davis economists can be contacted when inquiries pertaining to the budgets are necessary.

The percent of flood damages is also analyzed and reflects the botanical responds that is expected to the crops yield (and associated gross income) if a flood were to occur in the month. Therefore, the flood related damages depend on the crops response to a given flood event occurring in the particular month. During the period of October to December the affects are not as great as later in the production cycle. Although the seedbed has been prepared, planting has not occurred and crop production is limited by possible herbicide, pesticide, fertilizer, and organic waste contamination from adjoining fields.

i. Value of Perennial Crops. Damage caused by long-term duration flooding may result in permanent loss of perennial crops. The damage to perennials susceptible to flooding is computed based upon the assumption that the crop stands are at various ages, ranging from year 1 throughout their economic useful life. Accordingly, damage caused by long-term duration flooding is computed based upon a stand that is at the mid-point of its economic useful life.

j. Clean-up and Rehabilitation. Clean-up and rehabilitation of farm acreage is a genuine flood loss and is accordingly accounted for in the computation of agricultural flood damages. Erosion and deposition of debris and sediment may be caused by floods of any duration or time of year. Additionally, drainage and irrigation ditches may become clogged with silt and debris. Interviews with cooperative extension agents and local farmers have been conducted over the past several years. The costs are estimated using data received from the UC Davis agricultural budgets and also from local farmers. The clean up reflects the amount of effort that it takes to place the land into a “before flood event” condition. It does not include costs which would be considered as pre-planting costs as they are included in the crop budgets.

The requirement to restore agricultural land after having been inundated by a flood will require the removal of trash and debris that may have accumulated, dealing with sediment deposition, and reworking of fields to incorporate the sediment and re-level the irrigated cropland. The restoration costs are based on estimates of cultural procedures from the University of California, Davis. This cost for this type of flooding range from $0 to $92 for open cropland. This level of restoration requirement is consistent with the post-flood demands identified in other USACE studies. The estimated cost for agricultural land restoration requiring the largest amount of clean-up and restoration effort on a per acre basis is provided in Table 2.

Table 2 – Per Acre Field Cropland Restoration Costs

Operation	$ Cost/per Acre
Debris/Trash Removal	16.00
Chisel Plow (2X)	22.00
Disc and Roll (2X)	16.00
Triplane (2X)	22.00
Repair/Replace Irrigation System	16.00
Total (25% of acres)	92.00

The average cleanup and restoration costs over the entire floodplain are estimated to be $46 per acre. It is noted that the restoration costs include only those costs that re-establish the land to a condition prior to the incurrence of any of the expected annual production costs. Restoration costs do not provide for fertilizing, applying herbicide, or any pre-planting activities that are expected to occur during the normal growing season.

k. Flood Duration. The short and long-term damages were considered in the agricultural damage analysis. Short term damages are defined as those damages incurred as a result of a short duration flood. In many cases the short duration flood will not entirely destroy the crop but may have deleterious effects on the crop yield which results in a change in the gross income garnered from the crop. Long term damages are based on two criteria: the duration of the flood event, and secondly, on the affect on longevity of the perennial crop. Sometimes the duration can be so deleterious that the perennial crops such as orchards, vines, and alfalfa stands do not survive the flood and must be replanted. The loss of this investment is considered in the computation of the effects of long term flood events.

The duration of flooding within the study area was found to be correlated to the depth of flooding. Shallow overland flow areas in the northern part of the study area are expected to drain to the southern portion of the basin within several weeks. However, the deeper floodwaters within the southern portion of the study area would not be able to drain back to the channel until for several months.

Depth-Damage estimates were developed for each crop from either a short term or long term flood event. Damages for depths less than 10 feet were based on the assumption of short duration flooding. Depths greater than 15 feet were based on the assumption of long duration flooding. Damages between 10 feet and 15 feet were linearly interpolated.

l. Uncertainty. The uncertainty of price and yield data were accounted for by using triangular distributions in the estimation of flood related costs. Similarly, planting times and other cultural practice data were also input as triangular distributions to account for variability in seasons of the year. The resulting outputs were primarily the translation of the inputs based on simple linear mathematical equations. Due to the uncertainty in the spreadsheet inputs presented as triangular distribution values, @Risk simulation techniques are used in the study to generate a range of model outputs for the stage-damage curves.

m. Example Calculation. All crops undergo a consolidation of costs by month to arrive at the cumulative direct production costs that are at risk should a flood event occur. Below is a example presentation of the cash outlays for the processing tomatoes for the year 2007, which is the most current budget provided by UC Davis for the region in question. Table 3 below can be found on page 13 of the UC Davis budget located at http://coststudies.ucdavis.edu/files/tomatods_sv2007.pdf . A Summary of Annual Non-Cash Costs Per Acre to Produce Tomatoes is provided in Table 4. A Summary of Monthly Cash Cost Per Acre to Produce Tomatoes is provided in Table 5. The final costs used for the Sutter Feasibility Study are updated to current dollars using the producers paid index provided by the National Agricultural Statistics Service, United States Department of Agriculture.

Table 3

Monthly Cash Cost Per Acre to Produce Tomatoes

2007- Direct Seeded

Beginning SEP 06 Ending SEP 07	SEP 06	OCT 06	NOV 06	DEC 06	JAN 07	FEB 07	MAR 07	APR 07	MAY 07	JUN 07	JUL 07	AUG 07	SEP 07	TOTAL
Preplant:														
Land Prep - Laser Level - 4% of Acreage	7													7
Land Prep - Stubble Disc & Roll	9													9
Land Prep - Subsoil & Roll 2X	44													44
Land Prep - Disc & Roll X	16													16
Land Prep - Triplane 2X	22													22
Land Prep - Apply Gypsum on 20% of Acreage	26													26
Land Prep - List Beds		6												6
Land Prep - Shape & Fertilize		30												30
Weed Control - Roundup & Goal					12									12
Weed Control - Roundup					12									12
Weed Control - Cultivate 2X					22									22
TOTAL PREPLANT COSTS	123	36			47									206
Cultural:														
Power Mulch Beds							10							10
Apply Fumigant - Vapam on 30% of Acreage							22							22
Weed Control - Apply Devrinol on 30% of Acreage							22							22
Decap Vapam Beds							3							3
Plant Seed & Fertilize								220						220
Break Bed Crust								4						4
Weed Control - Apply Matrix 2X								32						32
Replant 10% of Acreage - No Additional Fertilizer								19						19
Insect Control - Sevin Bait on 50% of Acreage								5						5
Fertilize - Sidedress 20% of Acreage								5						5
Weed Control - Cultivate 5X								44			11			55
Weed Control - Thin & Hand Hoe								150						150
Insect Control - Sevin Spray on 10% of Acreage								1						1
Disease Control – Bacterial Speck on 30% of Acreage								5						5
Fertilize - Layby UN-32								82						82
Chisel Furrow								12						12
Weed Control – Treflan (& Dual on 30% of Acreage)								29						29
Irrigate - Sprinklers 3X								114						114
Open Ditches								1			1			2
Irrigate - Furrow 8X								55	55	55	53			218
Disease Control - Late Blight on 5% of Acreage										2				2
Close Ditches											2			2
Mite Control - Sulfur on 70% of Acreage											10			10
Weed Control - Hand Hoe											50			50
Train Vines											21			21
Insect Control - Aphids on 40% of Acreage											7			7
Disease Control - Late Blight on 15% of Acreage													4	4
Insect Control - Worms													26	26
Fruit Ripener - Ethrel on 5% of Acreage													5	5
Pickup Truck Use (2 pickups)	1	1	1	1	1	1	1	1	1	1	1	1	1	18
ATV Use	0	0	0	0	0	0	0	0	0	0	0	0	0	6
TOTAL CULTURAL COSTS	2	2	2	2	2	2	58	781	57	59	156	2	36	1,160
Harvest:														
Open Harvest Lane on 8% of Acreage											2	2	2	5
Harvest											103	103	10	216
In Field Hauling											27	26	6	58
TOTAL HARVEST COSTS											131	130	18	279
Assessment:														
Assessments/Fees													14	14
TOTAL ASSESSMENT COSTS													14	14
Interest on Operating Capital @ 10.00%	1	1	1	1	2	2	2	9	9	10	12	13	14	78
TOTAL OPERATING COSTS/ACRE	126	39	3	3	50	4	60	790	66	68	299	145	82	1,737
OVERHEAD:														
Liability Insurance					0									0
Office Expense	1	1	1	1	1	1	1	1	1	1	1	1	1	17
Field Sanitation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crop Insurance					25									25
Field Supervisor Salaries (2)	5	5	5	5	5	5	5	5	5	5	5	5	5	70
Land Rent @ 12% Of Gross Returns													265	265
Property Taxes						3					3			6
Property Insurance						2					2			5
Investment Repairs	0	0	0	0	0	0	0	0	0	0	0	0		5
TOTAL CASH OVERHEAD COSTS	7	7	7	7	33	13	7	7	7	7	13	7	271	393
TOTAL CASH COSTS/ACRE	134	47	10	10	83	16	67	797	73	76	312	152	353	2,131

Table 4
Summary of Annual Non-Cash Costs Per Acre to Produce Tomatoes
2007- Direct Seeded

NON-CASH OVERHEAD COSTS (CAPITAL RECOVERY):	
Shop Building	2
Storage Building	1
Fuel Tanks & Pumps	1
Shop Tools	0
Booster Pumps	3
Sprinkler Pipe	5
Main Line Pipe - 10"	3
Semi Truck & Lowbed Trailer	1
Implement Carrier	1
Truck-Service - 2 Ton	3
Pipe Trailers	2
Fuel Wagons	0
Closed Mix System	0
Siphon Tubes	0
Generators & Light	1
Equipment	130
TOTAL NON-CASH OVERHEAD COSTS/ACRE	153

Table 5
Summary of Monthly Cash Cost Per Acre to Produce Tomatoes
2007- Direct Seeded

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
TOTAL PREPLANT COSTS [11]	159			47									206
TOTAL CULTURAL COSTS [12]	4	2	2	2	2	58	781	57	59	156	2	36	1,160
TOTAL HARVEST COSTS										131	130	18	279
TOTAL ASSESSMENT COSTS [13]												14	14
INT ON OPERATING CAPITAL	2	1	1	2	2	2	9	9	10	12	13	14	78
TOTAL OPERATING COSTS/ACRE [14]	165	3	3	50	4	60	790	67	69	168	15	64	1,458
TOTAL CASH OVERHEAD COSTS [15]	29	29	29	56	36	29	29	29	29	36	29	33	393
TOTAL ALLOCATED NON-CASH COSTS [16]	13	13	13	13	13	13	13	13	13	13	12	12	153
TOTAL COSTS/ACRE [17]	207	45	45	119	53	102	832	109	111	217	56	109	2,005

[11] Preplant costs include land preparation soil cultivation and weed control.
[12] Cultural costs include seeding, fertilizing, and insect control.
[13] Assessment costs include assessment fees paid for marketing products.
[14] Total Operating Costs include all direct operating cash costs excluding harvest costs.
[15] Cash Overhead Costs include land rent, office expenses, and insurance. Cash overhead costs are allocated on a month-to-month basis as a monthly usage cost.
[16] Non-Cash costs (from Table 4) include capital recovery costs of equipment and tools
[17] Total Costs are the sum total of cash and non-cash costs that are expended to produce the respective crop.

n. Results. A tabulation of mean depth damage curves for land use types in the study area is presented in Table 6. A tabulation of Low and High estimated depth damage curves for land use types in the study area is presented in Table 7 and 8 respectively. The method used to calculate the depth-damage curves is discussed in detail in the economics appendix to the feasibility study report. The values in these tables were used as depth damage curves in the grid analysis used to estimate agricultural annual damages described below.

Table 6
Depth-Damage Curves for Agricultural Land Use Types, Mean Estimate

Land Use Type	Assumption	Damage ($/acre) by Flood Depth	
		Less than 10 feet	Greater Than 15 Feet
Abandoned	No Damage	$0	$0
Burned Over Areas	No Damage	$0	$0
Citrus and Subtropical	Prunes	$546	$5,011
Deciduous Fruits and Nuts	Walnuts	$473	$8,268
Entry Denied	No Damage	$0	$0
Field Crops	Corn	$285	$345
Grain and Hay Crops	Alfalfa	$282	$770
Idle	idle	$46	$46
Barren and Wasteland	No Damage	$0	$0
Native Classes Unsegregated	No Damage	$0	$0
Non-irrigated Idle	idle	$46	$46
Riparian Vegetation	No Damage	$0	$0
Not Surveyed	No Damage	$0	$0
Native Vegetation	idle	$46	$46
Water Surface	No Damage	$0	$0
Pasture	Pasture	$215	$215
Rice	Rice	$577	$803
Semi Agricultural and Incidental to Ag	idle	$46	$46
Truck, Nursery and Berry Crops	Tomatoes	$446	$446
Urban	See FDA model	$0	$0
Commercial	See FDA model	$0	$0
Industrial	See FDA model	$0	$0
Urban Landscape	See FDA model	$0	$0
Residential	See FDA model	$0	$0
Vacant	idle	$46	$46
Vineyards	Grapes	$2,512	$9,126
Outside study limit	No Damage	$0	$0

Table 7
Depth-Damage Curves for Agricultural Land Use Types, Low Estimate

Land Use Type	Assumption	Damage ($/acre) by Flood Depth	
		Less than 10 feet	Greater Than 15 Feet
Abandoned	No Damage	$0	$0
Burned Over Areas	No Damage	$0	$0
Citrus and Subtropical	Prunes	$340	$4,638
Deciduous Fruits and Nuts	Walnuts	$172	$7,278
Entry Denied	No Damage	$0	$0
Field Crops	Corn	$174	$204
Grain and Hay Crops	Alfalfa	$156	$603
Idle	idle	$23	$23
Barren and Wasteland	No Damage	$0	$0
Native Classes Unsegregated	No Damage	$0	$0
Non-irrigated Idle	idle	$23	$23
Riparian Vegetation	No Damage	$0	$0
Not Surveyed	No Damage	$0	$0
Native Vegetation	idle	$23	$23
Water Surface	No Damage	$0	$0
Pasture	Pasture	$98	$98
Rice	Rice	$297	$382
Semi Agricultural and Incidental to Ag	idle	$23	$23
Truck, Nursery and Berry Crops	Tomatoes	$196	$196
Urban	See FDA model	$0	$0
Commercial	See FDA model	$0	$0
Industrial	See FDA model	$0	$0
Urban Landscape	See FDA model	$0	$0
Residential	See FDA model	$0	$0
Vacant	idle	$23	$23
Vineyards	Grapes	$1,343	$7,994
Outside study limit	No Damage	$0	$0

