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Development of HEC-FIA Models for the Phase I Sacramento and San Joaquin Rivers Basin Study

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14. ABSTRACT
This report documents HEC's efforts to develop the Phase I Flood Impact Analysis models for the Sacramento District in support of the Sacramento and San Joaquin River Basins Comprehensive Study. HEC-FIA models were developed for the 1995 and 1997 events.

15. SUBJECT TERMS
Flood impacts, flood damage, area flooded, urban damage, crop damage, flood events, rating functions, watersheds, subbasins, congressional districts, counties, projects, reservoirs, levees, flood stage

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Acknowledgements

The flood impact analysis modeling for Phase I of the Sacramento and San Joaquin Rivers Basin Comprehensive Study was performed at the Hydrologic Engineering Center (HEC). The Corps' HEC-FIA, Flood Impact Analysis, program was used to evaluate the flood impacts of the 1995 and 1997 flood events. The development of the model and the writing of this report were made possible through the contributions of many people. Ms. Penni Baker was responsible for the technical coordination of debugging the code and testing the models. Ms. Judy Cheng performed the word processing tasks associated with the report and Mr. Cameron Ackerman worked diligently incorporating HEC-FIA output tables into this report. Mr. Chris Dunn was the team leader of the modeling effort.

Other HEC staff involvement included Mr. Michael Burnham, Chief, Planning Analysis Division. He not only provided general direction in the modeling effort but was also instrumental in the verification and calibration portion of the modeling. Mr. Darryl Davis was the HEC Director during the modeling effort.

Members of the Sacramento District office who assisted with the study were Messrs. Michael Deering, Kurt Keilman, Ron Milligan, and Larry Dacus. Mr. Deering helped to develop the initial FIA model. Mr. Keilman provided the flood damage information used in the model. Messers. Milligan and Dacus provided direction for the modeling effort and assisted with the logistics of the study.

Several people outside of HEC contributed to the HEC-FIA modeling effort. Messrs. Shannon Newbold and John DeGeorge of Resource Management Associates (RMA) developed the graphical user interface, converted the HEC-PBA Fortran algorithms into JAVA, and assisted with the debugging and the overall program design. Mr. Jason Needham of David Ford Consulting Engineers, assisted with the accumulation of the data and with populating the HEC-FIA models with data.

I. Introduction

A. General

This report documents the Hydrologic Engineering Center's (HEC) efforts to develop the Phase I flood impact analysis models for the Sacramento District in support of the Sacramento and San Joaquin Rivers Basins Comprehensive Study. HEC's objectives were to provide hydrologic and hydraulic technical and analytical assistance and prepare the flood damage analysis models to assist in post flood evaluations of the Sacramento and San Joaquin Rivers Basins. Specifically, HEC was to identify and assemble data for input into HEC's Flood Impact Analysis modeling software (HEC-FIA), execute HEC-FIA for the purpose of evaluating four historic floods (1983, 1986, 1995 and 1997) and report on the results.

B. Authorization

The Sacramento and San Joaquin Rivers Basins Comprehensive Study is being conducted in part under the House of Representatives report (105-190) on the 1998 Energy and Water Development Appropriations Bill.

C. Location

The study area is comprised of the Central Valley of California and includes both the Sacramento and San Joaquin Rivers Basins. The study area extends from the Shasta Dam in the north and from the upper reaches of the Fresno River in the south to the area known as the Delta at its outlet, See Figure 1, Study Area.

II. Flood Impact Analysis Model (HEC-FIA)

Before the Sacramento and San Joaquin study is discussed, a brief introduction of the FIA model is provided.

The Flood Impact Analysis Model (HEC-FIA) provides state-of-the-art techniques to calculate post-flood or forecasted-flood damages and to determine the flood damage reduction benefits attributed to flood control projects. It updates and replaces the earlier HEC-PBA, Project Benefit Accomplishment, software package.

HEC-FIA is used to assist with: (1) development of system-wide project operation rules and strategies; (2) real-time flood operation decision-support activities; (3) provide immediate post-flood impact assessments for disaster relief and assistance; and, (4) perform post-flood and annual assessments of Corps project benefit accomplishments. The two types of Corps projects considered in this study are levees and reservoirs. Analyses are performed system-wide and are based on specified

Figure 1: Sacramento & San Joaquin Rivers Study Areas

continuous or single event observed or forecasted hydrographs, and the potential impacts associated with urban and agricultural flood damage, number of structures, and population. As part of the Corps' Water Control Data System (WCDS), HEC-FIA is used to support decision making while floods are occurring and compute flood damages and project accomplishments following the flood event. Output reports are based on impact summaries associated with specific areas and boundaries such as: impact area, states, Corps Districts, counties, communities, and watersheds. Alternative scenarios may also be compared.

HEC-FIA is part of HEC's "Next Generation" (NexGen) effort, which is an integrated system of software, designed for interactive use in a multi-tasking, multi-user environment. The program consists of a graphical user interface (GUI), hydrologic engineering and economics components, management capabilities, graphics and reporting facilities.

Input for HEC-FIA includes all information regarding impact areas and their boundaries, protection projects, crop-loss functions, urban-damage functions and other information. Stage- or flow-hydrographs, stage-discharge (rating) functions, crop loss functions and crop-duration loss functions, and/or elevation versus crop area, urban damage, number of structures and population can be input directly, retrieved from an HEC-DSS file, or generated from GIS.

In order to use HEC-FIA, a watershed is divided into impact areas. Impact areas define boundaries for data aggregation, analysis and reporting. They represent the smallest analysis units and are delineated by unique watershed jurisdictional, political, economic, and project criteria. Impact area boundary data in HEC-FIA includes the following: Corps Districts, state, county, township, community, congressional district, watershed, subbasin, and flood control district. The number of structures, impacted population and urban and agricultural damage categories must be entered for each impact area. Whenever appropriate, levee and reservoir projects and their associated accomplishments are defined for each impact area as well. Total values for the system are computed and displayed.

Stage or discharge hydrographs of flood events are required for each impact area. However, rating curves must be provided if discharge hydrographs are used. Using the hydrographs and the other input listed above, HEC-FIA compares the results of various alternative forecasts, operation policies, and flood damage reduction measures. The program calculates agricultural damage, urban damage, and project benefits. Project benefit accomplishments are computed as the difference between with-project conditions and without-Corps projects conditions. The benefits are then allocated among the various projects according to the user's input.

The impact values are accumulated by impact areas for the entire system. Display of the results, by event, by damage category and by project is output for the watershed and any political boundaries as specified by the user. Reports summarize information on damage, area flooded, number of structures and population flooded. Additionally, the project benefit accomplishment for the period analyzed is also reported.

III. Sacramento and San Joaquin FIA Data Requirements

A. Flood Impact Areas

The Sacramento District divided the Sacramento River System into 55 impact areas and the San Joaquin River system into 38 impact areas for a total of 93 impact areas. They developed flood impact area maps, which were then used throughout the study, see Figure 2, Sacramento Impact Areas, for an example of the impact area configurations. The area of each impact area was determined based on several factors. A major factor was the Federal Emergency Management Agency's (FEMA) .01 and .002 exceedance probability event floodplain mapping. Overlaying the floodplain mapping on parcel books and page maps, the impact areas were delineated. Some communities outside the .01 exceedance probability event but in areas that were still at significant risk of flooding from a potential levee failure were included in the study. HEC's task was to define these impact areas in HEC-FIA and develop the input needed to compute damage. The boundary information for each impact area are shown in Tables 1 and 2. The following sections detail how the input data were developed.

B. Hydrology

Originally, four flood events on the Sacramento and the San Joaquin Rivers were to have been studied: 1983, 1986, 1995 and 1997. However, due to a lack of identified data, the 1983 and 1986 events were not incorporated into this study. The analysis periods for the 1995 and 1997 flood events are: March 8-22, 1995 and December 26, 1996 though January 10, 1997, respectively.

HEC-FIA requires that each impact area be represented by a hydrograph for a given event in order to compute damages for that event. To help find these hydrographs, the HEC-DSS file supplied by the Sacramento District office was evaluated. This file provided stage data for most of the available gages in the Sacramento and San Joaquin systems. For consistency, gages were only selected if the stage data for both the 1995 and 1997 events could be obtained or derived. Not all of the impact areas had gages located next to them; therefore, other methods had to be used to generate stage hydrographs for these remaining impact areas. These methods are described below.