Table 8
Depth-Damage Curves for Agricultural Land Use Types, High Estimate

Land Use Type	Assumption	Damage ($/acre) by Flood Depth	
		Less than 10 feet	Greater Than 15 Feet
Abandoned	No Damage	$0	$0
Burned Over Areas	No Damage	$0	$0
Citrus and Subtropical	Prunes	$792	$5,524
Deciduous Fruits and Nuts	Walnuts	$967	$9,977
Entry Denied	No Damage	$0	$0
Field Crops	Corn	$441	$492
Grain and Hay Crops	Alfalfa	$180	$1,027
Idle	idle	$92	$92
Barren and Wasteland	No Damage	$0	$0
Native Classes Unsegregated	No Damage	$0	$0
Non-irrigated Idle	idle	$92	$92
Riparian Vegetation	No Damage	$0	$0
Not Surveyed	No Damage	$0	$0
Native Vegetation	idle	$92	$92
Water Surface	No Damage	$0	$0
Pasture	Pasture	$408	$408
Rice	Rice	$1,065	$1,386
Semi Agricultural and Incidental to Ag	idle	$92	$92
Truck, Nursery and Berry Crops	Tomatoes	$750	$750
Urban	See FDA model	$0	$0
Commercial	See FDA model	$0	$0
Industrial	See FDA model	$0	$0
Urban Landscape	See FDA model	$0	$0
Residential	See FDA model	$0	$0
Vacant	idle	$92	$92
Vineyards	Grapes	$4,050	$10,303
Outside study limit	No Damage	$0	$0

6. ANNUALIZED DAMAGE S

Estimated annual damages were calculated for each 1000ft x 1000ft grid element within the study area. The first step was to calculate the potential agricultural damage within each grid for each of 16 sources. The potential damage was estimated by comparing the depth from each breach source to the depth-damage curve for the crop type within the grid. Probability weighted damage was then calculated for each of the 16 sources by multiplying the potential damage by the probability a breach would occur (1-assurance). The highest of the 16 probability weighted damage estimates were then selected for each grid. The above process was repeated for each of seven annual chance exceedance events. The next step was to annualize the damage for each grid. The last step was to add the annual damages for all grid cells within the study area.

a. Land Use. Butte and Sutter County Land use data were obtained in Arc GIS format from California Department of Water Resources Division of Planning and Local Assistance. The data were gathered using aerial photography and field visits and represent conditions in July through September 2004. GIS data were provided in variable sized polygons that represented each land use type. Land use within each grid element was determined by sampling at the center of the grid element. A map of land use types within the study area is provided in Plate 2.

b. Interior Drainage. Cherokee Canal, Wadsworth Canal, and the three largest pump stations were included in floodplain models. Interior drainage from the study area is primarily conveyed to the Butte Basin, Feather River, or Sutter Bypass by gravity through Cherokee Canal, Wadsworth Canal, and by 10 pump stations. The effects of the 10 smaller pump stations were assumed to be negligible during levee breach type scenarios.

c. Non Failure Stage Frequency. The stage frequency for each flood source was estimated over a range of flood events from a 50% Annual Chance of Exceedance (ACE) to 0.2% ACE. For each event, the peak stage was estimated using a hydraulic model that assumes flows are contained by the existing levee project (non failure). The ability of levees to sustain overtopping is highly uncertain. Therefore, flood flows were allowed to overtop upstream levees without failure. It should be noted that the probability of overtopping failure is accounted for in the analysis by reviewing the full suite of potential breach locations throughout the study area. Additional details regarding hydraulic model assumptions are described in the hydraulic model documentation.

d. Inundation maps. Inundation depth maps were developed for15 hypothetical breach failure sources and one natural inundation source throughout the study area. Breach locations were selected to reflect a full range of potential inundation patterns within the study area. Inundation maps were developed for a range of flood frequencies from 50% (1/2) ACE to 0.2% (1/500) ACE. Use of each inundation map must incorporate the probability of levee failure (or stage for natural inundation sources) to define flood probability. Each location (grid element) in the study could be inundated by multiple breach locations. All breach inundation maps and associated breach probability must be reviewed to assess flood potential.

e. Performance Assurance. The performance assurance (Conditional Non-exceedance Probability) for each flood source was calculated using an FDA model. FDA was used to combine flow-frequency, stage-discharge, geotechnical fragility, and stage-damage relationships for each flood source. Uncertainty in each relationship is incorporated by assigning uncertainty estimates and applying a Monte Carlo type approach to combine the results.

f. Critical Flood Source and Damages. The critical flood source and damages for each grid element was defined as the source which would result in the highest expected damage for each ACE event. This was determined by calculating the non-assurance probability weighted damage from each flood source and selecting the largest value. Since the probability of inundation and consequence of inundation varies by grid element, the procedure was done separately for each grid element.

The non-assurance probability weighted damage was calculated by multiplying the non-assurance probability of inundation times the consequence of the inundation. The non-assurance probability of inundation was defined by one minus the assurance (1-Conditional Exceedance Probability) computed by FDA. The consequence of inundation was determined by comparing the depth in the grid element for the assumed breach to the depth damage curve. The next step was to calculate a non-assurance weighted damage value by multiplying the potential damage by the non-assurance probability of inundation. This process was completed for each flood source (possible breach location). The last step was to select the source that generated the highest non-assurance probability weighted damage. It was assumed that for an infinitely long flood record, this damage would represent the most likely damages for that grid element for the given ACE event. An example calculation for the 1% ACE event at Grid Element 11243 (in the south portion of the study area) is presented in Table 9.

g. Estimated Annual Damages. Annualized damages were estimated by integrating the frequency vs: damage curve within each grid element. In the integration procedure, the damages were assumed to be negligible for events more frequent than 95% ACE because flood stages are below the natural bank elevation. Damage for the 0.1% ACE event was assumed to be the same as the 0.2% ACE event in the integration of the frequency vs: damage curve. Floodplain stage (and damages) was assumed to be relatively insensitive to flow for extreme events (less than 0.2% ACE) because of the large flood conveyance area once levees have overtopped and failed. The increment of annual damages for events greater than 0.1% ACE was assumed to be negligible because of its extremely rare frequency and small contribution in the integration calculations. An example calculation for Grid Element 11243 (in the south portion of the study area) is presented in Table 10.

h. Alternatives. Alternatives were evaluated by using fragility curves and inundation maps that reflect each alternative being evaluated.

13. RESULTS

The mean agricultural estimated annual damages for each of the final alternatives are presented in Table 12. The low and high estimates are provided in Table 13 and 14. Maps showing the mean agricultural EAD for each refined alternative are provided in Plates 3 through 5.

Table 9
Example Event Damage Calculation, Without Project Conditions
1% ACE Event, Grid Element 11243

Potential Flood Source	Probability of Inundation			Consequence of Inundation		Non-Assurance Probability Weighted Damage ($)
	Geotech Index	Non-Failure Channel Stage (NAVD88-ft)	Non-Assurance Probability (1-CNP)	Flood Depth Assuming Breach (ft)	Damage Assuming Breach ($)	
Butte Basin BB1.0	Natural	65.06	1.0	0	0	0
Interior Drainage	Natural	NA	NA	0	0	
Feather River F3.0R	MA3	55.95	0.16	18.53	18,435	2,863
Feather River F4.0R	LD1-3.99	61.73	0.46	20.83	18,435	8,487
Feather River F4.5R	LD1-9.31	67.95	0.44	21.46	18,435	8,063
Feather River F5.0R	LD9-0.52	76.57	0.40	21.26	18,435	7,383
Feather River F6.0R	LD9-0.52	76.57	0.40	12.53	15,872	6,357
Feather River F7.0R	MA16-0.9	83.85	0.28	0	0	0
Feather River F8.0R	MA7-Ham Bend	127.30	0.42	0	0	0
Feather River F9.0R	MA7-Ham Bend	127.30	0.42	1.05	13,246	5,594
Sutter Bypass S3.0L	Sutter Bypass 11.9	50.17	0.50	15.96	18,434	9,178
Sutter Bypass S4.0L	Sutter Bypass 6.2	54.44	0.78	17.55	18,434	**14,336**
Sutter Bypass S5.0L	SB LM 4.0	55.91	0.70	0	0	0
Cherokee Canal CC01L	Cherokee Canal 9.5	112.95	0.99	0	0	0
Cherokee Canal CC02L	Cherokee Canal 9.5	112.95	0.99	0	0	0
Wadsworth Canal W2.0L	Wadsworth LB 0.84	55.92	0.66	4.12	13,247	8,792
Wadsworth Canal W2.0R	Wadsworth RB 0.50	55.92	0.81	0	0	0
Critical flood damage source = S4.0L based on largest Non-Assurance Probability Weighted Damage of						**14,336**

Note 1: Non-Failure channel stage assumes upstream levee overtopping without failure. As a result, all potential flood sources must be reviewed to evaluate the probability of flood damages within the study area.
Note 2: The Butte Basin flood source is a natural system without levees. To be consistent with the approach, a fragility of 1 is assumed for all flood events.
Note 3: Summed values may vary due to round off error.

Table 10
Agricultural Damage Frequency Integration, Without Project Conditions
Grid Element 11243

Annual Chance Exceedance (Percent)	Exceedance Frequency Events/100yrs	Frequency Interval (Events per Year)	Non-Assurance Probability Weighted Damage ($)	Average Damage For Frequency Interval ($)	Frequency Interval Weighted Damage ($)	Percent of Total EAD
99.99	99.99		0			
		0.0499		0	0	0.0
95	95		0			
		0.45		3,072	1382	23.0
50	50		6,144			
		0.4		8,499	3400	56.6
10	10		10,854			
		0.06		11,512	691	11.5
4	4		12,171			
		0.02		12,578	252	4.2
2	2		12,985			
		0.01		13,661	137	2.3
1	1		14,336			
		0.005		15,104	76	1.3
0.5	0.5		15,871			
		0.003		16,571	50	0.8
0.2	0.2		17,271			
		0.001		17,271	17	0.3
0.1	0.1		17,271			
				Total EAD	6,003	100

Table 11
Agricultural Estimated Annual Damages
Mean Estimate

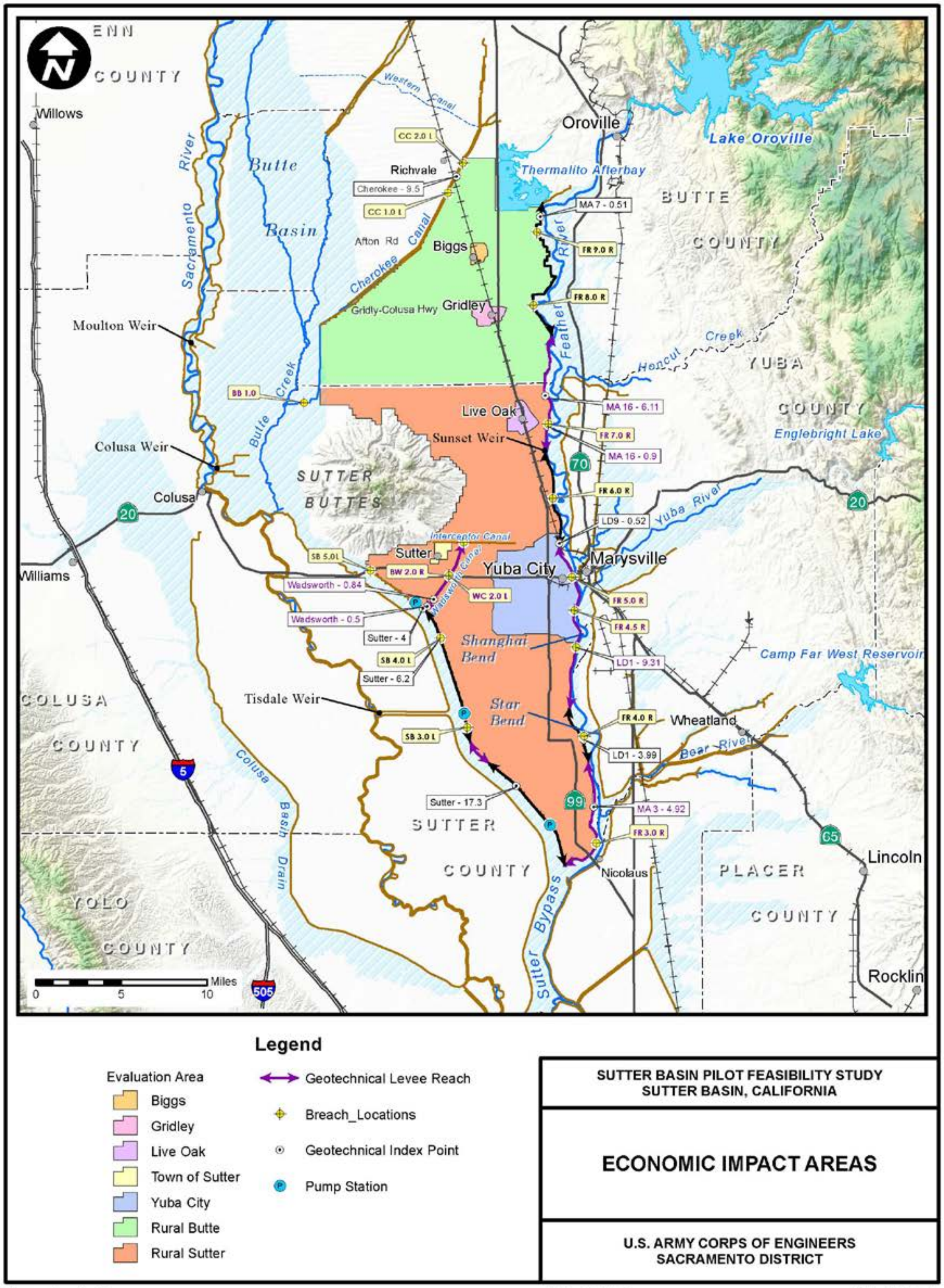
Economic Evaluation Area	Estimated Annual Agricultural Damages ($1000)		
	SB-1	SB-7	SB-8
	No Action	Fix-In-Place Feather River Sunset Weir to Laurel Ave	Fix-In-Place Feather River Thermalito to Laurel Ave
Town of Sutter	0	0	0
Yuba City Urban	246	65	57
Biggs Urban	4	4	0
Gridley Urban	5	5	0
Live Oak Urban	9	9	1
Sutter County Rural	16227	11802	11452
Butte County Rural	1875	1875	1208
Total	18366	13760	12718
Note: Damages for urban, industrial, urban-landscape, and residential are not included.			

Table 12
Agricultural Estimated Annual Damages
Low Estimate

Economic Evaluation Area	Estimated Annual Agricultural Damages ($1000)		
	SB-1	SB-7	SB-8
	No Action	Fix-In-Place Feather River Sunset Weir to Laurel Ave	Fix-In-Place Feather River Thermalito to Laurel Ave
Town of Sutter	0	0	0
Yuba City Urban	106	28	25
Biggs Urban	2	2	0
Gridley Urban	2	2	0
Live Oak Urban	3	3	0
Sutter County Rural	11006	6766	6610
Butte County Rural	921	921	620
Total	12040	7723	7255
Note: Damages for urban, industrial, urban-landscape, and residential are not included.			