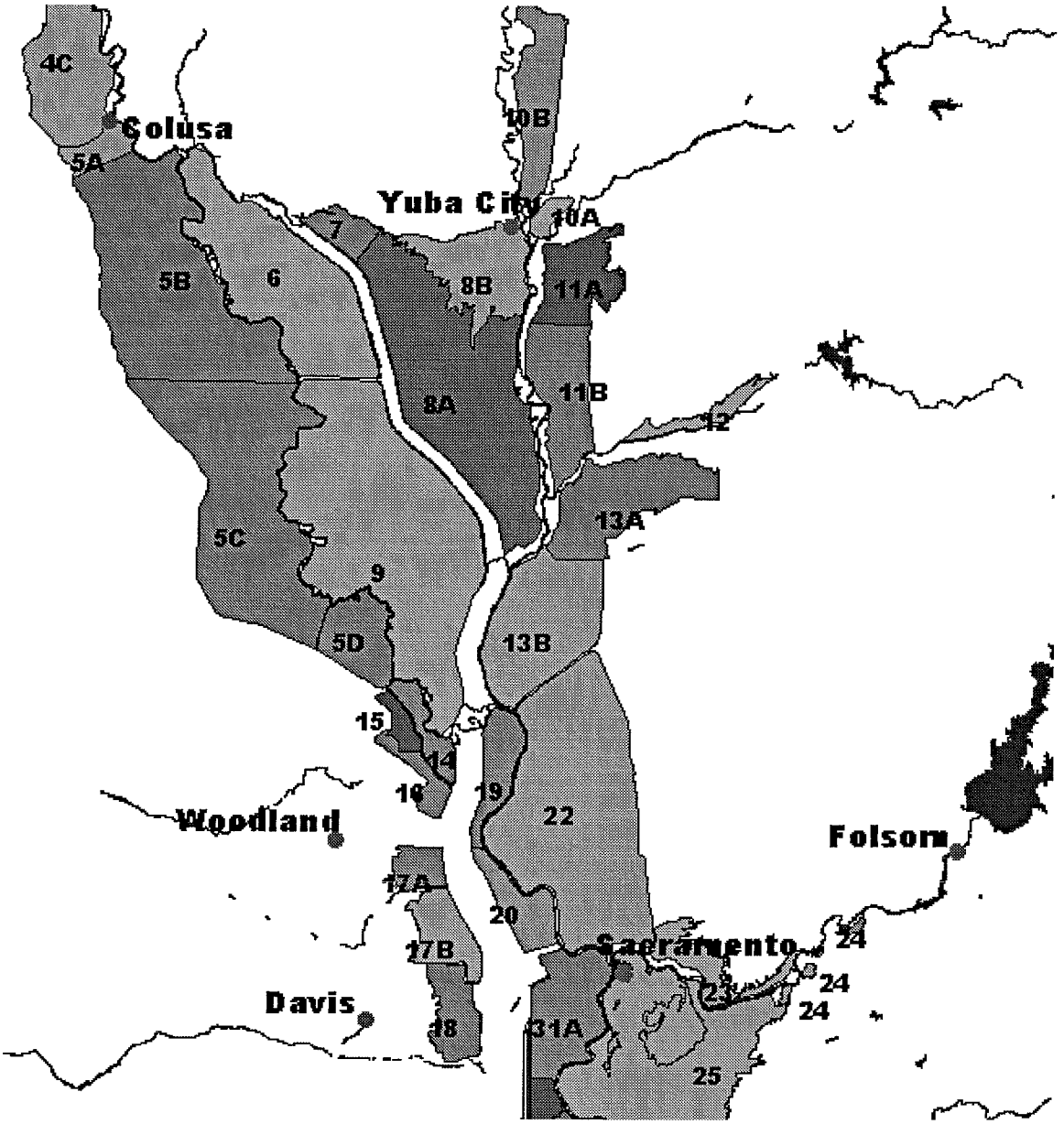

Figure 2: Sacramento Impact Areas

Table 1: Boundary Information for Impact Areas for Sacramento Study

Impact Area	Impact Area Desc.	Stream Name	Corps District	County	Watershed	Congressional District	Community	Flood District
Sac 24	East Sacramento Near	American River	Sacramento District	Sacramento	American River Water	District 11	Sacramento	none
Sac 23	North Sacramento	American River	Sacramento District	Sacramento	American River Water	District 5	Sacramento	none
Sac 12	Bear River at Wheatl	Bear River	Sacramento District	Yuba	Feather River Waters	District 2		RDs 537, 785, 827, 1
Sac 38	Cosumnes River	Cosumnes River	Sacramento District	Sacramento	Mokelumne River Wate	District 11		RDs 38, 341, 1601, 2
Sac 39	Cosumnes River	Cosumnes River	Sacramento District	San Joaquin	Mokelumne River Wate	District 11		RDs 3, 348, 349, 551
Sac08b	Yuba City Area Feath	Feather River	Sacramento District	Sutter	Feather River Waters	District 3	Yuba City	LD 1, RDs 9, 10, 784
Sac 10b	North of Marysville	Feather River	Sacramento District	Yuba	Feather River Waters	District 2		LD 1, RDs 9, 10, 784
Sac 10a	Marysville	Feather River	Sacramento District	Yuba	Yuba River Watershed	District 2	Marysville	LD 1, RDs 9, 10, 784
Sac 11a	Olivehurst / Linda A	Feather River	Sacramento District	Yuba	Feather River Waters	District 2	Olivehurst/Linda	LD 1, RDs 9, 10, 784
Sac 11b	Feather River South	Feather River	Sacramento District	Yuba	Feather River Waters	District 2		LD 1, RDs 9, 10, 784
Sac 13a	Feather River South	Feather River	Sacramento District	Sutter	Feather River Waters	District 3		LD 1, RDs 9, 10, 784
Sac 01a	Reading Reach	Sacramento River	Sacramento District	Tehama	Sacramento Watershed	District 3	Redding	none
Sac 26	Rural West Bank Area	Sacramento River	Sacramento District	Yolo	Sacramento Watershed	District 3		RDs 150, 307, 765, 8
Sac 07	Local Area	Sacramento River	Sacramento District	Sutter	Sacramento Watershed	District 3		none
Sac 25	Sacramento City	Sacramento River	Sacramento District	Sacramento	Sacramento Watershed	District 5	Sacramento	RDs 537, 785, 827, 1
Sac 41	Lower Sacramento Are	Sacramento River	Sacramento District	Sacramento	Sacramento Watershed	District 11		RDs 38, 341, 1601, 2
Sac 40	Local Area Sacrament	Sacramento River	Sacramento District	Sacramento	Sacramento Watershed	District 11		RDs 38, 341, 1601, 2
Sac 35	Sacramento River Are	Sacramento River	Sacramento District	Sacramento	Sacramento Watershed	District 11		RDs 38, 341, 1601, 2
Sac 34	Local Area Sacrament	Sacramento River	Sacramento District	Sacramento	Sacramento Watershed	District 11		RDs 3, 348, 349, 551
Sac 31	Area at South End Yo	Sacramento River	Sacramento District	Solano	Sacramento Watershed	District 3		RDs 501, 536, 1667,
Sac 33	Sacramento River Loc	Sacramento River	Sacramento District	Sacramento	Mokelumne River Wate	District 11		RDs 3, 348, 349, 551
Sac 32	Local Area Sacrament	Sacramento River	Sacramento District	Sacramento	Sacramento Watershed	District 11		RDs 3, 348, 349, 551
Sac 36	Small Local Area Sac	Sacramento River	Sacramento District	Sacramento	Mokelumne River Wate	District 11		RDs 38, 341, 1601, 2
Sac 37	Small Local Area Sac	Sacramento River	Sacramento District	Sacramento	Mokelumne River Wate	District 11		RDs 3, 348, 349, 551
Sac 28	Sacramento River Lev	Sacramento River	Sacramento District	Sacramento	Sacramento Watershed	District 11		RDs 3, 348, 349, 551
Sac 27	East Bank Sacramento	Sacramento River	Sacramento District	Sacramento	Sacramento Watershed	District 11		RDs 3, 348, 349, 551
Sac 21d	Large Rural Area Sou	Sacramento River	Sacramento District	Yolo	Sacramento Watershed	District 3		RDs 150, 307, 765, 8
Sac 21c	Rural Area South of	Sacramento River	Sacramento District	Yolo	Sacramento Watershed	District 3		RDs 3, 348, 349, 551
Sac 21b	Lisbon Area South of	Sacramento River	Sacramento District	Yolo	Sacramento Watershed	District 3		RDs 150, 307, 765, 8
Sac 21a	West Sacramento Area	Sacramento River	Sacramento District	Yolo	Sacramento Watershed	District 3	West Sacramento	RDs 150, 307, 765, 8
Sac 13b	Sacramento River at F	Sacramento River	Sacramento District	Sacramento	Sacramento Watershed	District 3		RDs 537, 785, 827, 1
Sac 22	Notomas	Sacramento River	Sacramento District	Sacramento	Sacramento Watershed	District 3	Notomas	RDs 537, 785, 827, 1
Sac 19	Sacramento River Bel	Sacramento River	Sacramento District	Yolo	Sacramento Watershed	District 3		RDs 537, 785, 827, 1
Sac 01b	Red Bluff Reach	Sacramento River	Sacramento District	Tehama	Sacramento Watershed	District 2	Red Bluff	none
Sac 02	Woodson Bridge to Or	Sacramento River	Sacramento District	Butte	Sacramento Watershed	District 2	Hamilton City	none
Sac 04a	Willows Reach	Sacramento River	Sacramento District	Glenn	Sacramento Watershed	District 3	Willows	LDs 1, 2, 3

Table 1: Boundary Information for Impact Areas for Sacramento Study

Impact Area	Impact Area Desc.	Stream Name	Corps District	County	Watershed	Congressional District	Community	Flood District
Sac 04b	Below Willows	Sacramento River	Sacramento District	Coulsa	Sacramento Watershed	District 3		LDs 1, 2, 3
Sac 03	Moulton Weir to abov	Sacramento River	Sacramento District	Glenn	Sacramento Watershed	District 3	Butte City	LDs 1, 2, 3
Sac 04c	Coulsa Weir Area	Sacramento River	Sacramento District	Coulsa	Sacramento Watershed	District 3		none
Sac 06	Ag Area above Tidsda	Sacramento River	Sacramento District	Sutter	Sacramento Watershed	District 3		RDs 70, 108, 730, 78
Sac 05b	Grimes Reach	Sacramento River	Sacramento District	Colusa	Sacramento Watershed	District 3	Grimes	RDs 70, 108, 730, 78
Sac 05c	Above Tidsdale Weir	Sacramento River	Sacramento District	Yolo	Sacramento Watershed	District 3		RDs 70, 108, 730, 78
Sac 14	Knights Landing to F	Sacramento River	Sacramento District	Yolo	Sacramento Watershed	District 3	Knights Landing	RDs 70, 108, 730, 78
Sac 05d	Local Area Upstream	Sacramento River	Sacramento District	Yolo	Sacramento Watershed	District 3		RDs 70, 108, 730, 78
Sac 05a	Colusa Reach at the	Sacramento river	Sacramento District	Colusa	Sacramento Watershed	District 3	Coulsa	none
Sac 09	Tidsdale to Freemoun	Sacramento river	Sacramento District	Sutter	Sacramento Watershed	District 3		RDs 70, 108, 730, 78
Sac08a	Area Between Sutter	Sutter Bypass	Sacramento District	Sutter	Feather River Waters	District 3		LD 1, RDs 9, 10, 784
Sac 29a	Local Area Nr. South	Yolo ByPass	Sacramento District	Solano	Sacramento Watershed	District 3		RDs 501, 536, 1667,
Sac 17a	Local Area Yolo Bypa	Yolo Bypass	Sacramento District	Yolo	Sacramento Watershed	District 3		RDs 537, 785, 827, 1
Sac 29b	Local Area NR. South	Yolo Bypass	Sacramento District	Solano	Sacramento Watershed	District 3		RDs 38, 341, 1601, 2
Sac 30	Rural Area South End	Yolo Bypass	Sacramento District	Solano	Sacramento Watershed	District 3		RDs 501, 536, 1667,
Sac 18	Yolo Bypass East of	Yolo Bypass	Sacramento District	Yolo	Sacramento Watershed	District 3		RDs 537, 785, 827, 1
Sac 20	Local Area North of	Yolo Bypass	Sacramento District	Yolo	Sacramento Watershed	District 3		RDs 537, 785, 827, 1
Sac 17b	Yolo Bypass	Yolo Bypass	Sacramento District	Yolo	Sacramento Watershed	District 3		RDs 537, 785, 827, 1
Sac 16	Local Area Between W	Yolo Bypass	Sacramento District	Yolo	Sacramento Watershed	District 3		RDs 70, 108, 730, 78
Sac 15	Yolo Bypass East of	Yolo Bypass	Sacramento District	Yolo	Sacramento Watershed	District 3	Woodland	RDs 70, 108, 730, 78

Table 2: Boundary Information for Impact Areas for San Joaquin Study

Impact Area	Impact Area Desc.	Stream Name	Corps District	County	Watershed	Congressional Dist	Community	Flood District
SJ 17	City of Merced	Bear Creek	San Joaquin	Merced	Bear Creek	District 18	Fresno, Madera, Mend	Lower San Joaquin Ri
SJ 10	Chowchilla Bypass	Chowchilla Bypass	San Joaquin	Merced	San Joaquin	District 18	Merced, Los Banos, G	Lower San Joaquin Ri
SJ 09	Chowchilla Bypass	Chowchilla Bypass	San Joaquin	Madera	Chowchilla	District 18	Fresno, Madera, Mend	Lower San Joaquin Ri
SJ 02	Chowchilla Bypass	Chowchilla Bypass	San Joaquin	Madera	San Joaquin	District 18	Fresno, Madera, Mend	Lower San Joaquin Ri
SJ 06b	San Joaquin River Ne	Chowchilla Bypass /	San Joaquin	Madera	San Joaquin	District 18	Merced, Los Banos, G	Lower San Joaquin Ri
SJ 06a	Chochilla Bypass/San	Chowchilla Bypass /	San Joaquin	Madera	San Joaquin	District 18	Fresno, Madera, Mend	Lower San Joaquin Ri
SJ 14	East Side Bypass-San	Eastside Bypass	San Joaquin	Merced	San Joaquin	District 18	Merced, Los Banos, G	Lower San Joaquin Ri
SJ 15	East Side Bypass-San	Eastside Bypass / Sa	San Joaquin	Merced	San Joaquin	District 18	Merced, Los Banos, G	none
SJ 13	San Joaquin River Ru	Eastside Bypass / Sa	San Joaquin	Merced	San Joaquin	District 18	Merced, Los Banos, G	Lower San Joaquin Ri
SJ 12	San Joaquin River Ru	Eastside Bypass / Sa	San Joaquin	Merced	San Joaquin	District 18		Lower San Joaquin Ri
SJ 08	San Joaquin River at	Fresno River	San Joaquin	Madera	Fresno	District 19	Merced, Los Banos, G	Lower San Joaquin Ri
SJ 07	Fresno River near Ch	Fresno River / Chowc	San Joaquin	Madera	Chowchilla	District 19	Fresno, Madera, Mend	Lower San Joaquin Ri
SJ 04	Kings River below Cr	Kings River	San Joaquin	Fresno	Kings	District 20	Fresno, Madera, Mend	Lower San Joaquin Ri
SJ 18	Merced River at Cres	Merced River	San Joaquin	Merced	Merced	District 18	Merced, Los Banos, G	Lower San Joaquin Ri
SJ 16	Merced Streams Group	Merced Streams Group	San Joaquin	Merced	Bear Creek	District 18	Merced, Los Banos, G	Lower San Joaquin Ri
SJ 35	Old River Near Tracy	Old River	San Joaquin	San Joaquin	San Joaquin	District 11	None	RDs 773, 1007, 2058,
SJ 34	Old River Near Tracy	Old River	San Joaquin	San Joaquin	San Joaquin	District 11	None	RDs 773, 1007, 2058,
SJ 33	Old River Near Tracy	Old River	San Joaquin	San Joaquin	San Joaquin	District 11	None	RDs 773, 1007, 2058,
SJ 30c	Large Area near Stoc	San Joaquin River	San Joaquin	San Joaquin	San Joaquin	District 11	Stockton	RDs 17, 404, 524, 54
SJ 30b	Small Urban Area In	San Joaquin River	San Joaquin	San Joaquin	San Joaquin	District 11	Stockton	RDs 17, 404, 524, 54
SJ 30a	San Joaquin River in	San Joaquin River	San Joaquin	San Joaquin	San Joaquin	District 11	Stockton	RDs 17, 404, 524, 54
SJ 29	San Joaquin River Up	San Joaquin River	San Joaquin	San Joaquin	San Joaquin	District 11	Tracy	RDs 773, 1007, 2058,
SJ 28	San Joaquin River ne	San Joaquin River	San Joaquin	San Joaquin	San Joaquin	District 11	Tracy	RDs 773, 1007, 2058,
SJ 27	San Joaquin River-Sm	San Joaquin River	San Joaquin	San Joaquin	San Joaquin	District 18	Tracy	RDs 2075, 2085, 2064
SJ 26	San Joaquin Area Nea	San Joaquin River	San Joaquin	San Joaquin	San Joaquin	District 18	Ripon	RDs 2075, 2085, 2064
SJ 24	San Joaquin River-Sm	San Joaquin River	San Joaquin	Stanislaus	San Joaquin	District 18	Ripon	RDs 2075, 2085, 2064

Table 2: Boundary Information for Impact Areas for San Joaquin Study

Impact Area	Impact Area Desc.	Stream Name	Corps District	County	Watershed	Congressional Dist	Community	Flood District
SJ 21	San Joaquin River-Sm	San Joaquin River	San Joaquin	Stanislaus	San Joaquin	District 18	Modesto	RDs 2100, 2102, 2092
SJ 20	San Joaquin River do	San Joaquin River	San Joaquin	Stanislaus	San Joaquin	District 18	Turlock, Patterson	RDs 1602, 2091, 2063
SJ 19	San Joaquin below Ne	San Joaquin River	San Joaquin	Stanislaus	San Joaquin	District 18	Turlock, Patterson	RDs 1602, 2091, 2063
SJ 11	San Joaquin River Ru	San Joaquin River	San Joaquin	Merced	San Joaquin	District 18	Merced, Los Banos, G	Lower San Joaquin Ri
SJ 05	San Joaquin River Up	San Joaquin River	San Joaquin	Fresno	Kings	District 20	Fresno, Madera, Mend	Lower San Joaquin Ri
SJ 03	San Joaquin River-Me	San Joaquin River	San Joaquin	Fresno	San Joaquin	District 20	Fresno, Madera, Mend	Lower San Joaquin Ri
SJ 01	San Joaquin River fr	San Joaquin River	San Joaquin	Madera	San Joaquin	District 19	Fresno, Madera, Mend	Lower San Joaquin Ri
SJ 23	Area near Modesto a	San Joaquin River /	San Joaquin	Stanislaus	San Joaquin	District 18	Ripon	RDs 2075, 2085, 2064
SJ 31	San Joaquin River/De	San Joaquin River-De	San Joaquin	San Joaquin	San Joaquin	District 11	None	RDs 17, 404, 524, 54
SJ 32	San Joaquin River-St	San Joaquin River-De	San Joaquin	San Joaquin	San Joaquin	District 11	Stockton	RDs 17, 404, 524, 54
SJ 25	Stanislaus River	Stanislaus River	San Joaquin	Stanislaus	Stanislaus	District 18	Ripon	RDs 2075, 2085, 2064
SJ 22	City of Modesto alon	Tuloumne River	San Joaquin	Stanislaus	Tuolumne	District 18	Modesto	RDs 2100, 2102, 2092

By overlaying a map of qualified HEC-DSS gages on the flood impact maps discussed above, locations where additional stage hydrographs were needed were identified. Based on this need, some additional gages in the Delta area were discovered by using the California Data Exchange Center (CDEC) web site: cdec.water.ca.gov. Tables 3a and 3b, Stage Data Sources for Selected Gages, lists the gages and sources used for the Sacramento and San Joaquin studies. Some of the data from a few of these gages and a few of the HEC-DSS gages had to be massaged so that they would include one-hour time steps. However, some impact areas were still not represented by a stage hydrograph, so three methods were employed to provide a stage hydrograph for each impact area.

First, whenever an observed hydrograph was found next to the impact area, that observed hydrograph was used. Of the 55 impact areas in the Sacramento system, 32 had gaged data that could be used to represent the stage hydrograph. Second, when an observed hydrograph was not found near the impact area, a hydrograph had to be developed using extrapolated data. This hydrograph was developed by linearly interpolating the hydrographs from the nearest upstream and downstream gages. Thirteen stage hydrographs were developed in this fashion in the Sacramento River system. Third, if the impact area was bordered by more than one river, the stage hydrograph from the gage that produced the maximum value when subtracting the peak stage from the top-of-levee on that particular river was used. Of the 55 Sacramento River impact areas, nine of them had stage hydrographs developed in this manner. Finally, one impact area had a stage hydrograph that was developed through a combination of methods two and three.

The gages and methodology that were used for each Sacramento & San Joaquin Rivers impact area are outlined in Appendix 1. All stage data were converted to mean sea level (National Geodetic Vertical Datum) before they were averaged.

C. Damage Functions

Each impact area must also be represented by economic damage-elevation functions for both urban and agricultural areas. These damage-elevation functions describe what the damage would be for crops and structures and how many people would be displaced for incremental stages in the river. Damage data were developed by overlaying the census data on top of the floodplain mapping, similar to how the impact areas were delineated. All urban damage functions used for the Sacramento system are based on data provided by the Sacramento District.

The economic data provided by the District were not tied to an elevation for each impact area and no damage-elevation information was provided for the zero damage elevation. Therefore, because the levees in the Sacramento River system are mostly Federal levees which are designed to contain the .01 exceedance probability discharge with some amount of freeboard, the damage relationship shown in Table 4 was used. Figure 3 shows an example aggregated damage-elevation function at an impact area index location.

Table 3a: Sacramento Stage Data Source for Selected Gages

River (1)	Gage (2)	Source (3)	Notes (4)
Sacramento	Tehama Bridge	SPK / CDEC	Time-series for '97 event was irregular, regular data was available from CDEC.
	Vina-Woodson Bridge	SPK / CDEC	See Tehama Bridge note
	Hamilton City	SPK	
	Ord Ferry	SPK	
	Butte City	SPK	Estimated suspicious data for '97 event
	Moulton Weir	SPK	
	Colusa Weir	SPK	
	Colusa Bridge	SPK	
	Tisdale Weir	SPK	
	Wilkens Slough	SPK	
	Fremont Weir	SPK	
	Verona	SPK	
	Sacramento Weir	SPK	Converted 15-min stage data to hourly data for '95 event with DSS-MATH function TTSR
	I Street	SPK	
	Freeport	SPK	
	Rio Vista	CDEC	Estimated missing values from 02JAN1997 01:00 to 10JAN1996 24:00 by adding 1' to Mallard Island stage
Feather	Gridley	SPK	
	Yuba City	SPK	
	Nicolaus	CDEC / SPK	SPK did not provide data for '95 event
Yuba	Marysville	SPK	Only daily flow data was available for '95 event. Converted to hourly flow using DSS-MATH function TTSR. Rating curve was developed from '97 hourly stage and flow data and used to convert '95 hourly flow to stage.
	Wheatland	SPK	
American	Fair Oaks	SPK	
	H Street	SPK	
Bypass	Meridian	SPK	
	RD 1500 PP	SPK	
	Woodland	SPK	Estimated missing values from 26DEC1996 00:00 to 28DEC1996 00:00 by interpolation
	Lisbon	SPK	
Delta	Bensons Ferry	CDEC	
	Mallard Island	CDEC	

Table 3b: San Joaquin Stage Data Source and Datum Offset for Selected Gages

River (1)	Gage (2)	Source (3)	NGVD Offset (4)	Notes (5)
San Joaquin	Below Friant Dam	SPK	+ 294.0	
	Mendota Pool	SPK	+ 140.5	
	El Nido	SPK	+ 90	
	Stevinson	SPK	0	
	Newman	SPK	0	
	Maze Road	SPK	0	
	Vernalis	SPK	0	
Bear Creek	McKee Rd.	SPK	+ 187.0	
Merced	Cressey	SPK	+ 116.8	
Tuolumne	Modesto	SPK	0	
Stanislaus	Ripon	SPK	+ 0.7	Only flow data was available for the '95 event. Derived a rating table from more recent CDEC data that had similar flow values to '95 event and then computed stage values for '95 event
Delta	Old River	CDEC	0	Estimated data for '97 event from 1/5/97 16:00 to 1/10/97 24:00
	Venice Island	CDEC	0	