Table 13
Agricultural Estimated Annual Damages
High Estimate

Economic Evaluation Area	Estimated Annual Agricultural Damages ($1000)		
	SB-1	SB-7	SB-8
	No Action	Fix-In-Place Feather River Sunset Weir to Laurel Ave	Fix-In-Place Feather River Thermalito to Laurel Ave
Town of Sutter	0	0	0
Yuba City Urban	470	126	111
Biggs Urban	8	8	1
Gridley Urban	8	8	0
Live Oak Urban	18	18	1
Sutter County Rural	24671	19873	19201
Butte County Rural	3498	3498	2227
Total	28673	23530	21541
Note: Damages for urban, industrial, urban-landscape, and residential are not included.			



Prepared by Jim Mars

JUL 2013

PLATE 1

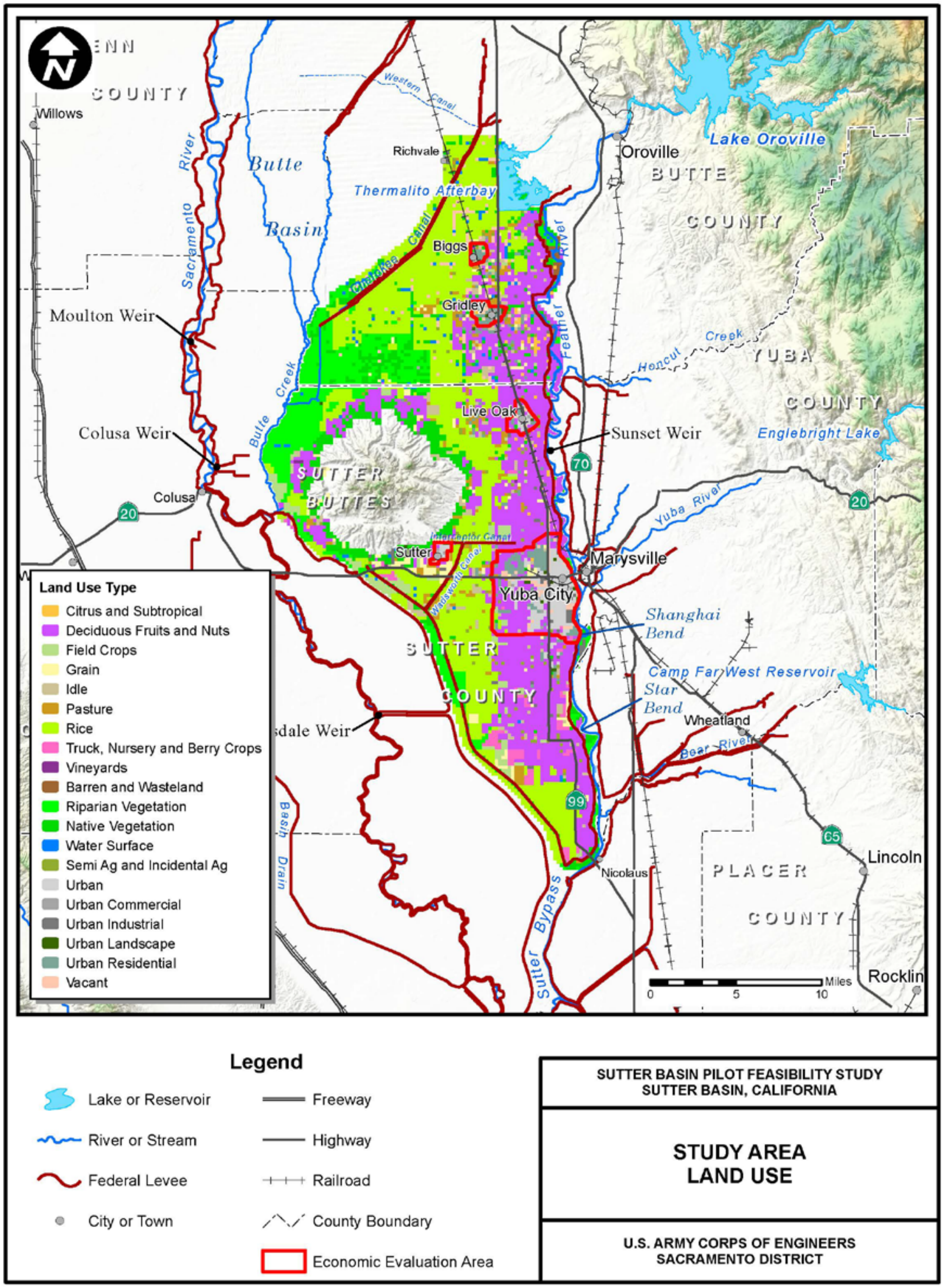


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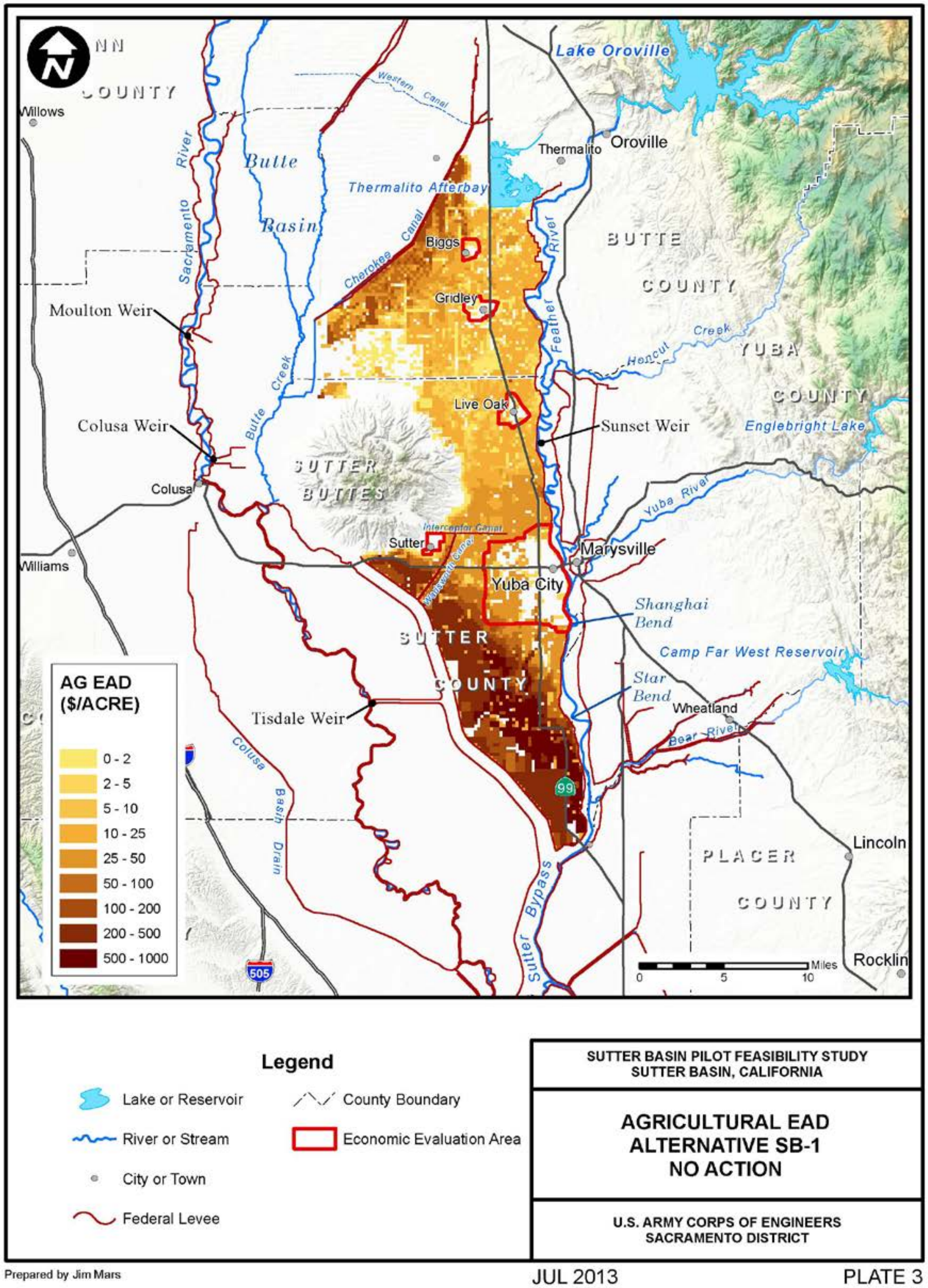
PLATE 2



Lake Oroville
Willows
Oroville
Thermalito
Butte
Thermalito Afterbay
Basin
Biggs
BUTTE
COUNTY
Gridley
Moulton Weir
Live Oak
Colusa Weir
Sunset Weir
Englebright Lake
SUTTER BUTTES
Colusa
Sutter
Marysville
Williams
Yuba City
Shanghai Bend
SUTTER
Camp Far West Reservoir
COUNTY
Star Bend
Wheatland
AG EAD ($/ACRE)
Tisdale Weir
0 - 2
2 - 5
5 - 10
10 - 25
25 - 50
50 - 100
100 - 200
200 - 500
500 - 1000
Lincoln
PLACER
COUNTY
Rocklin
Sutter Bypass
Miles
0
5
10
Legend
Lake or Reservoir
County Boundary
River or Stream
Economic Evaluation Area
City or Town
Federal Levee
SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA
AGRICULTURAL EAD
ALTERNATIVE SB-1
NO ACTION
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT
Prepared by Jim Mars
JUL 2013
PLATE 3

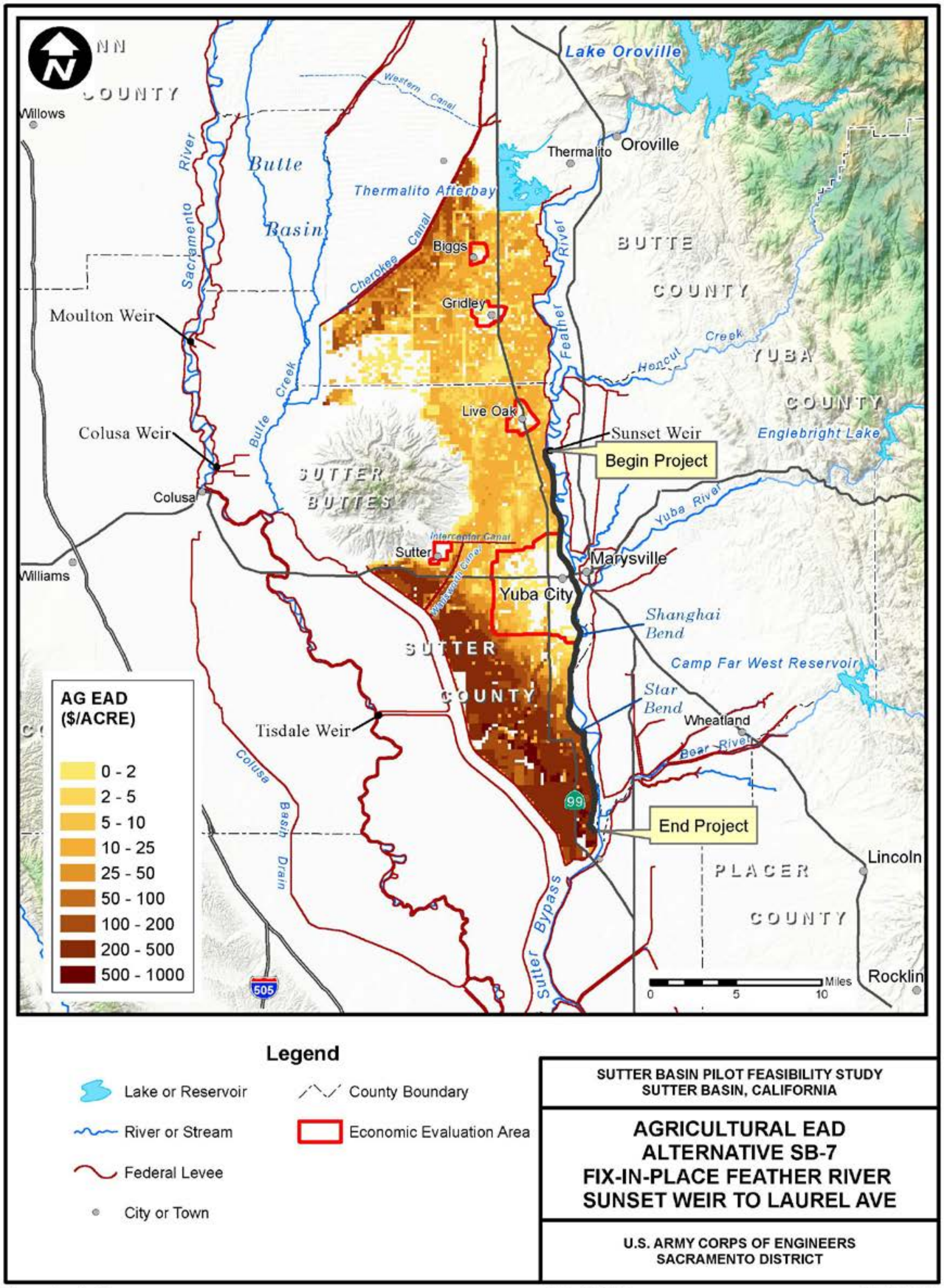


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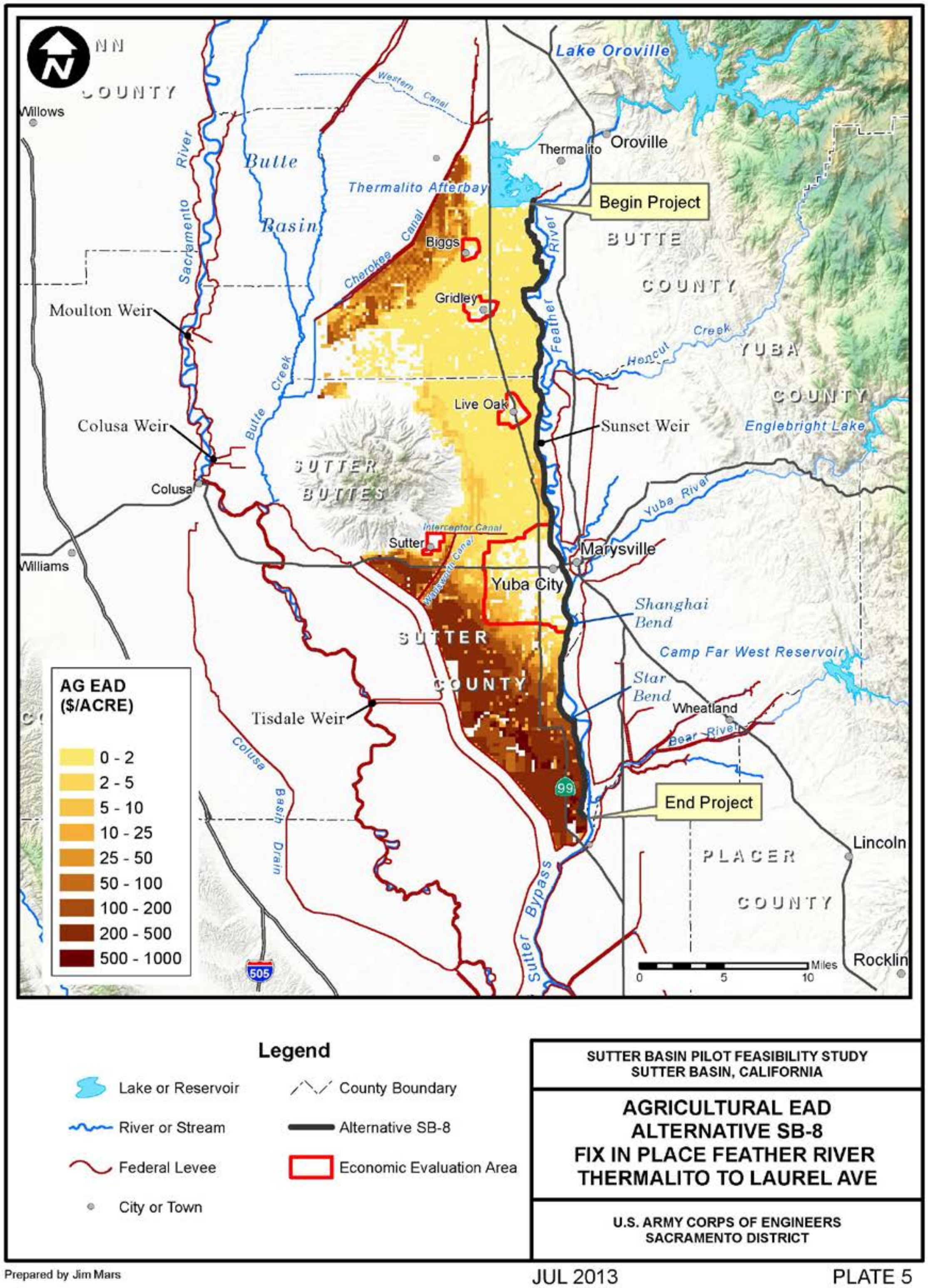
PLATE 4