Table 4: Sacramento River Damage-Elevation Relationship

Point	Elevation	Damage
(1)	Ground adjacent to index location	Zero Damage
(2)	(Top-of-levee) – 1 foot	Damage associated w/ .01 exceedance probability
(3)	(Top-of-levee) + 1 foot	Damage associated w/ .002 exceedance probability

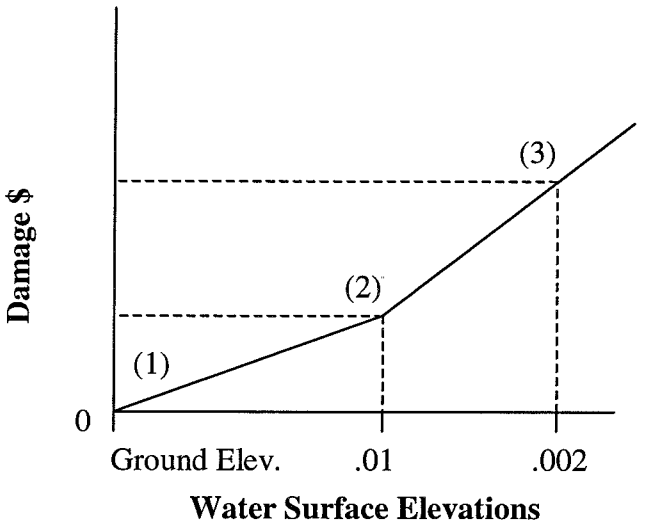

Figure 3: Example Impact Area Damage-Elevation Function

Because a number of the levees on the San Joaquin River system are not Federally constructed levees and have been built to lesser frequencies, a new damage relationship had to be developed for the San Joaquin River system. The damage relationship shown in Table 5 was used for the San Joaquin system.

Table 5: San Joaquin River Damage-Elevation Relationship

Point	Elevation	Damage
(1)	Ground adjacent to index point	Zero Damage
(2)	(Top-of-levee) + 1 foot	Damage associated w/ .01 exceedance probability
(3)	(Top-of-levee) + 3 foot	Damage associated w/ .002 exceedance probability

1. Urban

Urban damage categories include residential, public, commercial and industrial buildings, roads, bridges, open space etc. The damage analysis is based on peak flows and need not consider flood duration or the time of the year.

Categories of Structures:

Appendix 2 shows the total value of structures and contents at risk in each impact area inside the .01 exceedance probability event floodplain. The report also shows the values for the entire impact area including the area in the .002

exceedance probability floodplain. The structure types were divided into four land use categories:

1. Commercial – includes commercial and industrial buildings such as office buildings, restaurants, retail stores, warehouses machine shops etc.

2. Farmstead - includes outbuildings, farmsteads with residences, barns, some agricultural processing facilities.

3. Semi-public – includes buildings listed in the tax assessors rolls such as churches, private schools, private recreation and clubs. It does not include tax-exempt local, state and federal government buildings or public schools

4. Residential – includes all urban and some rural residences. Consists of single family residences, duplex structures, mobile homes, apartment complexes, townhouses, and residence hotels.

In order to develop the total cost for contents and structure, content values were estimated as a percentage of the improvement value for each land use type. Percentages used in several District studies were compared and generalized percentages were selected. For the commercial structures, the contents were estimated at 100 percent of the structure value. For the remaining three land use types, the contents were valuated at 50 percent of the structure costs.

It is important to note that the total value of damageable property did not include structures that did not have values listed in the parcel database. Public buildings and infrastructure such as roads and bridges were not included. For the urban areas, such as Sacramento, the reported total values will be proportionally lower than the rural reaches if this data were available.

Adjustment of Structure Values:

The assessed improvement values of structures listed in the parcel database do not reflect depreciated replacement values. The improvement values may increase at a maximum rate of two percent per year for the date that a property is sold. Therefore, the District made adjustments to the depreciated replacement values by comparing the Marshal and Swift Valuation, a recognized and authoritative residential and commercial property appraisal guide, to the maximum increases. Factors were estimated for updating books or pages based on average recording dates. These factors were used to bring improvements to depreciated replacement values.

The total damage incurred during a flood event is not equal to the total value of the property, but can be estimated as a percentage of the property value.

Therefore, the total values provided by the District were divided into structure and content values. Then, using the percentages provided by the District, were multiplied by the maximum percent damage for each category using FEMA depth versus percent damage curves to determine the actual maximum potential damage. The percentages used are shown in Table 6 and an example is provided below.

Table 6: Percentages Used to Adjust Potential Damage Values

Category (1)	% of Total Value[1]		Maximum % Damageable		Overall Factor (6)
	Structure (2)	Content (3)	Structure (4)	Content (5)	
Commercial	50	50	60	90	0.75
Farmstead	67	33	55	80	0.63
Public	67	33	50	60	0.53
Residential	67	33	50	50	0.50

[1] Values provided by Sacramento District

For example, the total value of the damageable commercial property inside the .01 exceedance probability event floodplain for impact area SAC01 is $258.8 million. Columns (2) and (3) show that 50% of this value is structure and 50% is content. Therefore:

Structure Value = 0.5 x $258.8 = $129.4 million
Content Value = 0.5 x $258.8 = $129.4 million

Next calculate the maximum potential damage to the structure and content using the FEMA percentages in columns (4) and (5).

Maximum potential damage to structure = 0.6 x $129.4 = $ 77.64 million
Maximum potential damage to contents = 0.9 x $129.4 = $116.46 million

Adding these together results in the total potential damage for impact area SAC01:

$77.64 + $116.46 = $194.1 million

The maximum potential damage can also be calculated by multiplying the overall factor in column (6) by the total value of the damageable commercial property inside the .01 exceedance probability floodplain. The overall factor is determined by adding the product of columns (2) and (4) to the product of columns (3) and (5):

(0.5 x 0.6) + (0.5 x 0.9) = 0.75

Then, the maximum potential damage is:

$258.8 x 0.75 = $194.1 million

Population:

Population for each damage area was estimated as a function of the number of residences and the number of people per household. Population data were gathered from the US Census by county and were estimated to represent two resident types, urban and rural. The urban population per household was adjusted to reflect both single and multi-family units. The rural population per household was adjusted to represent the estimated number of farm structures with residences.

Urban Damage Summary:

In total, when combining the Sacramento and San Joaquin Basins, nearly 190,000 structures are at risk of flooding during the .002 exceedance probability event. More than 500,000 people live within the damage boundaries with almost $35 billion in damageable property. As stated above, this total does not include public buildings not listed on parcel data, roads, bridges, public infrastructure or automobiles. Based on Corps Studies in other areas, the addition of public structures could increase the value of property at risk by 5 to 20 percent for the urban areas.

2. Agricultural

In addition to structures at risk, many of the 93 impact areas are subject to agricultural losses from flooding. To identify the type of crops at risk, land use acreage was determined. A GIS database, provided by the California Department of Water Resources, delineated the different land uses by county. The land use layer was combined with the 93 impact areas to determine the crop acreage at risk for each area. Within the database, land use codes include over 75 different crops. Categories were selected to reduce this number. Individual categories were selected based on the total number of acres within the impact areas and the value of the crop at risk. The remainder of the land uses were placed in general categories. The remaining non-agricultural acres were placed in either idle, native vegetation, or urban categories. The categories selected are shown in the tables in Appendix 3.

In addition to crop area, crop damage loss functions must be determined. Agricultural damage functions are more difficult to define than the urban damage functions. Crop loss functions include type of crop, duration and magnitude of flooding, time of year that flooding occurs, cropping patterns, crop values and yields, duration of flooding that a crop may withstand without damage, effects of replanting and late planting, time between floods, and dry out periods before re-entering the fields. Monetary damage values are determined from investment (and profit) losses, mature crop price values, and harvest costs. Additionally,

secondary business losses (loss of revenue by grain elevator managers, truck operators, equipment vendors, etc.) may also contribute to the flood losses associated with agricultural areas.

The Sacramento District provided land use and acreage data for the majority of the impact areas. Like the urban damage curves, an elevation-area curve for each impact area was developed. For the Sacramento River system, the elevation-area curve was a straight line, with zero area corresponding to the flood stage and maximum area corresponding to top-of-levee + 1 foot. These elevations are the same as those used for the urban stage-damage functions. For the San Joaquin River, the agricultural elevation-area curve is the same as the one used to calculate the urban damages for that system. They are shown in Tables 4 and 5 respectively.

3. Index Locations

An index location is a point in an impact zone where the stage or discharge hydrograph is defined and the aggregated damage-elevation function for the impact area is developed. Impact area index locations are defined at stream gaged locations because stage or discharge hydrographs may readily be obtained from records of observed events.

Index points were determined for each impact area by one of the following methods:

1. If the hydrograph from a single gage was used for the impact area, the index location was the point (elevation) inside the impact area closest to that gage.

2. If an average of two hydrographs was used to compute the stage at an impact area, the index location was chosen as the point inside the impact area closest to the midpoint of the river section joining the two gages. The elevation of the index point was determined using a 3 arc-second digital elevation model.

4. Levees

Flood stage, top-of-levee elevations and data source for each gage are shown in Table 7. Corresponding elevations were found for each impact area, using the same methods used for the stage hydrographs as noted in Appendix 1. The adjustment from the actual gage reading to mean sea level (NGVD) is also shown for each gage. Top-of-levee elevations are not applicable for the upper-most impact area on the Sacramento River because levees do not exist. In this case, zero damage was associated with the warning stage and then the damage-elevation curve was completed using the FEMA depth-percent damage curves; please see Appendix 4 for the levee heights and flood stages for each impact area.

Table 7: Flood stage, Top-of-levee and NGVD Offset for Sacramento Gages

River (1)	Gage (2)	NGVD offset (3)	NGVD Flood Stage (4)	NGVD Top-of-levee (5)	Source (6)
Sacramento	Tehama Bridge	-5.70	204.30	NA	FEOM[1]
	Vina-Woodson Bridge	-3.00	177.00	NA	FEOM
	Hamilton City	-2.92	140.08	NA	FEOM
	Ord Ferry	-2.48	119.12	122.52	FEOM
	Butte City	-2.92	94.28	98.08	FEOM
	Moulton Weir	-2.85	81.55	86.35	FEOM.
	Colusa Weir	-2.89	68.11	71.91	FEOM
	Colusa Bridge	-2.95	67.05	70.05	FEOM
	Tisdale Weir	-3.05	49.95	53.95	FEOM
	Wilkens Slough	-3.00	49.70	53.10	FEOM
	Fremont Weir	-3.00	37.80	42.40	FEOM
	Verona	-3.00	38.30	43.00	FEOM
	Sacramento Weir	0.00	31.50	38.50	FEOM
	I Street	0.00	31.00	34.00	FEOM
	Freeport	-100.00	25.30	28.30	Flood stage from SPK, USACE 1993[2]; TOL = FS + 3
	Rio Vista	-3.00	9.50	19.00	FEOM
Feather	Gridley	-2.90	100.90	104.30	FEOM
	Yuba City	-3.00	77.20	80.50	FEOM
	Nicolaus	-3.30	44.70	51.20	FEOM
Yuba	Marysville	-2.97	74.03	77.03	Flood stage from FFMG[3]; TOL = FS + 3'
	Wheatland	71.92	92.22	98.22	FEOM
American	Fair Oaks	71.53	102.00	105.00	TOL was estimated from quad map contours; FS = TOL – 3
	H Street	-3.07	39.73	44.43	FEOM
Bypass	Meridian	-3.00	67.00	70.00	TOL was estimated from quad map contours; FS = TOL – 3
	RD 1500 PP	-3.00	43.00	46.00	TOL from spot elevation on quad map; FS = TOL – 3
	Woodland	3.41	31.30	34.30	Flood stage from SPK, USACE 1993; TOL = FS + 3
	Lisbon	-3.00	23.20	29.10	FEOM
Delta	Bensons Ferry	-3.00	15.00	18.00	Flood stage from FFMG; TOL = FS + 3'
	Mallard Island	0.00	14.00	17.00	TOL was estimated from quad map contours; FS = TOL – 3

1. FEOM-Flood Emergency Operations Manual (1994). California Department of Water Resources Division of Flood Management.
2. SPK USACE-US Corps of Engineers (1993). "Sacramento River Flood Control Project Hydrology" Sacramento District.
3. FFMG-Flood Forecasting Monitoring Guide for River Stage. National Weather Service.