Lake Oroville
Oroville
Thermalito
Willows
Butte
Basin
Thermalito Afterbay
Begin Project
BUTTE
COUNTY
Biggs
Gridley
Cherokee Canal
Sacramento River
Feather River
Moulton Weir
Hencut
Creek
YUBA
COUNTY
Live Oak
Colusa Weir
Sunset Weir
Englebright Lake
Butte Creek
SUTTER
BUTTES
Colusa
Yuba River
Interceptor Canal
Sutter
Marysville
Williams
Yuba City
Shanghai
Bend
SUTTER
COUNTY
Camp Far West Reservoir
Star
Bend
Wheatland
Tisdale Weir
Bear River
AG EAD
($/ACRE)
0 - 2
2 - 5
5 - 10
10 - 25
25 - 50
50 - 100
100 - 200
200 - 500
500 - 1000
Colusa Basin Drain
99
End Project
Lincoln
PLACER
COUNTY
Sutter Bypass
505
Miles
0
5
10
Rocklin
Legend
Lake or Reservoir
River or Stream
Federal Levee
City or Town
County Boundary
Alternative SB-8
Economic Evaluation Area
SUTTER BASIN PILOT FEASIBILITY STUDY
SUTTER BASIN, CALIFORNIA
AGRICULTURAL EAD
ALTERNATIVE SB-8
FIX IN PLACE FEATHER RIVER
THERMALITO TO LAUREL AVE
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT
Prepared by Jim Mars
JUL 2013
PLATE 5

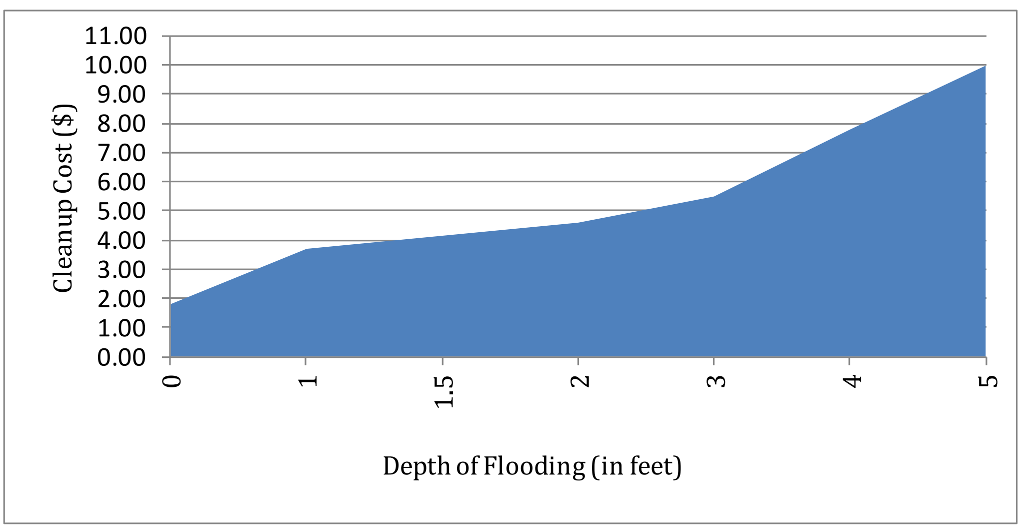
Attachment 3: Cleanup and Emergency Costs

OTHER FLOOD DAMAGE CATEGORIES LINKED TO STRUCTURE DAMAGES

Depreciated structure and structure content damages measure the cost of replacing damaged portions of structures and structure contents with those of similar use and condition. It does not, however, fully account for all the various costs incurred following a damaging flood event. In this report, four additional categories of damages directly related to structure and structure content damages were considered: cleanup costs, temporary housing and relocation assistance costs and other emergency costs. In the sub-sections below, these damage categories are explained and justified as legitimate flood damage reduction benefit categories. Following these explanations, the without-project damages associated with all four categories are summarized

CLEANUP COSTS

Floodwaters leave debris, sediment, salts and the dangers of diseases and mycotoxins throughout flooded structures. The cleaning of these structures is a necessary post-flood activity. Clean-up costs for the extraction of floodwaters, dry-out, and decontamination vary significantly based upon various factors, including depth of flooding. Based upon research and analysis conducted by both Sacramento and New Orleans Districts, a maximum value of ten dollars per square foot was assumed for such costs. This maximum per square foot cost includes the clean-up costs associated with mold and mildew abatement, including costs of paid to professional firms to apply fans, chemicals, etc., to eliminate any mold and prevent mold in inundated areas. This maximum cost was applied for flood depths equal to and exceeding five feet, with damage percentages scaled down for depths between zero and five feet. The figure below displays per square foot cleanup costs as a function of flood depths.

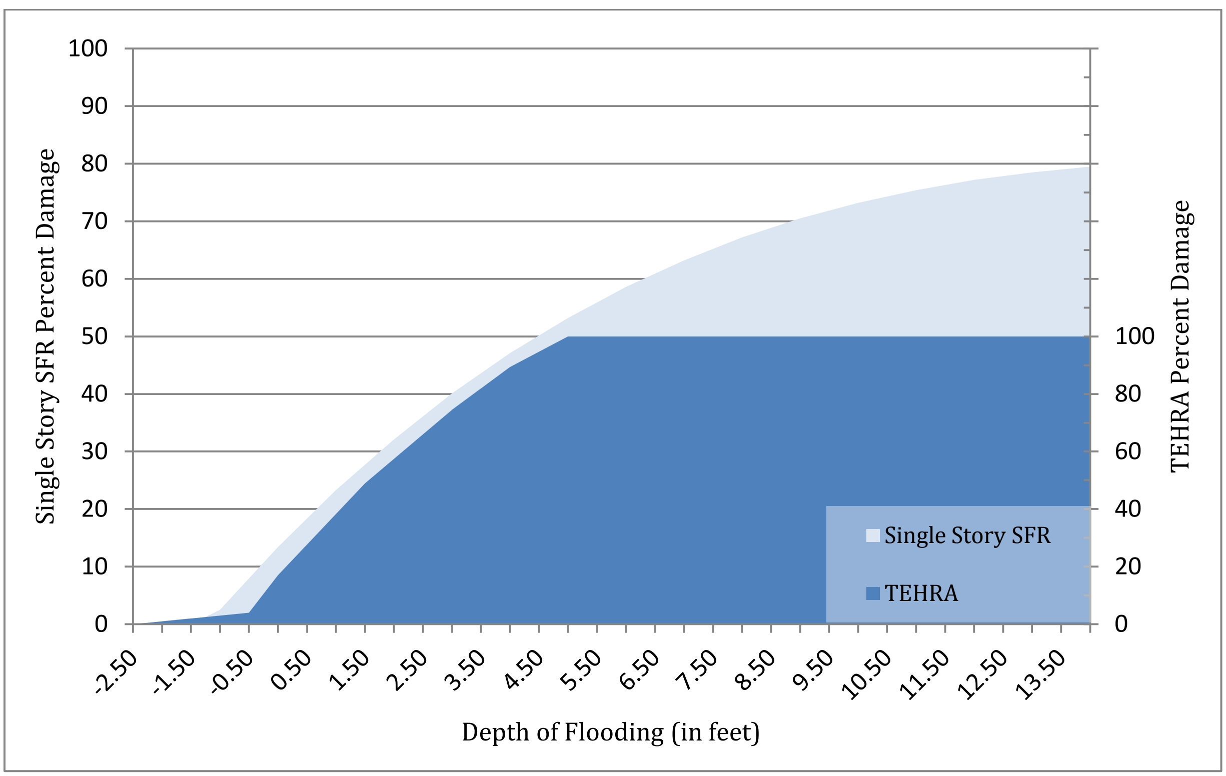


TEMPORARY EVACUATION, RELOCATION AND HOUSING ASSISTANCE COSTS

ER 1105-2-100 states, “Flood damages are classified as physical damages or losses, income losses, and emergency costs.” The ER then defines emergency costs as “those expenses resulting from a flood what would not otherwise be incurred…" The ER further requires that emergency costs should not be estimated by applying an arbitrary percentage to the physical damage estimates.

The Federal Emergency Management Agency (FEMA) provides grants to assist individuals and families to find suitable housing when they are displaced in cases of federally declared disasters. The program assures that people have a safe place to live until their homes can be repaired. This assistance is directly attributable to the disaster, since it is an expenditure that is only undertaken when a disaster occurs. Therefore, it falls under the emergency cost guidance of ER 1105-2-100, and the funds expended by FEMA for temporary evacuation, relocation and housing assistance (TERHA) in the event of flooding are a legitimate NED account flood damage reduction category.

Costs estimates for the relocation and emergency services provided to floodplain residents displaced during peak flood events and post-flood structural renovations were based on FEMA's methodology for evaluating TEHRA costs. This methodology relates TEHRA costs to relocation costs, structure damage percentages and the number of days residents spend displaced from their structures. The maximum TEHRA costs of $9,960 correspond with one year of FEMA evacuation, relocation and/or housing assistance costs. These costs are based on the median price for a two bedroom apartment within the City of Yuba City, posted on the rent.com website. It is applied whenever a structure sustains at least 50 percent damage, with a scaled down cost being computed for less damaging flood events. The figure below shows percent of maximum TEHRA damages as a function of the depth of flooding. This depth-damage relationship for single story single family residences (SFR) is also shown as a point of reference.



OTHER EMERGENCY COSTS

Other emergency costs, in addition to TEHRA costs, incurred in the event of a flood are included in this report's analysis. These additional emergency cost categories account for cash-based assistance disaster survivors receive to pay for uninsured medical care, funeral expenses and living expenses; and public assistance received by local governments and non-profit institutions to repair critical public infrastructure. Both of these assistance programs are administered by FEMA. Special care was taken to ensure temporary evacuation, relocation and housing assistance costs described above were explicitly excluded from this damage category.

A basic methodology for the calculation of other emergency costs was presented in the Centralia Flood Damage Reduction Project - Chehalis River, Washington, General Reevaluation Study. The Chief's Report for the Centralia Flood Damage Reduction Project - Chehalis River, Washington, General Reevaluation Study includes two relevant benefit categories: temporary rental assistance and public assistance. In the Chehalis River study, these benefit categories are based on FEMA disaster report data published between 1997 and 1999. Since 1999, many flooding events have occurred and FEMA damage reports are available.

Several changes have occurred since data was compiled for the Chehalis River study. Foremost, the benefit category of temporary rental assistance underwent a program change. When data was compiled for the Chehalis study, temporary rental assistance was a separate program line item. It has since been rolled into another program, under the name of housing assistance. Since the new housing assistance program can include temporary evacuation, relocation and housing assistance costs, included in the TEHRA section above, special care was taken to explicitly exclude these costs from this analysis. The portion of the new housing assistance program that was included under this flood damage reduction category is referred to as the other needs assistance program. This program provides assistance to applicants who have disaster-related necessary expenses and serious needs not covered by insurance. These needs may include medical, dental and funeral expenses, as well as transportation and other emergency expenses. Seventy five-percent of this aid is contributed by FEMA; the remaining 25 percent is contributed by the state.

The public assistance program, included under this flood damage reduction category, provides supplemental Federal disaster grant assistance for the repair, replacement or restoration of disaster-damaged publicly owned facilities, as well as the facilities of some private non-profit organizations. The Federal share of assistance is not less than 75 percent of the eligible cost for emergency measures and permanent restoration. The state determines how the non-Federal share, of up to 25 percent is split between the applicants.

To be eligible, the work must be required as the result of the disaster, be located within the designated disaster area and be the legal responsibility of an eligible applicant. Work that is eligible for supplemental Federal disaster grant assistance is classified as either emergency work or permanent work.

(1) Emergency Work: Debris removal from public roads and rights-of-way, as well as from private property when determined to be in the public interest, and emergency protective measures performed to eliminate or reduce immediate threats to the public, including search and rescue, warning of hazards and demolition of unsafe structures.

(2) Permanent Work: Work to restore an eligible damaged facility to its pre-disaster design; this work can range from minor repairs to total replacement. Categories of permanent work may include:

   a. Repairs to roads, bridges and associated features, such as shoulders, ditches, culverts, lighting and signs
   b. Repairs to water control facilities including drainage channels, pumping facilities, and the emergency repair of levees
   c. Repairs to utility distribution systems, such as water treatment and delivery systems; power generation facilities and distribution lines; and sewage collection and treatment facilities
   d. Repairs to public parks, recreational facilities and other facilities, including playgrounds, swimming pools and cemeteries

The evaluation of other needs assistance and public assistance is based on the disaster reports contained in the archive at FEMA's web site. Unfortunately for this evaluation, FEMA does not have available either a final summary of expenditures by disaster or an annual expenditure report by disaster for analysis. Instead, interim reports by disaster are the only available data sources. To minimize the influences of factors other than flooding, the current analysis excludes from its database: hurricanes, tropical storms, flooding events associated with tornadoes and other non-flood events.

The cost per temporary relocation assistance claim ($1,537) in the Chehalis River study was based on 13 disasters. An updated database of 132 disaster housing grants was obtained for this report. The average dollar amount per application for housing assistance in this sample was $1,550, the median was $1,479 and the standard deviation of the sample is $717. Other needs expenditures average $825 per housing assistance claim, with a standard deviation of $651 and minimum and maximum of $0 and $3,702, respectively.

Public assistance benefits in the Chehalis study were based upon the ratio of public assistance expenditures to disaster housing grants (temporary relocation assistance expenditures). In the Chehalis study, this ratio was based on total expenditures during public assistance and/or disaster housing grant claims, not individual or comparable events. This methodology may have been selected because only six disasters in the Chehalis sample had data for both expenditures. The current database contains 60 events having data for both housing assistance and public assistance claims. The larger sample size permitted the use of a more representative public-to-housing assistance ratio, based on the sample of 60 comparable events. Based on a ratio of 2.83, it was estimated that public assistance grants average $4,387 on a per household basis, following flood events. Therefore, the total other emergency costs of $5,212 estimated on a per household basis, is the sum of this amount and the average other needs assistance claim reported above.

The table below summarizes the without-project damages estimates for the four damage categories discussed above. Since all of these categories are directly linked to the floodplain structure damages, structure and structure content damages are also restated. The table shows that total without-project damages in the cleanup, TEHRA, Other Needs Assistance and Public Assistance.

Annual Damages for Without Project					
Data in $1,000					
EIA	Clean-up Costs	TEHRA	Other Need Assistance	Public Assistance	**TOTAL**
Yuba City	$7,440	$3,622	$409	$2,168	**$13,639**
Biggs	$105	$83	$10	$54	**$252**
Gridley	$254	$143	$19	$104	**$520**
Live Oak	$308	$218	$33	$175	**$734**
Rural Butte	$152	$102	$15	$82	**$351**
Rural Sutter	$4,231	$1,871	$204	$1,078	**$7,384**
TOTAL	**$12,490**	**$6,039**	**$690**	**$3,661**	**$22,880**

For the proposed projects of SB-7 and SB-8, the following tables provide the residual damages and total annual benefits for each of the four damage categories: clean-up costs, TEHRA, Other Need Assistance, and Public Assistance.

Annual Residual Damages and Annual Benefits for Alt SB-7					
Data in $1,000					
	Clean-up Costs	TEHRA	Other Need Assistance	Public Assistance	**TOTAL**
Yuba City	$1,183	$565	$56	$295	**$2,099**
Biggs	$105	$83	$10	$54	**$252**
Gridley	$254	$143	$19	$104	**$520**
Live Oak	$308	$218	$33	$175	**$734**
Rural Butte	$152	$102	$15	$82	**$351**
Rural Sutter	$2,919	$1,268	$145	$766	**$5,098**
TOTAL	**$4,921**	**$2,379**	**$278**	**$1,476**	**$9,054**
Total Annual Benefits	**$7,569**	**$3,660**	**$412**	**$2,185**	**$13,826**

Annual Residual Damages and Annual Benefits for Alt SB-8					
Data in $1,000					
	Clean-up Costs	TEHRA	Other Need Assistance	Public Assistance	**TOTAL**
Yuba City	$1,183	$565	$56	$295	**$2,099**
Biggs	$37	$26	$3	$17	**$83**
Gridley	$47	$28	$4	$20	**$99**
Live Oak	$60	$40	$4	$23	**$127**
Rural Butte	$30	$19	$3	$14	**$66**
Rural Sutter	$2,919	$1,268	$145	$766	**$5,098**
TOTAL	**$4,202**	**$1,914**	**$210**	**$1,116**	**$7,442**
Total Annual Benefits	**$8,288**	**$4,125**	**$480**	**$2,545**	**$15,438**

Attachment 4: Population Growth and Executive Order 11988

Evaluation of Developable Acreage

Prepared by: SBFCA & USACE

INTRODUCTION

The US Army Corps of Engineers (USACE) is currently evaluating several alternatives to provide improved flood protection in the Yuba City Basin of Sutter and Butte Counties. The USACE has identified a set of criteria to use in evaluation of alternatives for the purpose of identifying a Recommended Plan. One of the criteria is "wise use of the floodplain", measured as the potentially developable acreage in the basin under each alternative, where existence of a floodplain is the only barrier to development (Table 1). Under the no-action alternative, the USACE quantifies the developable acreage at approximately 71,800 acres – most of which is located in the vicinity of Yuba City and in the northern portions of the basin, and is subject to shallow (less than 3-feet) flooding in a levee break, with the assumption that development could proceed by elevating structures. Under the action alternatives, more of the basin is protected, and therefore the USACE estimate of developable acreage increases. This is judged to be a negative consequence of providing flood protection under Federal policy (Executive Order 11988).

Development is limited by factors other than just floodplain restrictions, including local land use policies and ordinances, economic and market factors. Proof of success of these forces at controlling growth is in observation of past growth. The cities of Biggs, Gridley, Live Oak, and Yuba City have not historically been mapped within the FEMA 100-year floodplain, and are not currently mapped within the 100-year floodplain. Despite the lack of floodplain development restrictions, development in Biggs, Gridley, Live Oak, and Yuba City has been modest. It is SBFCA's contention, therefore, that past growth trends illustrate the fact that development in the basin is effectively controlled by existing policies, ordinances, economic and market and factors, thereby minimizing the "wise use of floodplain" differences between action alternatives. In short, implementation of flood control improvements will not change any of the drivers responsible for growth in the basin.

The purpose of this Technical Memorandum (TM) is to illustrate that flood control improvements will not change the fundamental drivers of urban growth by evaluating historical and future growth data, summarizing current growth inhibitors, lack of market/economic drivers, and development restrictions in place at the local, state, and federal level, which will continue to control and limit urbanized development, even with the implementation of these improvements. Furthermore, this TM will illustrate that growth in the basin over the next 60 years is projected to be less than the developable acreage under the no-action alternative.

PROJECT ALTERNATIVES

The Sutter Basin Pilot Feasibility Study identified two primary action alternatives, plus the no-action alternative, and estimated the acreage of developable land for each alternative (Table 1). The "wise use of the floodplain" is a criteria used by the USACE which estimates the potentially developable acreage in the basin under each alternative, defined as the total area not subject to flooding depths greater than 3-feet in a 100-year flood, excluding State protected lands.

Table 1 - Sutter Basin Pilot Feasibility Study Developable Acreage			
	SB-1 (No-Action)	**SB-7 (NED)**	**SB-8 (Recommended Plan)**
Developable Area (Acres)	71,832 acres	88,200 acres	100,200 acres

The acreage in Table 1 is simply the estimate of acreage in the basin not subject to flooding depths greater than 3-feet in a 100-year flood (excluding State protected lands). These values do not consider market demand, land use restrictions, or other encumbrances which govern growth in the basin. An assessment of future growth in the basin needs to be performed to see if demand exists for this developable acreage.

GROWTH PROJECTIONS

In order to put future growth projections into perspective, the growth in the basin over the past 50 years was assessed. Table 2 below presents the population and respective historical growth rates for the cities in the basin in 1960 and 2010. These were also compared to the growth rates of Sutter & Butte County, and the State of California at the request of USACE.

Table 2 – Historical Growth Rates			
Jurisdiction	**1960 Population**[1]	**2010 Population**[2]	**Avg. Annual Growth Rate**
Yuba City	11,507	64,925	3.52%
Live Oak	2,276	8,392	2.64%
Biggs	831	1,707	1.45%
Gridley	3,343	6,584	1.36%
Sutter County	33,380	94,737	2.11%
Butte County	82,030	220,000	1.99%
State of California	15,717,204	37,253,956	1.74%

1 – According to the California Department of Finance
2 – According to the 2010 Census

The table above illustrates that growth in the basin has historically been modest, with Yuba City being the fastest growing area. The increased growth rate of Yuba City is largely attributed to its proximity to Sacramento, since residents can live and commute to the metro area. Growth rates have been slower in Biggs and Gridley primarily due to lack of economic drivers in and around these small agricultural communities. Growth in the basin has occurred relatively free from floodplain-related development restrictions. Urban development and growth was centered around the largest urban area in the basin – Yuba City – while the rural towns maintained slower growth rates, consistent with the General Plans for these areas.

Sources for future population estimates range from the General Plans for Sutter and Butte County, the California Department of Finance (CDOF), and the Sacramento Area Council of Governments (SACOG). A summary comparing the various population growth projections in included in Table 3.

Table 3 – Comparison of Future (Year 2030) Projected Growth Rates									
	General Plan/CDOF			**BCAG**			**SACOG**		
Jurisdiction	**Low**	**Med**	**High**	**Low**	**Med**	**High**	**Low**	**Med**	**High**
Yuba City	-	2.5%	-	-	-	-	-	2.5%	-
Live Oak	-	2.6%*	-	-	-	-	-	-	-
Biggs	3.3%	3.7%	4.1%	3.3%	3.7%	4.1%	-	5.2%	-
Gridley	-	5.1%	-	3.2%	3.5%	3.9%	-	3.5%	-
Sutter County	-	2.6%*	-	-	-	-	-	1.7%	-
Butte County	0.9%*	1.6%	-	1.4%	1.6%	1.8%	-	1.1%	-
State of California	-	0.7%*	-	-	-	-	-	-	-

*References CDOF Estimates (Year 2060 Horizon)

The projected growth rates are assumed to be accurate beyond 2030 for purposes of estimating the populations in these jurisdictions in 2070. These projections are estimates only, and are subject to change over time.

The table above is presented in order to compare population projections from various sources. For purposes of this TM, the SACOG projections are used in order to address comments received on the Draft report. It should be noted SACOG growth estimates for Biggs and Gridely are projected by SACOG to be significantly higher than historic growth rates. Even though SBFCA contends these growth rates are overstated, these values will be used to estimate the maximum demand for new developable acreage in the basin.

The growth rates referenced by SACOG and the CDOF use a baseline cohort-component method to project population by age, gender, and race/ethnicity. The method uses seven mutually exclusive race/ethnic groups and assumes people have the right to migrate where they choose and no major natural catastrophes or war will befall the state or the nation. The cohort-component method traces people born in a given year through their lives. As each year passes, cohorts change due to the mortality and migration assumptions. Applying the fertility assumptions to the women of childbearing age forms new cohorts.

A comparison of the 2070 population estimates for each jurisdiction noted above is presented in Table 4 below.

Table 4 – Projected Population (Year 2070)		
	SACOG	
Jurisdiction	**Med Growth Rate**	**Est. Population**
Yuba City	2.5%	285,656
Live Oak	2.6%*	39,148
Biggs	5.2%	35,742
Gridley	3.5%	51,869
Sutter County	1.7%	260,482
Butte County	1.1%	424,123

*City of Live Oak Growth Rate used since SACOG estimate was not available for Live Oak

The population figures presented above do not relate directly to demand for developable acreage. In order to compare the USACE's estimate of Developable Area in Table 1 to the demand for developable land necessary to accommodate the projected population presented in Table 4, the Medium Population Growth rates were applied to existing developed acreage in each jurisdiction. The projected urban development within each City's Sphere of Influence (SOI) as shown in each General Plan is shown in the Tables 5 & 6.

Table 5 - Projected Sutter County Developed Area			
Sutter County Growth Areas[1]	**Existing Developed Acreage[2]**	**Projected New Urban Acreage from 2010-2030[3]**	**Projected New Urban Acreage from 2010-2070[4]**
Yuba City SOI & Employment Corridor	8,965	12,019	30,479
Live Oak SOI	1,165	6,511	11,667[5]
Other (Sutter & Tudor)	2,037	2,939	7,465
Subtotal Sutter County	**12,167**	**21,469**	**49,611**

1 – As indicated in the Sutter County General Plan Draft EIR
2 – Acreage within the City limits are assumed to be fully developed
3 – As indicated in the Sutter County General Plan Draft EIR. Does not subtract out existing development in the SOI
4 – Assumes population projected growth rate of 2.6% also applies to urbanized development
5 – Growth rate of 2.6% applied to new acreage in 2030 (6,511 acres)

Table 6 - Projected Butte County Developed Area			
Butte County Growth Areas	**Existing Developed Acreage**	**Projected New Urban Acreage from 2010-2030[3]**	**Projected New Urban Acreage from 2010-2070[4]**
Biggs SOI	414[2]	541[2]	8,524
Gridley SOI	1,300[3]	2,900[3]	8,941
Subtotal Butte County	**5,155**	**3,441**	**17,465**
Total for Sutter & Butte County	**17,322**	**24,910**	**67,076**

1 – Does not subtract out existing development in the SOI
2 – As indicated in the City of Biggs General Plan
3 – Acreage values not included – gross acreage scaled off map in Gridley General Plan
4 – Assumes projected growth rate of 5.2% and 3.5% for Biggs and Gridley, respectively, also applies to urbanized development

The data presented in Tables 5 & 6 indicates that only about 67,000 new acres are projected to be developed by 2070 within the basin, assuming SACOG projected growth rates are maintained beyond 2030. Furthermore, Yuba City accounts for about half of the demand for developable acreage (approx. 30,000 acres). This estimated projected new urban acreage is far less than the Developable Area under the No Action, SB-7, and SB-8 alternatives. Therefore, this data indicates the estimated demand by 2070 for approximately 60,000 acres of developable land – far less than the 71,800 acres projected to be available in the basin under the no-action alternative.

Furthermore, it is worthy to note that the Developable Acreage shown in Table 1 is primary located in the northern basin where current flooding depths are relatively shallow. Land located in the deep floodplain in the southern portion of the basin is not removed from the floodplain under either alternative, and is therefore not included in the acreage estimates noted in Table 1.

ECONOMIC AND MARKET DRIVERS

Development does not occur in the absence of demand. Land use in the basin is primarily dominated by agricultural uses. This type of land use does not support rapid, urbanized growth. Furthermore, the necessary public infrastructure (i.e. roadways, water/sewer systems, utilities, etc) do not exist, and would require a substantial investment from the State, County, and development community. This type of investment is not and likely will not be warranted due to the lack of demand from consumers to develop land outside the Yuba City.

The projected growth rates from CDOF and BCAG are reasonable based on historical growth data in the basin, and are further supported by forward-looking statements in each County's General Plan:

Sutter County's General Plan states "A majority of the County has historically been set aside for agriculture and other resource uses, with rural development focused within the County's unincorporated communities. Urban growth has largely been directed to the incorporated cities, Yuba City and Live Oak. The 2030 General

Plan supports a broad continuation of the current land use pattern, while affording new opportunities for growth and change. It balances the County's vision to maintain and enhance its high quality rural lifestyle, agricultural heritage, and natural resources, with a commitment to promoting a vibrant and sustainable economy that attracts diverse jobs and services. It does so by advocating managed growth that is comprehensively planned, efficient, and compatible with adjacent uses and valued resources".

Similarly, Butte County's vision statement in the General Plan indicates that "Agriculture and open space will continue to dominate Butte County's landscape and be an important part of the County's culture and economy."