IV. FIA Model Calibration and Verification

After the input data was incorporated into HEC-FIA, the program was run and the output reviewed to determine if the program correctly identified the location and the amount of damage that was known to have occurred. The District supplied HEC with flood damage costs by county for both the 1995 and 1997 events for the Sacramento and San Joaquin systems. They also provided the locations where the levee failures occurred, which was used to calibrate the model. Their report provided total damage by individual, public, business and agricultural damage categories. It is important to note that the District's report included some types of damages not modeled by the program. These included local flood damage which occurred behind the levees, damage caused by tributaries which may not have been modeled with HEC-FIA and damage to public buildings which HEC-FIA had little or no data. Additionally, the District's report included damage for the whole county, when only a portion of the county may have been modeled. These alternative methods of accumulating damage appear to be especially important for the 1995 event as much of its damage was caused by local or tributary flooding not modeled by HEC-FIA. Therefore, the reported flood damage values and the damage values developed from the HEC-FIA model are not the same. The District's reported flood damage values are important as they are used to verify that HEC-FIA results are reasonable based on the assumptions and data available for the model. As the assumptions and input data become better defined so will the modeling results. The results of the modeling are described in Section V, Results.

V. Results

Summary output tables depicting the HEC-FIA modeling results are included in Tables 8 through 11. The four tables represent the results of the 1995 and 1997 events for both the Sacramento and San Joaquin Rivers. The summary tables list the urban, crop and total damage as well as the numbers of structures flooded and population impacted. All these damage types are listed by impact regions within given counties. In addition, Tables 12 through 15 show total damage by congressional districts. As noted in Section II, Flood Impact Analysis Model (HEC-FIA), damage can be listed with a number of tables including an agricultural table that displays the amount of damage for each type of crop in every impact area, county, congressional district etc.

The District's report showed the 1995 total damage to be $305,924,000 and $193,300,000 for the Sacramento and San Joaquin Rivers, respectively. The HEC-FIA model showed $114,296,000 and $127,560,000 in damages for the two rivers, respectively. The reason our values are lower can best be explained by the fact that much of the damage created by the 1995 event was due to local drainage behind the levees or from tributary streams not modeled by the program. Please see the description of damages in Section IV.

The 1997 total damages reported by the District were $300,659,000 and $223,291,000 for the Sacramento and San Joaquin, respectively. The HEC-FIA model estimated $277,802,000 and $266,366,000 in total damages for the two rivers respectively. The explanation for the increased flood damages due to the 1997 event is two fold. First, is the obvious reason that the 1997 event was a bigger event than the 1995 event and therefore more flooding took place. Second, numerous levees failed during the 1997 event especially on the San Joaquin River system. The one failure on the Feather River near Olivehurst (Impact Area 11b) caused over $50,000,000 by itself. Four levee failures on the Sacramento River and 20 levee failures on the San Joaquin led to a significant amount of damage.

Overall, the program's output appears to be consistent with the type and degree of damages that were reported for the 1995 and 1997 events. With more precise data, the model may more accurately estimate the actual damages.

VI. Summary

This report documents the Hydrologic Engineering Center's efforts to develop the Phase I flood impact analysis models for the Sacramento and San Joaquin Rivers for the Sacramento District office. The Corps' HEC-FIA, Flood Impact Analysis, computer model was used to evaluate the flood damage for the 1995 and 1997 flood events.

Using input data supplied by the District office, as well as developing some at HEC, the model was populated with a significant amount of information. First, the watersheds were divided into impact areas based on geographical, project or political boundaries. Next, in order to develop the proper hydrology for each impact area, stage hydrographs were developed from local stream gage data. If no gages existed within an impact area, data from nearby gages were averaged to approximate the stage hydrograph for that area. Each impact area was then populated with various damage-elevation curves for urban areas, agricultural lands, population and numbers of structures. Levee heights were input at the index locations to truncate the interior damage function until the levee overtopped or geotechnically failed. Once each impact area was properly defined, the program was run and the results were reviewed. Because some of the data were preliminary and a number of assumptions had to be made, the results of the modeling can only be assumed to be preliminary. However, HEC-FIA did approximate the damage values and location of damage for the Sacramento and San Joaquin River systems. Additionally, with improved data and better assumptions, the results are expected to improve and more realistic damage estimates made. The next section lists the recommendations we consider imperative for Phase II of the modeling.

Table 8: County Summary Damage Report for 1995 Event for Sacramento (Damages in $1,000)

County	Impact Area	Description	Stream Name	Urban Damages	Crop Damages	Total Damages	Structures Flooded	Pop. Impacted
Tehama	Sac 01b	Red Bluff Reach	Sacramento River	108127	104	108232	282	660
	Sac 01a	Reading Reach	Sacramento River	186	0	186	12	44
			Sub-Total for Tehama	108313	104	108417	294	704
Glenn	Sac 03	Moulton Weir to abov	Sacramento River	0	0	0	0	0
	Sac 04a	Willows Reach	Sacramento River	0	0	0	0	0
			Sub-Total for Glenn	0	0	0	0	0
Butte	Sac 02	Woodson Bridge to Or	Sacramento River	0	0	0	0	0
			Sub-Total for Butte	0	0	0	0	0
Colusa	Sac 05b	Grimes Reach	Sacramento River	0	0	0	0	0
	Sac 05a	Colusa Reach at the	Sacramento River	0	0	0	0	0
	Sac 04c	Coulsa Weir Area	Sacramento River	0	0	0	0	0
	Sac 04b	Below Willows	Sacramento River	0	0	0	0	0
			Sub-Total for Colusa	0	0	0	0	0
Sutter	Sac 13a	Feather River South	Feather River	0	0	0	0	0
	Sac 09	Tidsdale to Freemoun	Sacramento River	0	0	0	0	0
	Sac 06	Ag Area above Tidsda	Sacramento River	0	0	0	0	0
	Sac 07	Local Area	Sacramento River	0	0	0	0	0
	Sac08b	Yuba City Area Feath	Feather River	0	0	0	0	0
	Sac08a	Area Between Sutter	Sutter Bypass	0	0	0	0	0
			Sub-Total for Sutter	0	0	0	0	0
Yuba	Sac 11b	Feather River South	Feather River	0	0	0	0	0
	Sac 12	Bear River at Wheatl	Bear River	0	0	0	0	0
	Sac 11a	Olivehurst / Linda A	Feather River	0	0	0	0	0
	Sac 10a	Marysville	Feather River	0	0	0	0	0
	Sac 10b	North of Marysville	Feather River	0	0	0	0	0
			Sub-Total for Yuba	0	0	0	0	0
Yolo	Sac 05d	Local Area Upstream	Sacramento River	0	0	0	0	0
	Sac 15	Yolo Bypass East of	Yolo Bypass	0	0	0	0	0
	Sac 16	Local Area Between W	Yolo Bypass	364	42	406	2	8
	Sac 14	Knights Landing to F	Sacramento River	0	0	0	0	0
	Sac 05c	Above Tidsdale Weir	Sacramento River	0	0	0	0	0
	Sac 19	Sacramento River Bel	Sacramento River	4732	740	5472	14	40
	Sac 17b	Yolo Bypass	Yolo Bypass	0	1	1	0	0
	Sac 20	Local Area North of	Yolo Bypass	0	0	0	0	0
	Sac 18	Yolo Bypass East of	Yolo Bypass	0	0	0	0	0

Table 8: County Summary Damage Report for 1995 Event for Sacramento (Damages in $1,000)

County	Impact Area	Description	Stream Name	Urban Damages	Crop Damages	Total Damages	Structures Flooded	Pop. Impacted
	Sac 21a	West Sacramento Area	Sacramento River	0	0	0	0	0
	Sac 21b	Lisbon Area South of	Sacramento River	0	0	0	0	0
	Sac 21c	Rural Area South of	Sacramento River	0	0	0	0	0
	Sac 21d	Large Rural Area Sou	Sacramento River	0	0	0	0	0
	Sac 26	Rural West Bank Area	Sacramento River	0	0	0	0	0
	Sac 17a	Local Area Yolo Bypa	Yolo Bypass	0	0	0	0	0
			Sub-Total for Yolo	5096	783	5879	16	48
Sacramento	Sac 22	Notomas	Sacramento River	0	0	0	0	0
	Sac 13b	Saramento River at F	Sacramento River	0	0	0	0	0
	Sac 27	East Bank Sacramento	Sacramento River	0	0	0	0	0
	Sac 28	Sacramento River Lev	Sacramento River	0	0	0	0	0
	Sac 37	Small Local Area Sac	Sacramento River	0	0	0	0	0
	Sac 36	Small Local Area Sac	Sacramento River	0	0	0	0	0
	Sac 32	Local Area Sacrament	Sacramento River	0	0	0	0	0
	Sac 33	Sacramento River Loc	Sacramento River	0	0	0	0	0
	Sac 34	Local Area Sacrament	Sacramento River	0	0	0	0	0
	Sac 38	Cosumnes River	Cosumnes River	0	0	0	0	0
	Sac 35	Sacramento River Are	Sacramento River	0	0	0	0	0
	Sac 40	Local Area Sacrament	Sacramento River	0	0	0	0	0
	Sac 41	Lower Sacramento Are	Sacramento River	0	0	0	0	0
	Sac 23	North Sacramento	American River	0	0	0	0	0
	Sac 25	Sacramento City	Sacramento River	0	0	0	0	0
	Sac 24	East Sacramento Near	American River	0	0	0	0	0
			Sub-Total for Sacram	0	0	0	0	0
Solano	Sac 31	Area at South End Yo	Sacramento River	0	0	0	0	0
	Sac 30	Rural Area South End	Yolo Bypass	0	0	0	0	0
	Sac 29a	Local Area Nr. South	Yolo ByPass	0	0	0	0	0
	Sac 29b	Local Area NR. South	Yolo Bypass	0	0	0	0	0
			Sub-Total for Solano	0	0	0	0	0
San Joaquin	Sac 39	Cosumnes River	Cosumnes River	0	0	0	0	0
			Sub-Total for San Jo	0	0	0	0	0
Placer			Sub-Total for Placer	0	0	0	0	0
El Dorado			Sub-Total for El Dor	0	0	0	0	0
Alpine			Sub-Total for Alpine	0	0	0	0	0
Amador			Sub-Total for Amador	0	0	0	0	0

Table 8: County Summary Damage Report for 1995 Event for Sacramento (Damages in $1,000)

County	Impact Area	Description	Stream Name	Urban Damages	Crop Damages	Total Damages	Structures Flooded	Pop. Impacted
Napa			Sub-Total for Napa	0	0	0	0	0
Sonoma			Sub-Total for Sonoma	0	0	0	0	0
Lake			Sub-Total for Lake	0	0	0	0	0
Contra Costa			Sub-Total for Contra	0	0	0	0	0
Sonoma			Sub-Total for Sonoma	0	0	0	0	0
			Totals	113409	887	114296	310	752

Table 9: County Summary Damage Report for 1995 Event for San Joaquin (Damages in $1,000)

County	Impact Area	Description	Stream Name	Urban Damages	Crop Damages	Total Damages	Structures Flooded	Pop. Impacted
San Joaquin	SJ 27	San Joaquin River-Sm	San Joaquin River	0	0	0	0	0
	SJ 28	San Joaquin River ne	San Joaquin River	0	0	0	0	0
	SJ 29	San Joaquin River Up	San Joaquin River	0	0	0	0	0
	SJ 30a	San Joaquin River in	San Joaquin River	0	0	0	0	0
	SJ 30b	Small Urban Area In	San Joaquin River	0	0	0	0	0
	SJ 30c	Large Area near Stoc	San Joaquin River	0	0	0	0	0
	SJ 31	San Joaquin River/De	San Joaquin River-De	0	0	0	0	0
	SJ 32	San Joaquin River-St	San Joaquin River-De	0	0	0	0	0
	SJ 33	Old River Near Tracy	Old River	0	0	0	0	0
	SJ 34	Old River Near Tracy	Old River	0	0	0	0	0
	SJ 35	Old River Near Tracy	Old River	0	0	0	0	0
			Sub-Total for San Jo	0	0	0	0	0
Madera	SJ 01	San Joaquin River fr	San Joaquin River	0	0	0	0	0
	SJ 02	Chowchilla Bypass	Chowchilla Bypass	0	0	0	0	0
	SJ 06a	Chochilla Bypass/San	Chowchilla Bypass /	8028	1769	9797	135	566
	SJ 06b	San Joaquin River Ne	Chowchilla Bypass /	0	0	0	0	0
	SJ 07	Fresno River near Ch	Fresno River / Chowc	0	0	0	0	0
	SJ 08	San Joaquin River at	Fresno River	0	0	0	0	0

Table 9: County Summary Damage Report for 1995 Event for San Joaquin (Damages in $1,000)

County	Impact Area	Description	Stream Name	Urban Damages	Crop Damages	Total Damages	Structures Flooded	Pop. Impacted
	SJ 09	Chowchilla Bypass	Chowchilla Bypass	0	0	0	0	0
			Sub-Total for Madera	8028	1769	9797	135	566
Fresno	SJ 03	San Joaquin River-Me	San Joaquin River	0	0	0	0	0
	SJ 04	Kings River below Cr	Kings River	0	0	0	0	0
	SJ 05	San Joaquin River Up	San Joaquin River	114598	1351	115949	98	0
	SJ 08	San Joaquin River at	Fresno River	0	0	0	0	0
			Sub-Total for Fresno	114598	1351	115949	98	0
Merced	SJ 10	Chowchilla Bypass	Chowchilla Bypass	0	0	0	0	0
	SJ 11	San Joaquin River Ru	San Joaquin River	167	4	171	6	20
	SJ 12	San Joaquin River Ru	Eastside Bypass / Sa	122	2	124	1	4
	SJ 13	San Joaquin River Ru	Eastside Bypass / Sa	0	0	0	0	0
	SJ 14	East Side Bypass-San	Eastside Bypass	0	0	0	0	0
	SJ 15	East Side Bypass-San	Eastside Bypass / Sa	0	0	0	0	0
	SJ 16	Merced Streams Group	Merced Streams Group	0	0	0	0	0
	SJ 17	City of Merced	Bear Creek	0	0	0	0	0
	SJ 18	Merced River at Cres	Merced River	0	0	0	0	0
			Sub-Total for Merced	289	6	294	7	24
Stanislaus	SJ 19	San Joaquin below Ne	San Joaquin River	0	0	0	0	0
	SJ 20	San Joaquin River do	San Joaquin River	0	0	0	0	0
	SJ 21	San Joaquin River-Sm	San Joaquin River	1520	0	1520	3	0
	SJ 22	City of Modesto alon	Tuloumne River	0	0	0	0	0
	SJ 23	Area near Modesto a	San Joaquin River /	0	0	0	0	0
	SJ 24	San Joaquin River-Sm	San Joaquin River	0	0	0	0	0
	SJ 25	Stanislaus River	Stanislaus River	0	0	0	0	0
			Sub-Total for Stanis	1520	0	1520	3	0
			Totals	124435	3126	127560	243	590

Table 10: County Summary Damage for 1997 Event for Sacramento (Damages in $1,000)

County	Impact Area	Description	Stream Name	Urban Damages	Crop Damages	Total Damages	Structure Flooded	Pop. Impacted
Tehama	Sac 01b	Red Bluff Reach	Sacramento River	175709	0	175709	743	2310
	Sac 01a	Reading Reach	Sacramento River	2830	0	2830	182	630
			Sub-Total for Tehama	178539	0	178539	925	2940
Glenn	Sac 03	Moulton Weir to abov	Sacramento River	0	0	0	0	0
	Sac 04a	Willows Reach	Sacramento River	0	0	0	0	0
			Sub-Total for Glenn	0	0	0	0	0
Butte	Sac 02	Woodson Bridge to Or	Sacramento River	0	0	0	0	0
			Sub-Total for Butte	0	0	0	0	0
Colusa	Sac 05b	Grimes Reach	Sacramento River	0	0	0	0	0
	Sac 05a	Colusa Reach at the	Sacramento River	0	0	0	0	0
	Sac 04c	Coulsa Weir Area	Sacramento River	0	0	0	0	0
	Sac 04b	Below Willows	Sacramento River	0	0	0	0	0
			Sub-Total for Colusa	0	0	0	0	0
Sutter	Sac 13a	Feather River South	Feather River	0	0	0	0	0
	Sac 09	Tidsdale to Freemoun	Sacramento River	0	0	0	0	0
	Sac 06	Ag Area above Tidsda	Sacramento River	0	0	0	0	0
	Sac 07	Local Area	Sacramento River	0	0	0	0	0
	Sac08b	Yuba City Area Feath	Feather River	0	0	0	0	0
	Sac08a	Area Between Sutter	Sutter Bypass	0	0	0	0	0
			Sub-Total for Sutter	0	0	0	0	0
Yuba	Sac 11b	Feather River South	Feather River	50500	1	50501	677	2400
	Sac 12	Bear River at Wheatl	Bear River	0	0	0	0	0
	Sac 11a	Olivehurst / Linda A	Feather River	0	0	0	0	0
	Sac 10a	Marysville	Feather River	0	0	0	0	0
	Sac 10b	North of Marysville	Feather River	0	0	0	0	0
			Sub-Total for Yuba	50500	1	50501	677	2400
Yolo	Sac 05d	Local Area Upstream	Sacramento River	0	0	0	0	0
	Sac 15	Yolo Bypass East of	Yolo Bypass	0	0	0	0	0
	Sac 16	Local Area Between W	Yolo Bypass	700	0	700	4	16
	Sac 14	Knights Landing to F	Sacramento River	0	0	0	0	0
	Sac 05c	Above Tidsdale Weir	Sacramento River	0	0	0	0	0
	Sac 19	Sacramento River Bel	Sacramento River	9100	0	9100	27	80
	Sac 17b	Yolo Bypass	Yolo Bypass	0	1	1	0	0
	Sac 20	Local Area North of	Yolo Bypass	0	0	0	0	0

Table 10: County Summary Damage for 1997 Event for Sacramento (Damages in $1,000)

County	Impact Area	Description	Stream Name	Urban Damages	Crop Damages	Total Damages	Structure Flooded	Pop. Impacted
	Sac 18	Yolo Bypass East of	Yolo Bypass	0	0	0	0	0
	Sac 21a	West Sacramento Area	Sacramento River	0	0	0	0	0
	Sac 21b	Lisbon Area South of	Sacramento River	0	0	0	0	0
	Sac 21c	Rural Area South of	Sacramento River	0	0	0	0	0
	Sac 21d	Large Rural Area Sou	Sacramento River	0	0	0	0	0
	Sac 26	Rural West Bank Area	Sacramento River	0	0	0	0	0
	Sac 17a	Local Area Yolo Bypa	Yolo Bypass	0	0	0	0	0
			Sub-Total for Yolo	9800	1	9801	31	96
Sacramento	Sac 22	Notomas	Sacramento River	0	0	0	0	0
	Sac 13b	Saramento River at F	Sacramento River	0	0	0	0	0
	Sac 27	East Bank Sacramento	Sacramento River	0	0	0	0	0
	Sac 28	Sacramento River Lev	Sacramento River	0	0	0	0	0
	Sac 37	Small Local Area Sac	Sacramento River	8535	0	8535	97	438
	Sac 36	Small Local Area Sac	Sacramento River	1437	0	1437	13	32
	Sac 32	Local Area Sacrament	Sacramento River	0	0	0	0	0
	Sac 33	Sacramento River Loc	Sacramento River	0	0	0	0	0
	Sac 34	Local Area Sacrament	Sacramento River	0	0	0	0	0
	Sac 38	Cosumnes River	Cosumnes River	507	0	507	8	50
	Sac 35	Sacramento River Are	Sacramento River	0	0	0	0	0
	Sac 40	Local Area Sacrament	Sacramento River	0	0	0	0	0
	Sac 41	Lower Sacramento Are	Sacramento River	0	0	0	0	0
	Sac 23	North Sacramento	American River	0	0	0	0	0
	Sac 25	Sacramento City	Sacramento River	0	0	0	0	0
	Sac 24	East Sacramento Near	American River	0	0	0	0	0
			Sub-Total for Sacram	10478	0	10478	118	520
Solano	Sac 31	Area at South End Yo	Sacramento River	0	0	0	0	0
	Sac 30	Rural Area South End	Yolo Bypass	0	0	0	0	0
	Sac 29a	Local Area Nr. South	Yolo ByPass	0	0	0	0	0
	Sac 29b	Local Area NR. South	Yolo Bypass	0	0	0	0	0
			Sub-Total for Solano	0	0	0	0	0
San Joaquin	Sac 39	Cosumnes River	Cosumnes River	26195	2288	28483	230	0
			Sub-Total for San Jo	26195	2288	28483	230	0
Placer			Sub-Total for Placer	0	0	0	0	0
El Dorado			Sub-Total for El Dor	0	0	0	0	0