As further discussed below, the visions in these General Plans provide the long-term vision to maintain the rural character of both Sutter and Butte Counties. These General Plans dictate where and what type of land uses are permitted; deviating from the General Plans involves a lengthy process, which would have to be funded by a developer.

DEVELOPMENT RESTRICTIONS

Various development restrictions are in place at the local, state, and federal levels as summarized below (Source: "Summary of Discretionary Approvals Requisite for Development in California" prepared by Downey Brand for SBFCA)

Local-Level Development Restrictions

State law requires that every city adopt a "general plan" that incorporates a long term framework for the physical development of the city itself, and any outlying land that is necessarily related to the city's land use planning. (Cal. Gov't Code § 65300.) While a city may add optional elements, each general plan must include seven mandatory elements; land use, circulation, housing, conservation, open space, noise, and safety. (Cal. Gov't Code § 65302.)

The general plan is considered the "constitution for all future development." (Lesher Communications, Inc. v. City of Walnut Creek, 52 Cal.3d 531, 540 (1990).) Furthermore, zoning ordinances are used to establish land uses included in a General Plan. Therefore, no development may occur within a given California city unless such development is consistent with the zoning and land use elements codified in a valid general plan. In the case where approving a land use decision would require amending the general plan, the city must follow a complicated procedure involving comment by numerous agencies and public hearings before the planning commission and city council. (Cal. Gov't Code § 65350 et seq.)

California's State Zoning Law gives all general law cities and counties the authority to divide land within a given entity's jurisdiction into use districts. (Cal. Gov't Code § 65800 et seq.) In addition, zoning laws allow a city or county to regulate the size and shape of physical structures. (See O'Loane v. O'Rourke, 231 Cal.App.2d 774, 780 (1965).) Zoning ordinances typically classify use districts into four different types: residential; commercial; industrial; and agricultural. Within each use category, the city may impose a different set of restrictions to regulate both the use to which a landowner may dedicate property and the size and placement of physical structures on the property. (See O'Loane, 231 Cal.App.2d at 780.) City and county zoning ordinances receive an extreme degree of deference from the courts, as they need only be "reasonably related" to the promotion of the public welfare. (See City of Del Mar v. City of San Diego, 133 Cal.App.3d 401, 409 (1982).)

Federal-Level Development Restrictions

Cities and counties participating in the National Flood Insurance Program (NFIP) must conform to Federal Emergency Management Agency regulations regarding approval of development and/or the type of development that may occur. These regulations have severe growth limiting measures for areas that are mapped in the 100-year floodplain. FEMA also incentivizes cities and counties (through reduced NFIP insurance rates) to limit or regulate development in the floodplain. Virtually all cities and counties in the State participate in the NFIP.

OTHER DEVELOPMENT RESTRICTIONS

WILLIAMSON ACT CONTRACTS

Sutter and Butte County participate in the Williamson Act agricultural land preservation program. The Williamson Act aims to preserve agricultural and open space lands by discouraging premature and unnecessary conversion to urban uses. In exchange for agreeing to maintain Williamson Act compatible land uses, landowners receive the benefit of reduced property tax rates from the County. Williamson Act contracts are voluntarily established between a landowner and the County and are automatically renewed every ten years, unless a notice of non-renewal is filed by the landowner.

A Williamson Act contract influences a landowner's ability to use, subdivide or separately sell any parcel of land under an existing contract. Compatible uses under the Williamson Act generally consist of agricultural (i.e. farming, ranching, grazing, timber) and related uses such as processing facilities. One single-family home and agricultural housing is also allowed under the Williamson Act. Subdividing, selling, or using property in a manner not compatible with the Williamson Act can have serious consequences.

There are three ways a landowner can terminate a Williamson Act contract: non-renewal, cancellation, and breach of contract.

Non-renewal is the preferred method of terminating a contract. On each anniversary date of a Williamson Act contract, the original ten year term of the contract is automatically renewed unless notice is given by the landowner. When notice is provided on or before September 30th, the contract shall expire nine years from December 31st of the year that notice was provided. Upon notice of non-renewal, tax rates are incrementally increased over the nine year period up to the fair market valuation assessment. While the tax rate changes during this period, the land use restriction maintain in effect until the contract expires.

A landowner may also terminate a contract by petitioning the County for immediate cancellation of a contract for all or a portion of the property. These requests are only granted under extraordinary circumstances and must be consistent with Williamson Act principles, or be shown to have significant public benefit. To invoke this method of contract termination, the local government is required to make specific statutory findings that the termination is consistent with the Williamson Act requirements and/or that the cancellation has significant public benefit. A cancellation penalty equal to 12 ½% of the unrestricted fair market value is assessed to the landowner if the petition is granted.

If property subject to the Williamson Act is developed, divided, or sold, it could be considered a material breach of the contract. This could result in contract non-renewal and related increase in the property tax rate. Additionally, a material breach of contract can result in a monetary penalty up to 25% of the unrestricted fair market value of the land, plus 25% of the value of any incompatible building and related improvements on the contracted land.

The local government may allow a lesser monetary penalty to be negotiated. Negotiating a lesser penalty involves the local government, the department and the landowner and could result in the monetary penalty being reduced to no less than 12½ percent of the unrestricted fair market value of the land and related improvements. The monetary penalty assessed is secured by a lien payable to the county treasurer. Simple interest of 10 percent per year will be assessed against any unpaid penalty after 60 days. Upon full payment of the lien, the local government will record a termination of contract by breach for the affected portion of land.

Table 7 – Williamson Act Contracts in Sutter Basin			
	Approx. Number of Parcels under Williamson Act Contracts	Approx. Acreage under Williamson Act Contracts	Approx. Average Annual Tax Benefit ($/ac)*
Butte County	190	16,800	$1,650
Sutter County	80	10,700	$1,650
Total	**270**	**27,500**	

*The average annual tax benefits can vary based on prime/non-prime land, and crop type.

In summary, the Williamson Act is intended to preserve the agricultural and open space resources in rural California. These contracts are typically renewed in ten year increments and offer participating landowners tax breaks on the assessed land value. While the consequences can have monetary impacts, there are several options available for landowners to terminate or non-renew these contracts.

AGRICULTURAL/CONSERVATION EASEMENTS

There are numerous agricultural and conservation easements within the Sutter Basin. These easements differ from the Williamson Act parcels in that the majority of the conservation easements are legal agreements between a landowner and a land trust that conserve agricultural or open space resources by permanently limiting future development. Conservation easements are tailor made to meet the needs of an individual landowner and can cover an entire parcel or portions of a property. Tax benefits and/or financial compensation are often available for grantors of conservation easements.

Conservation easements typically restrict development and subdivision to the degree that is necessary to protect the significant conservation values of that particular property. Some conservation easements include “home sites,” or areas known as “exclusions” where development is allowed. Generally, home sites or exclusions are small in size (1-2 acres) and located on areas low in conservation value. Landowners and land trusts work together to draft conservation easements that reflect both the landowner's desires and the need to protect conservation values. The majority of the agricultural & conservation easements in the Sutter Basin are held by US Fish and Wildlife Service or Wetlands America Trust (Ducks Unlimited).

Ag & conservation easements within the Sutter Basin were obtained from numerous sources. The California Department of Conservation (CDC) and the National Conservation Easement Database (NCED) provided GIS shapefiles for known easements within Sutter and Butte County. Sutter County also provided information on conservation easements within the County. Butte County was contacted but does not maintain GIS information on conservation easements within the County. Additionally, information requests were sent to: The Nature Conservancy, the Northern California Regional Land Trust, and Sutter & Butte County Resource Conservation Districts to obtain as much information as possible regarding existing easements in the Sutter Basin.

The conservation easement shapefile provided by Sutter County was compared against the data provided by the CDC and NCED to identify overlapping datasets. In general, the CDC shapefile did not specifically outline easements; rather it illustrated different types of farming in each county. The NCED shapefile had nearly all the same conservation easements as the file provided by Sutter County. The primary difference was that the NCED separated easements by permanent and temporary duration. All but one NCED conservation easement in the Sutter Basin is permanent. Furthermore, the National Conservation Easement Database website notes that their easements are generally permanent preservation easements. According to discussions with the Wildlife Conservation Board, Department of Fish & Game, and US Fish & Wildlife Service, the average fee paid to a landowner for an easement is approximately $1,000 - $2,000/acre, and varies depending on land use, location, and extent of the easement.

Table 8 – Ag/Conservation Easements in Sutter Basin								
	NCED Easements (Permanent)		NCED Easements (Temporary)		NCED Easements (Unknown)		Other Conservation Easements Provided by County (Unknown Duration)	
	No. Parcels	Approx. Acreage	No. Parcels	Approx. Acreage	No. Parcels	Approx. Acreage	No. Parcels	Approx. Acreage
Butte County	13	2900	0	0	0	0	0	0
Sutter County	35	3500	0	0	1	45	21	2500
Total	**48**	**6400**	**0**	**0**	**1**	**45**	**21**	**2500**

As noted above, these easements were generally found to be permanently attached to the specific parcels of land. Therefore, it is unlikely these parcels will be developed in the future, regardless of flood control improvements completed with the Sutter Basin.

CONCLUSION

The project alternatives proposed by the USACE indicate an increase in developable area ranging from approximately 88,000 acres to 100,000 acres. However, population and growth projections, as well as current zoning ordinances and land use practices in Sutter and Butte County's General Plan indicate more restrictive policies which will limit future development to approximately 60,000 acres – significantly less than the 71,800 acres projected to be available under the no-action alternative. This analysis has resulted in two primary conclusions:

1. These policies, combined with federal regulations, will limit the developable land to approximately 60,000 acres by 2070 under all alternatives, not within a range of 88,000 to 100,000 as shown in Table 1.
2. Historical growth and future projects indicate that economic and market drivers will continue to direct growth around existing urban centers (i.e. Yuba City).

Attachment 5: Project Costs and IDC Calculations

Detailed project costs and IDC Calculations for SB-7 (NED) and SB-8 (Recommended Plan) at 3.5% and 7% can be found beginning on the next page.

****TOTAL PROJECT COST SUMMARY****

10/10/2013

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE DRAFT FEASIBILITY REPORT, ALT. SB-7
PROJECT: Sutter Basin TPCS
LOCATION: CALIFORNIA

U. S. ARMY CORPS OF ENGINEER, SACRAMENTO DISTRICT
P.O.C.: JEREMIAH A. FROST, CHIEF, COST ENGINEERING SECTION

Current MCACES Estimate Prepared: 25-Jul-2013
Effective Price Level (EPL): 1-Oct-2013

PROGRAM YEAR(BUDGET EC) 2014
EFF. PRICE LEVEL DATE:1-Oct-2013

TOTAL PROJECT COST (FULLY FUNDED)

		ESTIMATED COST				PROJECT FIRST COST				TOTAL PROJECT COST (FULLY FUNDED) SPENT THRU: 1-Oct-2013				
WB NO.	Civil Works FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC. (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	COST ($K)	ESC. MIDPT(%)	COST ($K)	CNTG ($K)	FULLY FUNDED ($K)
Index Codes: 0 - no esc. applied; A - Administration; C - Combined indexes; All other codes used coincides with the Code of Accounts.														
		Contingency Applied To Remaining Cost Only												
	FEDERAL COSTS													
6	FISH & WILDLIFE FACILITIES	5,032	1,006	20	6,038	0.00	5,032	1,006	6,038	0	12	5,611	1,122	6,733
11	LEVEES & FLOODWALLS	176,205	63,717	36	239,922	0.00	176,205	63,717	239,922	0	11	196,085	70,906	266,991
18	CULT. RESRC. PRESERV. (1	1,655	598		2,253		1,655	598	2,253	0		1,841	665	2,506
	Data Recovery	1,200	433		1,633	0.00	1,200	433	1,633	0		1,334	482	1,816
	Inventory/Evaluation/Mitigation Costs	455	165	36	620	0.00	455	165	620	0	11	507	183	690
	SUBTOTAL FEDERAL & NON-FEDERAL CONSTRUCTION COSTS	182,892	65,321		248,213		182,892	65,321	248,213	0		203,537	72,693	276,230
1	LANDS & DAMAGES, Admin (2	6,952	348	5	7,300	0.00	6,952	348	7,300	0	17	8,168	408	8,576
30	PLAN/ENGINEERING/DESIGN	32,622	11,797	36	44,419	0.00	32,622	11,797	44,419	0	18	38,534	13,934	52,468
31	CONSTRUCTION MANAGE'MT	15,406	5,570	36	20,976	0.00	15,406	5,570	20,976	0	23	18,943	6,849	25,792
	SUBTOTAL FEDERAL & NON-FEDERAL CONTRIBUTION	237,872	83,036		320,908		237,872	83,036	320,908	0		269,182	93,884	363,066
	NON-FEDERAL CONTRIBUTION (-)	-48,533	-17,105		-65,638		-48,533	-17,105	-65,638	0		-56,289	-19,847	-76,136
	TOTAL FEDERAL COSTS	**$189,339**	**$65,931**		**$255,270**		**$189,339**	**$65,931**	**$255,270**	**$0**		**$212,893**	**$74,037**	**$286,930**
	NON-FEDERAL COSTS													
1	LANDS AND DAMAGES	31,811	10,579	33	42,390	0.00	31,811	10,579	42,390	0	8.5	34,523	11,481	46,004
2	RELOCATIONS	20,962	7,580		28,542		20,962	7,580	28,542	0		23,105	8,355	31,460
	Relocations Construction Cost	16,376	5,922	36	22,298	0.00	16,376	5,922	22,298	0	10	18,074	6,536	24,610
	Plan/Engineering/Design	2,948	1,066	36	4,014	0.00	2,948	1,066	4,014	0	8.8	3,209	1,160	4,369
	Construction Mangement	1,638	592	36	2,230	0.00	1,638	592	2,230	0	11	1,822	659	2,481
	SUBTOTAL NON-FEDERAL	52,773	18,159		70,932		52,773	18,159	70,932	0		57,628	19,836	77,464
	NON-FEDERAL CONTRIBUTION (+)	48,533	17,105		65,638		48,533	17,105	65,638	0		56,289	19,847	76,136
	TOTAL NON-FEDERAL COSTS	**$101,306**	**$35,264**		**$136,570**		**$101,306**	**$35,264**	**$136,570**	**$0**		**$113,917**	**$39,683**	**$153,600**
	TOTAL FEDERAL AND NON-FEDERAL COSTS	**$290,645**	**$101,195**		**$391,840**		**$290,645**	**$101,195**	**$391,840**	**$0**		**$326,810**	**$113,720**	**$440,530**

GENERAL NOTES

(1 Cultural Resources Preservation costs was provided by Cultural Resources Archaeologist.
(2 Federal administrative costs for non-Federal land acquisition.
(3 The Fully Funded cost estimate was prepared in compliance with Indexes used from CWCCIS reflecting OMB future rates Mar. 31, 2013
(4 01 Account for Land and Damages cost are from Real Estates.
(5 06 Account Fish and Wildlife Cost was provided by SPK Environmental Planning.
(6 30 Account Planning, Engineering and Design and 31 Account Construction Management cost was provided by its respective organizations.

CONTINGENCY RATIONALE

(A CONTINGENCIES USED WAS DERIVED BY THE COST RISK ANALYSIS PROCESS AND IS BASED ON A 80% CONFIDENCE LEVEL

______________________ **CHIEF, COST ENGINEERING**

TOTAL FEDERAL COSTS	**$286,930**
TOTAL NON-FEDERAL COSTS	**$153,600**
THE MAXIMUM PROJECT COSTS	**$440,530**

______________________ **PROJECT MANAGER**

______________________ **CHIEF, REAL ESTATE**

****TOTAL PROJECT COST SUMMARY****

10/10/2013

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE DRAFT FEASIBILITY REPORT, ALT. SB-8
PROJECT: Sutter Basin TPCS
LOCATION: CALIFORNIA

U. S. ARMY CORPS OF ENGINEER, SACRAMENTO DISTRICT
P.O.C.: JEREMIAH A. FROST, CHIEF, COST ENGINEERING SECTION

Current MCACES Estimate Prepared: 25-Jul-2013
Effective Price Level (EPL): 1-Oct-2013

WB NO.	Civil Works FEATURE DESCRIPTION		ESTIMATED COST: COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	PROGRAM YEAR(BUDGET EC) 2014 / EFF. PRICE LEVEL DATE:1-Oct-2013: ESC. (%)	PROJECT FIRST COST: COST ($K)	CNTG ($K)	TOTAL ($K)	TOTAL PROJECT COST (FULLY FUNDED): SPENT THRU: 1-Oct-2013 COST ($K)	ESC. MIDPT(%)	COST ($K)	CNTG ($K)	FULLY FUNDED ($K)
	Index Codes: 0 - no esc. applied; A - Administration; C - Combined indexes; All other codes used coincides with the Code of Accounts.														
			Contingency Applied To Remaining Cost Only												
	FEDERAL COSTS														
6	FISH & WILDLIFE FACILITIES		6,330	1,265	20	7,595	0.00	6,330	1,265	7,595	0	14	7,226	1,445	8,671
11	LEVEES & FLOODWALLS		306,367	106,488	35	412,855	0.00	306,367	106,488	412,855	0	13	347,604	120,821	468,425
18	CULT. RESRC. PRESERV. (1		3,030	1,076		4,106		3,030	1,076	4,106			3,399	1,207	4,606
	Federal Obligations from NED Cost.		1,655	598		2,253		1,655	598	2,253			1,841	665	2,506
	Data Recovery		1,200	433		1,633		1,200	433	1,633	0		1,334	482	1,816
	Inventory/Evaluation/Mitigation Costs		455	165		620		455	165	620	0		507	183	690
	Cost Beyond NED Cost.		1,375	478		1,853		1,375	478	1,853	0		1,558	542	2,100
	Data Recovery	18	1,000	348	35	1,348	0.00	1,000	348	1,348	0	13	1,134	394	1,528
	Inventory/Evaluation/Mitigation Costs	18	375	130	35	505	0.00	375	130	505	0	13	424	148	572
	SUBTOTAL FEDERAL & NON-FEDERAL CONSTRUCTION COSTS		315,727	108,829		424,556		315,727	108,829	424,556	0		358,229	123,473	481,702
1	LANDS & DAMAGES, Admin (2		11,143	557	5	11,700	0.00	11,143	557	11,700	0	22	13,549	677	14,226
30	PLAN/ENGINEERING/DESIGN		56,285	19,565	35	75,850	0.00	56,285	19,565	75,850	0	22	68,804	23,916	92,720
31	CONSTRUCTION MANAGE'MT		26,580	9,239	35	35,819	0.00	26,580	9,239	35,819	0	27	33,791	11,746	45,537
	SUBTOTAL FEDERAL & NON-FEDERAL CONTRIBUTION		409,735	138,190		547,925		409,735	138,190	547,925	0		474,373	159,812	634,185
	NON-FEDERAL CONTRIBUTION(-)		-220,396	-72,259		-292,655		-220,396	-72,259	-292,655	0		-261,480	-85,775	-347,255
	TOTAL FEDERAL NED COSTS		**$189,339**	**$65,931**		**$255,270**		**$189,339**	**$65,931**	**$255,270**	**$0**		**$212,893**	**$74,037**	**$286,930**
	NON-FEDERAL COSTS														
1	LANDS AND DAMAGES		41,795	11,751	28	53,546	0.00	41,795	11,751	53,546	0	11	46,222	12,995	59,217
2	RELOCATIONS		64,900	22,559		87,459		64,900	22,559	87,459	0		73,143	25,425	98,568
	Relocations Construction Cost		50,703	17,624	35	68,327	0.00	50,703	17,624	68,327	0	13	57,271	19,907	77,178
	Plan/Engineering/Design		9,127	3,172	35	12,299	0.00	9,127	3,172	12,299	0	11	10,123	3,519	13,642
	Construction Management		5,070	1,763	35	6,833	0.00	5,070	1,763	6,833	0	13	5,749	1,999	7,748
	SUBTOTAL NON-FEDERAL		106,695	34,310		141,005		106,695	34,310	141,005	0		119,365	38,420	157,785
	NON-FEDERAL CONTRIBUTION (+)		220,396	72,259		292,655		220,396	72,259	292,655	0		261,480	85,775	347,255
	Non-Federal Contribution - NED		48,533	17,105		65,638		48,533	17,105	65,638	0		56,289	19,847	76,136
	Additional Cost Above NED		171,863	55,154		227,017		171,863	55,154	227,017	0		205,191	65,928	271,119
	TOTAL NON-FEDERAL COSTS		**$327,091**	**$106,569**		**$433,660**		**$327,091**	**$106,569**	**$433,660**	**$0**		**$380,845**	**$124,195**	**$505,040**
	TOTAL FEDERAL AND NON-FEDERAL COSTS		**$516,430**	**$172,500**		**$688,930**		**$516,430**	**$172,500**	**$688,930**	**$0**		**$593,738**	**$198,232**	**$791,970**

GENERAL NOTES

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(2 Federal administrative costs for non-Federal land acquisition.
(3 The Fully Funded cost estimate was prepared in compliance with Indexes used from CWCCIS reflecting OMB future rates Mar. 31, 2013
(4 01 Account for Land and Damages cost are from Real Estates.
(5 06 Account Fish and Wildlife Cost was provided by SPK Environmental Planning.
(6 30 Account Planning, Engineering and Design and 31 Account Construction Management cost was provided by its respective organizations.

(A CONTINGENCIES USED WAS DERIVED BY THE COST RISK ANALYSIS PROCESS AND IS BASED ON A 80% CONFIDENCE LEVEL

	DOLLAR(K)
TOTAL FEDERAL COSTS	**$286,930**
TOTAL NON-FEDERAL COSTS	**$505,040**
THE MAXIMUM PROJECT COSTS	**$791,970**

______________________________ **CHIEF, COST ENGINEERING**

______________________________ **PROJECT MANAGER**

______________________________ **CHIEF, REAL ESTATE**

DETAILED ESTIMATE OF INTEREST DURING CONSTRUCTION						
PROJECT: Sutter Basin_NED (Alt SB7) **LOCATION: CALIFORNIA** **INTEREST RATE: 3.500%**						
ACCOUNT NUMBER	**DESCRIPTION**	**AMOUNT ($)**	**CONTRACT START DATE**	**CONTRACT END DATE**	**PLANT USAGE DATE**	**INTEREST DURING CONSTRUCTION**
	Effective Price Level (EPL): 1-Oct-2013					
	FEDERAL COSTS					
1	LANDS AND DAMAGES, Administration	7,300,000				985,728
		7,300,000	3-Feb-2016	4-Feb-2020	Oct-21	985,728
6	FISH & WILDLIFE FACILITIES	6,038,000				488,264
3--	WILDLIFE FACILITIES & SANCTUARIES					
	Contract A (Reach 2-5)	2,012,000	4-Feb-2020	15-Sep-2021	Oct-21	59,915
	Contract Star Bend FIP (Reach 6)	24,000	5-Feb-2019	13-Jun-2020	Oct-21	1,691
	Contract B (Reach 7-12)	1,633,000	5-Feb-2019	14-Sep-2020	Oct-21	107,484
	Contract C1 (Reach 13-18)	1,590,000	3-Feb-2017	24-Oct-2018	Oct-21	222,227
	Contract C2 (Reach 19-21)	779,000	5-Feb-2018	3-Aug-2018	Oct-21	96,947
11	LEVEES AND FLOODWALLS	239,922,000				20,353,675
	Contract A (Reach 2-5)	66,563,000	4-Feb-2020	15-Sep-2021	Oct-21	1,982,168
	Contract Star Bend FIP (Reach 6)	9,010,000	5-Feb-2019	13-Jun-2020	Oct-21	634,857
	Contract B (Reach 7-12)	64,199,000	5-Feb-2019	14-Sep-2020	Oct-21	4,225,588
	Contract C1 (Reach 13-18)	68,388,000	3-Feb-2017	24-Oct-2018	Oct-21	9,558,261
	Contract C2 (Reach 19-21)	31,762,000	5-Feb-2018	3-Aug-2018	Oct-21	3,952,801
18	CULTURAL RESOURCE PRES. (NO IDC)	1,633,000				
18	CULTURAL RESOURCE PRES.	620,000				52,926
	COST SUBJECT TO (IDC)	620,000	3-Feb-2017	15-Sep-2021	Oct-21	52,926
30	PLANNING, ENGR. & DESIGN	44,419,000				5,807,164
		44,419,000	1-Oct-2014	1-Oct-2021	Oct-21	5,807,164
31	CONSTRUCTION MANAGEMENT	20,976,000				1,773,890
		20,976,000	3-Feb-2017	1-Oct-2021	Oct-21	1,773,890
CASH CONTRIBUTION (-)		65,638,000	Feb-17		Oct-21	5,550,847
TOTAL FEDERAL COST		**$255,270,000**				**$23,910,800**
	NON-FEDERAL COSTS					
1	LANDS AND DAMAGES	42,390,000				5,723,976
		42,390,000	3-Feb-2016	4-Feb-2020	Oct-21	5,723,976
2	RELOCATIONS	22,298,000				2,256,149
	Constr. Activities	22,298,000				2,256,149
1--	ROADS					
	Contract B (Reach 7-12)	422,000	5-Feb-2019	14-Sep-2020	Oct-21	27,776
	Contract C1 (Reach 13-18)	2,003,000	3-Feb-2017	24-Oct-2018	Oct-21	279,950
3--	CEMETERIES, UTILITIES, & STRUCTURES					
	Contract A (Reach 2-5)	3,977,000	4-Feb-2020	15-Sep-2021	Oct-21	118,430
	Contract Star Bend FIP (Reach 6)	1,732,000	5-Feb-2019	13-Jun-2020	Oct-21	122,039
	Contract B (Reach 7-12)	2,366,000	5-Feb-2019	14-Sep-2020	Oct-21	155,730
	Contract C1 (Reach 13-18)	5,482,000	3-Feb-2017	24-Oct-2018	Oct-21	766,193
	Contract C2 (Reach 19-21)	5,780,000	5-Feb-2018	3-Aug-2018	Oct-21	719,325
	Contract C2 (Reach 19-21)	536,000	5-Feb-2018	3-Aug-2018	Oct-21	66,706
30	PLANNING, ENGR. & DESIGN	4,014,000				524,774
		4,014,000	1-Oct-2014	1-Oct-2021	Oct-21	524,774
31	CONSTRUCTION MANAGEMENT	2,230,000				188,586
		2,230,000	3-Feb-2017	Oct-21	Oct-21	188,586
CASH CONTRIBUTION (+)		65,638,000	3-Feb-2017		Oct-21	5,550,847
TOTAL NON-FEDERAL		**$136,570,000**				**$14,244,332**
TOTAL		**$391,840,000**				**$38,155,132**

DETAILED ESTIMATE OF INTEREST DURING CONSTRUCTION

PROJECT: Sutter Basin_NED (Alt SB7)
LOCATION: CALIFORNIA
INTEREST RATE: 7.000%

ACCOUNT NUMBER	DESCRIPTION	AMOUNT ($)	CONTRACT START DATE	CONTRACT END DATE	PLANT USAGE DATE	INTEREST DURING CONSTRUCTION
	Effective Price Level (EPL): 1-Oct-2013					
	FEDERAL COSTS					
1	LANDS AND DAMAGES, Administration	7,300,000				2,078,228
		7,300,000	3-Feb-2016	4-Feb-2020	Oct-21	2,078,228
6	FISH & WILDLIFE FACILITIES	6,038,000				1,010,731
3--	WILDLIFE FACILITIES & SANCTUARIES					
	Contract A (Reach 2-5)	2,012,000	4-Feb-2020	15-Sep-2021	Oct-21	119,853
	Contract Star Bend FIP (Reach 6)	24,000	5-Feb-2019	13-Jun-2020	Oct-21	3,441
	Contract B (Reach 7-12)	1,633,000	5-Feb-2019	14-Sep-2020	Oct-21	218,390
	Contract C1 (Reach 13-18)	1,590,000	3-Feb-2017	24-Oct-2018	Oct-21	466,923
	Contract C2 (Reach 19-21)	779,000	5-Feb-2018	3-Aug-2018	Oct-21	202,124
11	LEVEES AND FLOODWALLS	239,922,000				42,166,801
	Contract A (Reach 2-5)	66,563,000	4-Feb-2020	15-Sep-2021	Oct-21	3,965,107
	Contract Star Bend FIP (Reach 6)	9,010,000	5-Feb-2019	13-Jun-2020	Oct-21	1,291,896
	Contract B (Reach 7-12)	64,199,000	5-Feb-2019	14-Sep-2020	Oct-21	8,585,670
	Contract C1 (Reach 13-18)	68,388,000	3-Feb-2017	24-Oct-2018	Oct-21	20,082,965
	Contract C2 (Reach 19-21)	31,762,000	5-Feb-2018	3-Aug-2018	Oct-21	8,241,163
18	CULTURAL RESOURCE PRES. (NO IDC)	1,633,000				
18	CULTURAL RESOURCE PRES.	620,000				109,769
	COST SUBJECT TO (IDC)	620,000	3-Feb-2017	15-Sep-2021	Oct-21	109,769
30	PLANNING, ENGR. & DESIGN	44,419,000				12,396,577
		44,419,000	1-Oct-2014	1-Oct-2021	Oct-21	12,396,577
31	CONSTRUCTION MANAGEMENT	20,976,000				3,679,032
		20,976,000	3-Feb-2017	1-Oct-2021	Oct-21	3,679,032
	CASH CONTRIBUTION (-)	65,638,000	Feb-17		Oct-21	11,512,409
	TOTAL FEDERAL COST	**$255,270,000**				**$49,928,729**
	NON-FEDERAL COSTS					
1	LANDS AND DAMAGES	42,390,000				12,067,957
		42,390,000	3-Feb-2016	4-Feb-2020	Oct-21	12,067,957
2	RELOCATIONS	22,298,000				4,694,952
	Constr. Activities	22,298,000				4,694,952
1--	ROADS					
	Contract B (Reach 7-12)	422,000	5-Feb-2019	14-Sep-2020	Oct-21	56,436
	Contract C1 (Reach 13-18)	2,003,000	3-Feb-2017	24-Oct-2018	Oct-21	588,205
3--	CEMETERIES, UTILITIES, & STRUCTURES					
	Contract A (Reach 2-5)	3,977,000	4-Feb-2020	15-Sep-2021	Oct-21	236,907
	Contract Star Bend FIP (Reach 6)	1,732,000	5-Feb-2019	13-Jun-2020	Oct-21	248,342
	Contract B (Reach 7-12)	2,366,000	5-Feb-2019	14-Sep-2020	Oct-21	316,418
	Contract C1 (Reach 13-18)	5,482,000	3-Feb-2017	24-Oct-2018	Oct-21	1,609,856
	Contract C2 (Reach 19-21)	5,780,000	5-Feb-2018	3-Aug-2018	Oct-21	1,499,714
	Contract C2 (Reach 19-21)	536,000	5-Feb-2018	3-Aug-2018	Oct-21	139,074
30	PLANNING, ENGR. & DESIGN	4,014,000				1,120,238
		4,014,000	1-Oct-2014	1-Oct-2021	Oct-21	1,120,238
31	CONSTRUCTION MANAGEMENT	2,230,000				391,125
		2,230,000	3-Feb-2017	Oct-21	Oct-21	391,125
	CASH CONTRIBUTION (+)	65,638,000	3-Feb-2017		Oct-21	11,512,409
	TOTAL NON-FEDERAL	**$136,570,000**				**$29,786,681**
	TOTAL	**$391,840,000**				**$79,715,410**