Table 10: County Summary Damage for 1997 Event for Sacramento (Damages in $1,000)

County	Impact Area	Description	Stream Name	Urban Damages	Crop Damages	Total Damages	Structure Flooded	Pop. Impacted
Alpine			Sub-Total for Alpine	0	0	0	0	0
Amador			Sub-Total for Amador	0	0	0	0	0
Napa			Sub-Total for Napa	0	0	0	0	0
Sonoma			Sub-Total for Sonoma	0	0	0	0	0
Lake			Sub-Total for Lake	0	0	0	0	0
Contra Costa			Sub-Total for Contra	0	0	0	0	0
			Totals	275512	2290	277802	1981	5956

Table 11: County Summary Damage Report for 1997 Event for San Joaquin (Damages in $1,000)

County	Impact Area	Description	Stream Name	Urban Damages	Crop Damages	Total Damages	Structures Flooded	Pop. Impacted
San Joaquin	SJ 27	San Joaquin River-Sm	San Joaquin River	0	0	0	0	0
	SJ 28	San Joaquin River ne	San Joaquin River	0	0	0	0	0
	SJ 29	San Joaquin River Up	San Joaquin River	0	0	0	0	0
	SJ 30a	San Joaquin River in	San Joaquin River	0	0	0	0	0
	SJ 30b	Small Urban Area In	San Joaquin River	0	0	0	0	0
	SJ 30c	Large Area near Stoc	San Joaquin River	0	0	0	0	0
	SJ 31	San Joaquin River/De	San Joaquin River-De	22278	3289	25567	287	1060
	SJ 32	San Joaquin River-St	San Joaquin River-De	0	0	0	0	0
	SJ 33	Old River Near Tracy	Old River	0	0	0	0	0
	SJ 34	Old River Near Tracy	Old River	0	0	0	0	0
	SJ 35	Old River Near Tracy	Old River	0	0	0	0	0
			Sub-Total for San Jo	22278	3289	25567	287	1060
Madera	SJ 01	San Joaquin River fr	San Joaquin River	12169	1	12169	35	126
	SJ 02	Chowchilla Bypass	Chowchilla Bypass	0	0	0	0	0
	SJ 06a	Chochilla Bypass/San	Chowchilla Bypass /	4516	1245	5761	76	318
	SJ 06b	San Joaquin River Ne	Chowchilla Bypass /	0	0	0	0	0
	SJ 07	Fresno River near Ch	Fresno River / Chowc	0	0	0	0	0

Table 11: County Summary Damage Report for 1997 Event for San Joaquin (Damages in $1,000)

County	Impact Area	Description	Stream Name	Urban Damages	Crop Damages	Total Damages	Structures Flooded	Pop. Impacted
	SJ 08	San Joaquin River at	Fresno River	0	0	0	0	0
	SJ 09	Chowchilla Bypass	Chowchilla Bypass	0	0	0	0	0
			Sub-Total for Madera	16685	1246	17930	111	444
Fresno	SJ 03	San Joaquin River-Me	San Joaquin River	0	0	0	0	0
	SJ 04	Kings River below Cr	Kings River	0	0	0	0	0
	SJ 05	San Joaquin River Up	San Joaquin River	105430	1069	106500	88	0
	SJ 08	San Joaquin River at	Fresno River	0	0	0	0	0
			Sub-Total for Fresno	105430	1069	106500	88	0
Merced	SJ 10	Chowchilla Bypass	Chowchilla Bypass	4183	546	4729	84	266
	SJ 11	San Joaquin River Ru	San Joaquin River	1393	5	1398	58	180
	SJ 12	San Joaquin River Ru	Eastside Bypass / Sa	1013	3	1016	15	40
	SJ 13	San Joaquin River Ru	Eastside Bypass / Sa	0	0	0	0	0
	SJ 14	East Side Bypass-San	Eastside Bypass	0	0	0	0	0
	SJ 15	East Side Bypass-San	Eastside Bypass / Sa	0	0	0	0	0
	SJ 16	Merced Streams Group	Merced Streams Group	0	0	0	0	0
	SJ 17	City of Merced	Bear Creek	0	0	0	0	0
	SJ 18	Merced River at Cres	Merced River	86970	1677	88647	129	420
			Sub-Total for Merced	93559	2231	95790	286	906
Stanislaus	SJ 19	San Joaquin below Ne	San Joaquin River	0	0	0	0	0
	SJ 20	San Joaquin River do	San Joaquin River	0	0	0	0	0
	SJ 21	San Joaquin River-Sm	San Joaquin River	1520	0	1520	3	0
	SJ 22	City of Modesto alon	Tuloumne River	0	0	0	0	0
	SJ 23	Area near Modesto a	San Joaquin River /	1234	1	1235	10	38
	SJ 24	San Joaquin River-Sm	San Joaquin River	0	0	0	0	0
	SJ 25	Stanislaus River	Stanislaus River	17762	62	17824	21	90
			Sub-Total for Stanis	20516	63	20579	34	128
			Totals	258468	7898	266366	806	2538

Table 12: Congressional District Summary Damage Report for 1995 Event Sacramento (Damages in $1,000)

Congressional District	Urban Damages	Crop Damages	Total Damages	Structures Flooded	Pop. Impacted
District 2	108127	104	108232	282	660
District 3	5282	783	6064	28	92
District 5	0	0	0	0	0
District 11	0	0	0	0	0
Totals	113409	887	114296	310	752

Table 13: Congressional District Summary Damage Report for 1995 Event San Joaquin (Damages in $1,000)

Congressional District	Urban Damages	Crop Damages	Total Damages	Structures Flooded	Pop. Impacted
District 11	0	0	0	0	0
District 18	9837	1775	11612	145	590
District 19	0	0	0	0	0
District 20	114598	1351	115949	98	0
Totals	124435	3126	127561	243	590

Table 14: Congressional District Summary Damage Report for 1997 Event Sacramento (Damages in $1,000)

Congressional District	Urban Damages	Crop Damages	Total Damages	Structures Flooded	Pop. Impacted
District 2	226209	2	226210	1420	4710
District 3	12630	1	12631	213	726
District 5	0	0	0	0	0
District 11	36673	2288	38961	348	520
Totals	275512	2290	277802	1981	5956

Table 15: Congressional District Summary Damage Report for 1997 Event San Joaquin (Damages in $1,000)

Congressional District	Urban Damages	Crop Damages	Total Damages	Structures Flooded	Pop. Impacted
District 11	22278	3289	25567	287	1060
District 18	118591	3539	122131	396	1352
District 19	12169	1	12169	35	126
District 20	105430	1069	106500	88	0
Totals	258469	7898	266366	806	2538

VII. Recommendations for Phase II

The following are recommendations for developing an enhanced modeling capability in Phase II of the Sacramento and San Joaquin Rivers Basins Comprehensive Study.

A. Damage-Elevation Relationships

Development of impact area aggregated elevation vs. damage (and elevation vs. area for crops) relationships by damage categories would significantly improve the model. The relationships would be generated at the index locations where gaged or computed hydrographs are available. The proposed procedure is to use GIS and HEC's DAMCAL program to produce the elevation vs. damage relationships. The data are presently available and include: 7 ½ digital elevation models from the USGS, land use maps, polygons of the impact areas, and FEMA flood inundation maps. Where available, more detailed data such as better terrain, UNET generated inundation boundaries, etc. would be used. The relationships would be calibrated to the District's present information. Spatial displays of flood inundation boundaries, depths, and damage would also be developed. The results will be a consistent set of information for the study area that can be supplanted by better information, if it exists.

B. Crop-loss Relationships

Better crop-loss relationships are needed in the present HEC-FIA models. It is proposed that they be developed using a team comprised of a District Economist, a University of California, Davis, agricultural economist, two county agronomists, and HEC staff. With some pre-meeting preparation, the relationships could be developed within a short period of time.

C. Interior Sub-Area Flooding

Delineation of interior sub-areas will be reviewed and impact areas redefined based on consideration of both interior flow paths and modeling of flood inundation from levee geotechnical failures or overtopping. The redefinition of the areas will enable analysis of interior flooding such as that resulting from local rainstorms and/or seepage from prolonged exterior flooding. The interior area impacts will be reported individually and as a sum for the levee system. For events involving levee failure or overtopping, the results of UNET or other models will be used to determine the damage for the interior areas. The greater of the interior flooding or levee overtopping damage will be used.

D. Environmental Impact Areas and Assessments

A key aspect missing from the existing HEC-FIA model is the environmental impact component. This assessment of conditions would develop habitat impact relationships similar to the crop-loss relationships and would consider desired and critical low flow conditions as well as flood flow impacts. Output reports and displays would be generated.

E. Watershed and Feasibility Studies

The HEC-FIA, HEC-Structure Inventory and Analysis, and HEC-Flood Damage Analysis (old Monte) programs are being developed to form a fully integrated package for watershed and project assessment studies. They can be used to analyze observed or forecasted event consequences and to perform feasibility analyses of flood damage reduction studies including nonstructural alternatives. The use of HEC-FIA may identify areas for these studies.

F. Project Benefit Accomplishments

The HEC-FIA is designed to readily develop project benefit accomplishment reports as required annually by HQUSACE for reports to Congress. With and without-project hydrographs of observed events throughout the year are used in the analysis. This capability exists in the present models and it is recommended that HEC-FIA be used to develop these reports.

G. Displays

Several additional displays on the HEC-FIA workspace screen might enhance its utility during flood events. For example, impact area icons could flash yellow, when warning stages are reached, orange for flood stages, and red for levee overtopping. Small bar charts showing damage at each impact area by categories could also be displayed.