DETAILED ESTIMATE OF INTEREST DURING CONSTRUCTION

PROJECT: Sutter Basin_LPP (Alt SB8)
LOCATION: CALIFORNIA
INTEREST RATE: 3.500%

ACCOUNT NUMBER	DESCRIPTION	AMOUNT ($)	CONTRACT START DATE	CONTRACT END DATE	PLANT USAGE DATE	INTEREST DURING CONSTRUCTION
	Effective Price Level (EPL): 1-Oct-2013					
	FEDERAL COSTS					
1	LANDS AND DAMAGES, Administration	11,700,000				2,057,605
		11,700,000	3-Feb-2016	4-Feb-2022	Oct-23	2,057,605
6	FISH & WILDLIFE FACILITIES	7,595,000				845,220
3--	WILDLIFE FACILITIES & SANCTUARIES					
	Contract A (Reach 2-5)	2,012,000	4-Feb-2022	15-Sep-2023	Oct-23	59,816
	Contract Star Bend FIP (Reach 6)	24,000	5-Feb-2021	14-Jun-2022	Oct-23	1,689
	Contract B (Reach 7-12)	1,633,000	5-Feb-2021	14-Sep-2022	Oct-23	107,402
	Contract C1 (Reach 13-18)	1,590,000	3-Feb-2017	24-Oct-2018	Oct-23	351,302
	Contract C2 (Reach 19-25)	779,000	2-Feb-2018	8-Nov-2019	Oct-23	139,353
	Contract D1 (Reach 26-33)	649,000	4-Feb-2019	26-Oct-2020	Oct-23	90,569
	Contract D2 (Reach 34-41)	908,000	3-Feb-2020	16-Aug-2021	Oct-23	95,089
	Contract C2 (Reach 19-25)	0	2-Feb-2018	8-Nov-2019	Oct-23	0
11	LEVEES AND FLOODWALLS	412,855,000				50,784,138
	Contract A (Reach 2-5)	65,879,000	4-Feb-2022	15-Sep-2023	Oct-23	1,958,572
	Contract Star Bend FIP (Reach 6)	8,917,000	5-Feb-2021	14-Jun-2022	Oct-23	627,405
	Contract B (Reach 7-12)	63,539,000	5-Feb-2021	14-Sep-2022	Oct-23	4,178,926
	Contract C1 (Reach 13-18)	66,594,000	3-Feb-2017	24-Oct-2018	Oct-23	14,713,608
	Contract C2 (Reach 19-25)	61,300,000	2-Feb-2018	8-Nov-2019	Oct-23	10,965,805
	Contract D1 (Reach 26-33)	85,696,000	4-Feb-2019	26-Oct-2020	Oct-23	11,958,996
	Contract D2 (Reach 34-41)	60,930,000	3-Feb-2020	16-Aug-2021	Oct-23	6,380,826
18	CULTURAL RESOURCE PRES. (NO IDC)	1,633,000				
18	CULTURAL RESOURCE PRES.	2,473,000				402,281
	COST SUBJECT TO (IDC)	2,473,000	3-Feb-2017	15-Sep-2021	Oct-23	402,281
30	PLANNING, ENGR. & DESIGN	75,850,000				13,058,248
		75,850,000	1-Oct-2014	1-Oct-2023	Oct-23	13,058,248
31	CONSTRUCTION MANAGEMENT	35,819,000				5,796,084
		35,819,000	3-Feb-2017	1-Oct-2021	Oct-23	5,796,084
	CASH CONTRIBUTION (-)	292,655,000	Feb-17		Oct-23	36,225,004
	TOTAL FEDERAL COST	**$255,270,000**				**$36,718,572**
	NON-FEDERAL COSTS					
1	LANDS AND DAMAGES	53,546,000				9,416,796
		53,546,000	3-Feb-2016	4-Feb-2022	Oct-23	9,416,796
2	RELOCATIONS	68,327,000				8,945,230
	Constr. Activities	68,327,000				8,945,230
1--	ROADS					
	Contract B (Reach 7-12)	418,000	5-Feb-2021	14-Sep-2022	Oct-23	27,492
	Contract C1 (Reach 13-18)	1,982,000	3-Feb-2017	24-Oct-2018	Oct-23	437,913
	Contract C2 (Reach 19-25)	445,000	2-Feb-2018	8-Nov-2019	Oct-23	79,605
	Contract D1 (Reach 26-33)	168,000	4-Feb-2019	26-Oct-2020	Oct-23	23,445
	Contract D2 (Reach 34-41)	383,000	3-Feb-2020	16-Aug-2021	Oct-23	40,109
3--	CEMETERIES, UTILITIES, & STRUCTURES					
	Contract A (Reach 2-5)	3,936,000	4-Feb-2022	15-Sep-2023	Oct-23	117,017
	Contract Star Bend FIP (Reach 6)	1,714,000	5-Feb-2021	14-Jun-2022	Oct-23	120,598
	Contract B (Reach 7-12)	2,342,000	5-Feb-2021	14-Sep-2022	Oct-23	154,032
	Contract C1 (Reach 13-18)	5,425,000	3-Feb-2017	24-Oct-2018	Oct-23	1,198,626
	Contract C2 (Reach 19-25)	6,283,000	2-Feb-2018	8-Nov-2019	Oct-23	1,123,950
	Contract D1 (Reach 26-33)	22,321,000	4-Feb-2019	26-Oct-2020	Oct-23	3,114,927
	Contract D2 (Reach 34-41)	20,397,000	3-Feb-2020	16-Aug-2021	Oct-23	2,136,053
	Contract C2 (Reach 19-25)	528,000	2-Feb-2018	8-Nov-2019	Oct-23	94,453
	Contract D1 (Reach 26-33)	1,985,000	4-Feb-2019	26-Oct-2020	Oct-23	277,010
30	PLANNING, ENGR. & DESIGN	12,299,000				2,117,382
		12,299,000	1-Oct-2014	1-Oct-2023	Oct-23	2,117,382
31	CONSTRUCTION MANAGEMENT	6,833,000				845,793
		6,833,000	3-Feb-2017	Oct-23	Oct-23	845,793
	CASH CONTRIBUTION (+)	292,655,000	3-Feb-2017		Oct-23	36,225,004

DETAILED ESTIMATE OF INTEREST DURING CONSTRUCTION(CONT'ED)						
ACCOUNT NUMBER	DESCRIPTION	AMOUNT ($)	CONTRACT START DATE	CONTRACT END DATE	PLANT USAGE DATE	INTEREST DURING CONSTRUCTION
		Effective Price Level (EPL): 1-Oct-2013				
	TOTAL NON-FEDERAL	$433,660,000				$57,550,205
	TOTAL	$688,930,000				$94,268,777

DETAILED ESTIMATE OF INTEREST DURING CONSTRUCTION						
PROJECT: Sutter Basin_LPP (Alt SB8) **LOCATION: CALIFORNIA** **INTEREST RATE: 7.000%**						
ACCOUNT NUMBER	**DESCRIPTION**	**AMOUNT ($)**	**CONTRACT START DATE**	**CONTRACT END DATE**	**PLANT USAGE DATE**	**INTEREST DURING CONSTRUCTION**
	Effective Price Level (EPL): 1-Oct-2013					
	FEDERAL COSTS					
1	LANDS AND DAMAGES, Administration	11,700,000				4,443,038
		11,700,000	3-Feb-2016	4-Feb-2022	Oct-23	4,443,038
6	FISH & WILDLIFE FACILITIES	7,595,000				1,791,104
3--	WILDLIFE FACILITIES & SANCTUARIES					
	Contract A (Reach 2-5)	2,012,000	4-Feb-2022	15-Sep-2023	Oct-23	119,652
	Contract Star Bend FIP (Reach 6)	24,000	5-Feb-2021	14-Jun-2022	Oct-23	3,436
	Contract B (Reach 7-12)	1,633,000	5-Feb-2021	14-Sep-2022	Oct-23	218,215
	Contract C1 (Reach 13-18)	1,590,000	3-Feb-2017	24-Oct-2018	Oct-23	764,971
	Contract C2 (Reach 19-25)	779,000	2-Feb-2018	8-Nov-2019	Oct-23	297,939
	Contract D1 (Reach 26-33)	649,000	4-Feb-2019	26-Oct-2020	Oct-23	190,279
	Contract D2 (Reach 34-41)	908,000	3-Feb-2020	16-Aug-2021	Oct-23	196,612
	Contract C2 (Reach 19-25)	0	2-Feb-2018	8-Nov-2019	Oct-23	0
11	LEVEES AND FLOODWALLS	412,855,000				107,487,670
	Contract A (Reach 2-5)	65,879,000	4-Feb-2022	15-Sep-2023	Oct-23	3,917,774
	Contract Star Bend FIP (Reach 6)	8,917,000	5-Feb-2021	14-Jun-2022	Oct-23	1,276,671
	Contract B (Reach 7-12)	63,539,000	5-Feb-2021	14-Sep-2022	Oct-23	8,490,607
	Contract C1 (Reach 13-18)	66,594,000	3-Feb-2017	24-Oct-2018	Oct-23	32,039,290
	Contract C2 (Reach 19-25)	61,300,000	2-Feb-2018	8-Nov-2019	Oct-23	23,444,990
	Contract D1 (Reach 26-33)	85,696,000	4-Feb-2019	26-Oct-2020	Oct-23	25,124,971
	Contract D2 (Reach 34-41)	60,930,000	3-Feb-2020	16-Aug-2021	Oct-23	13,193,367
18	CULTURAL RESOURCE PRES. (NO IDC)	1,633,000				
18	CULTURAL RESOURCE PRES.	2,473,000				859,615
	COST SUBJECT TO (IDC)	2,473,000	3-Feb-2017	15-Sep-2021	Oct-23	859,615
30	PLANNING, ENGR. & DESIGN	75,850,000				28,592,558
		75,850,000	1-Oct-2014	1-Oct-2023	Oct-23	28,592,558
31	CONSTRUCTION MANAGEMENT	35,819,000				12,382,872
		35,819,000	3-Feb-2017	1-Oct-2021	Oct-23	12,382,872
CASH CONTRIBUTION (-)		292,655,000	Feb-17		Oct-23	76,997,295
TOTAL FEDERAL COST		**$255,270,000**				**$78,559,562**
	NON-FEDERAL COSTS					
1	LANDS AND DAMAGES	53,546,000				20,333,926
		53,546,000	3-Feb-2016	4-Feb-2022	Oct-23	20,333,926
2	RELOCATIONS	68,327,000				18,862,069
	Constr. Activities	68,327,000				18,862,069
1--	ROADS					
	Contract B (Reach 7-12)	418,000	5-Feb-2021	14-Sep-2022	Oct-23	55,857
	Contract C1 (Reach 13-18)	1,982,000	3-Feb-2017	24-Oct-2018	Oct-23	953,567
	Contract C2 (Reach 19-25)	445,000	2-Feb-2018	8-Nov-2019	Oct-23	170,196
	Contract D1 (Reach 26-33)	168,000	4-Feb-2019	26-Oct-2020	Oct-23	49,255
	Contract D2 (Reach 34-41)	383,000	3-Feb-2020	16-Aug-2021	Oct-23	82,932
3--	CEMETERIES, UTILITIES, & STRUCTURES					
	Contract A (Reach 2-5)	3,936,000	4-Feb-2022	15-Sep-2023	Oct-23	234,071
	Contract Star Bend FIP (Reach 6)	1,714,000	5-Feb-2021	14-Jun-2022	Oct-23	245,398
	Contract B (Reach 7-12)	2,342,000	5-Feb-2021	14-Sep-2022	Oct-23	312,957
	Contract C1 (Reach 13-18)	5,425,000	3-Feb-2017	24-Oct-2018	Oct-23	2,610,042
	Contract C2 (Reach 19-25)	6,283,000	2-Feb-2018	8-Nov-2019	Oct-23	2,403,016
	Contract D1 (Reach 26-33)	22,321,000	4-Feb-2019	26-Oct-2020	Oct-23	6,544,232
	Contract D2 (Reach 34-41)	20,397,000	3-Feb-2020	16-Aug-2021	Oct-23	4,416,628
	Contract C2 (Reach 19-25)	528,000	2-Feb-2018	8-Nov-2019	Oct-23	201,941
	Contract D1 (Reach 26-33)	1,985,000	4-Feb-2019	26-Oct-2020	Oct-23	581,977
30	PLANNING, ENGR. & DESIGN	12,299,000				4,636,254
		12,299,000	1-Oct-2014	1-Oct-2023	Oct-23	4,636,254
31	CONSTRUCTION MANAGEMENT	6,833,000				1,797,757
		6,833,000	3-Feb-2017	Oct-23	Oct-23	1,797,757
CASH CONTRIBUTION (+)		292,655,000	3-Feb-2017		Oct-23	76,997,295

DETAILED ESTIMATE OF INTEREST DURING CONSTRUCTION(CONT'ED)						
ACCOUNT NUMBER	DESCRIPTION	AMOUNT ($)	CONTRACT		PLANT USAGE DATE	INTEREST DURING CONSTRUCTION
			START DATE	END DATE		
	Effective Price Level (EPL): 1-Oct-2013					
TOTAL NON-FEDERAL		$433,660,000				$122,627,301
TOTAL		$688,930,000				$201,186,863