Appendix 1a: Sacramento Gage Selection and Translation Methodology

Impact Area (1)	Procedure (2)	Gage Name (3)
Sac01	NA	Tehama Bridge
Sac02	Mean of stages at Hamilton City and Vina	Sac02 stage
Sac03	Mean of stages at Butte City and Moulton Weir	Sac03 stage
Sac04a	Mean of stages at Ord Ferry and Butte City	Sac04a stage
Sac04b	Mean of stages at Moulton Weir and Butte City	Sac04b stage
Sac04c	NA	Colusa Weir
Sac05a	NA	Colusa Bridge
Sac05b	Mean of stages at Colusa Bridge and Tisdale Weir	Sac05b stage
Sac05c	NA	Wilkens Slough
Sac05d	Mean of Stage at Freemont Weir and Wilkins Slough	Sac05d
Sac06	Tisdale Weir or Meridian (Butte Slough). Use gage that produces maximum value when peak stage for that event is subtracted from corresponding top-of-levee.	Tisdale Weir for '95 and '97
Sac07	NA	Meridian
Sac08a	NA	Nicolaus
Sac08b	NA	Yuba City
Sac09	Fremont Weir, Wilkens, or RD 1500. Use gage that produces maximum value when peak stage for that event is subtracted from corresponding top-of-levee.	Fremont for '95 and '97
Sac10a	Marysville (Yuba R) or Yuba City (Feather R). Use gage that produces maximum value when peak stage for that event is subtracted from corresponding top-of-levee.	Marysville for '95 and '97
Sac10b	Mean of stages at Gridley and Yuba City	Sac10b
Sac11a	NA	Yuba City
Sac11b	NA	Yuba City
Sac12	NA	Wheatland
Sac13a	NA	Nicolaus
Sac13b	Mean of stages at Nicolaus and RD 1500	Sac13b
Sac14	NA	Fremont Weir
Sac15	NA	Fremont Weirt
Sac16	Fremont Weir or Woodland. Use gage that produces maximum value when peak stage for that event is subtracted from corresponding top-of-levee.	Woodland for '95 and '97
Sac17a	NA	Woodland
Sac17b	NA	Woodland
Sac18	NA	Woodland

Appendix 1a: Sacramento Gage Selection and Translation Methodology continued

Impact Area (1)	Procedure (2)	Gage Name (3)
Sac19	Verona or Woodland. Use gage that produces maximum value when peak stage for that event is subtracted from corresponding top-of-levee.	Woodland for '95 and '97
Sac20	Woodland or Sacramento Weir. Use gage that produces maximum value when peak stage for that event is subtracted from corresponding top-of-levee.	Woodland for '95 and '97
Sac21a	NA	I Street
Sac21b	Lisbon or Freeport. Use gage that produces maximum value when peak stage for that event is subtracted from corresponding top-of-levee.	Freeport for '95 and '97
Sac21c	NA	Freeport
Sac21d	Freeport and Lisbon. Use gage that produces maximum value when peak stage for that event is subtracted from corresponding top-of-levee.	Freeport for '95 and '97
Sac22	Mean of stages at Sacramento Weir and Verona	Sac22 stage
Sac23	NA	H Street
Sac24	NA	Fair Oaks
Sac25	Freeport, I Street, or H Street. Use gage that produces maximum value when peak stage for that event is subtracted from corresponding top-of-levee.	Freeport in '95 I Street in '97
Sac26	NA	Freeport
Sac27	NA	Freeport
Sac28	NA	Freeport
Sac29a	Mean of stages at Freeport and Rio Vista	Sac29a stage
Sac29b	Mean of stages at Freeport and Rio Vista	Sac29b stage
Sac30	NA	Rio Vista
Sac31	NA	Rio Vista
Sac32	Mean of stages at Freeport and Rio Vista	Sac32 stage
Sac33	Mean of stages at Freeport and Rio Vista or stage at Bensons Ferry. Use gage that produces maximum value when peak stage for that event is subtracted from corresponding top-of-levee.	Bensons Ferry for '95 and '97
Sac34	Mean of stages at Freeport and Rio Vista	Sac34 stage
Sac35	NA	Rio Vista
Sac36	NA	Bensons Ferry
Sac37	NA	Bensons Ferry
Sac38	NA	Bensons Ferry
Sac39	NA	Bensons Ferry
Sac40	NA	Rio Vista
Sac41	NA	Mallard Island

Appendix 1b: San Joaquin Gage Selection and Translation Methodology

Impact Area (1)	Procedure (2)	Gage Name (3)
SJ01	Mean of stages at below Friant Dam and Mendota Pool	SJ01 stage
SJ02	NA	Mendota Pool
SJ03	NA	Mendota Pool
SJ04	NA	Mendota Pool
SJ05	NA	Mendota Pool
SJ06a	NA	Mendota Pool
SJ06b	NA	El Nido
SJ07	NA	El Nido
SJ08	NA	El Nido
SJ09	NA	El Nido
SJ10	NA	El Nido
SJ11	NA	El Nido
SJ12	NA	El Nido
SJ13	NA	Stevinson
SJ14	NA	Stevinson
SJ15	NA	Stevinson
SJ16	Mean of stages at El Nido and Stevinson	SJ16 stage
SJ17	NA	McKee Road (Bear Creek)
SJ18	NA	Cressey
SJ19	Mean of stages at Newman and Maze Road	SJ19 stage
SJ20	Mean of stages at Newman and Maze Road	SJ20 stage
SJ21	NA	Modesto
SJ22	NA	Modesto
SJ23	NA	Maze Road
SJ24	NA	Maze Road
SJ25	NA	Ripon
SJ26	NA	Vernalis
SJ27	NA	Vernalis
SJ28	Mean of stages at Vernalis and Old River	SJ28 stage
SJ29	Mean of stages at Vernalis and Old River	SJ29 stage
SJ30a	Mean of stages at Vernalis and Old River	SJ30a stage
SJ30b	Mean of stages at Vernalis and Old River	SJ30b stage
SJ30c	Mean of stages at Vernalis and Old River	SJ30c stage
SJ31	Mean of stages at Vernalis and Venice Island	SJ31 stage
SJ32	Mean of stages at Vernalis and Venice Island	SJ32 stage
SJ33	NA	Old River
SJ34	NA	Old River
SJ35	NA	Old River

Appendix 2a: Sacramento Economic Data by Impact Area

Values in October 1998 Prices (In $ Millions)

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	542	$258.8		790	$580.8	
	FARM	99	$25.5		240	$41.2	
	SEMI-	34	$22.4		59	$37.0	
	RES	3,958	$392.1		6,893	$702.1	
SAC 1	**TOTAL**	**4,633**	**$698.8**	**11,080**	**7,982**	**$1,361.1**	**19,380**
	COMM	19	$7.8		41	$13.1	
	FARM	434	$77.4		447	$83.0	
	SEMI-	14	$5.5		16	$5.9	
	RES	386	$31.7		663	$47.9	
SAC 2	**TOTAL**	**853**	**$122.4**	**1,570**	**1,167**	**$149.9**	**2,330**
	COMM	0	$0.0		6	$0.6	
	FARM	0	$0.0		77	$6.2	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		43	$1.7	
SAC 3	**TOTAL**	**0**	**$0.0**	**0**	**126**	**$8.5**	**230**
	COMM	0	$0.0		0	$0.0	
	FARM	0	$0.0		192	$20.1	
	SEMI-	0	$0.0		3	$2.6	
	RES	0	$0.0		34	$2.6	
SAC 4A	**TOTAL**	**0**	**$0.0**	**0**	**229**	**$25.3**	**360**
	COMM	3	$0.1		4	$0.4	
	FARM	71	$10.0		148	$15.4	
	SEMI-	1	$0.2		1	$0.2	
	RES	11	$0.5		28	$1.7	
SAC 4B	**TOTAL**	**86**	**$10.8**	**120**	**181**	**$17.7**	**270**

Appendix 2a: Sacramento Economic Data by Impact Area continued

Values in October 1998 Prices (In $ Millions) continued

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	23	$2.4		23	$2.4	
	FARM	156	$15.7		156	$15.7	
	SEMI-	4	$0.1		4	$0.1	
	RES	100	$14.7		100	$14.7	
SAC 4C	**TOTAL**	**283**	**$32.9**	**480**	**283**	**$32.9**	**480**
	COMM	168	$25.9		168	$25.9	
	FARM	26	$2.0		26	$2.0	
	SEMI-	25	$7.5		25	$7.5	
	RES	899	$66.5		899	$66.5	
SAC 5A	**TOTAL**	**1,118**	**$101.9**	**2,570**	**1,118**	**$101.9**	**2,570**
	COMM	13	$1.7		13	$1.7	
	FARM	143	$14.1		143	$14.1	
	SEMI-	10	$0.6		10	$0.6	
	RES	89	$4.8		89	$4.8	
SAC 5B	**TOTAL**	**255**	**$21.2**	**440**	**255**	**$21.2**	**440**
	COMM	0	$0.0		0	$0.0	
	FARM	130	$9.5		139	$23.9	
	SEMI-	6	$0.1		9	$0.7	
	RES	107	$6.4		107	$6.4	
SAC 5C	**TOTAL**	**243**	**$16.0**	**470**	**255**	**$31.0**	**480**
	COMM	0	$0.0		1	$5.0	
	FARM	0	$0.0		16	$3.4	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		1	$0.1	
SAC 5D	**TOTAL**	**0**	**$0.0**	**0**	**18**	**$8.5**	**20**

Appendix 2a: Sacramento Economic Data by Impact Area continued

Values in October 1998 Prices (In $ Millions) continued

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	0	$0.0		3	$0.6	
	FARM	0	$0.0		145	$7.0	
	SEMI-	0	$0.0		8	$0.3	
	RES	0	$0.0		289	$26.6	
SAC 6	**TOTAL**	**0**	**$0.0**	**0**	**445**	**$34.5**	**1,140**
	COMM	0	$0.0		12	$24.8	
	FARM	0	$0.0		25	$3.4	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		19	$1.5	
SAC 7	**TOTAL**	**0**	**$0.0**	**0**	**56**	**$29.7**	**100**
	COMM	0	$0.0		10	$131.6	
	FARM	0	$0.0		154	$13.0	
	SEMI-	0	$0.0		5	$0.6	
	RES	0	$0.0		148	$15.2	
SAC 8A	**TOTAL**	**0**	**$0.0**	**0**	**317**	**$160.4**	**690**
	COMM	0	$0.0		809	$548.9	
	FARM	0	$0.0		225	$18.7	
	SEMI-	0	$0.0		99	$75.5	
	RES	0	$0.0		10,068	$1,172.3	
SAC 8B	**TOTAL**	**0**	**$0.0**	**0**	**11,201**	**$1,815.4**	**33,320**
	COMM	0	$0.0		27	$24.0	
	FARM	0	$0.0		90	$4.6	
	SEMI-	0	$0.0		5	$0.8	
	RES	0	$0.0		123	$10.8	
SAC 9	**TOTAL**	**0**	**$0.0**	**0**	**245**	**$40.2**	**520**
	COMM	0	$0.0		387	$92.4	
	FARM	0	$0.0		0	$0.0	
	SEMI-	0	$0.0		34	$23.5	
	RES	0	$0.0		3,248	$276.9	
SAC 10A	**TOTAL**	**0**	**$0.0**	**0**	**3,669**	**$392.8**	**10,490**

Appendix 2a: Sacramento Economic Data by Impact Area continued

Values in October 1998 Prices (In $ Millions) continued

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	0	$0.0		27	$31.7	
	FARM	0	$0.0		95	$8.6	
	SEMI-	0	$0.0		8	$5.1	
	RES	0	$0.0		292	$41.2	
SAC 10B	**TOTAL**	**0**	**$0.0**	**0**	**422**	**$86.6**	**1,070**
	COMM	0	$0.0		186	$68.5	
	FARM	0	$0.0		35	$1.7	
	SEMI-	0	$0.0		39	$12.7	
	RES	0	$0.0		3,967	$271.2	
SAC 11A	**TOTAL**	**0**	**$0.0**	**0**	**4,227**	**$354.1**	**12,860**
	COMM	0	$0.0		6	$2.9	
	FARM	0	$0.0		65	$11.5	
	SEMI-	0	$0.0		2	$0.1	
	RES	0	$0.0		604	$36.0	
SAC 11B	**TOTAL**	**0**	**$0.0**	**0**	**677**	**$50.5**	**2,040**
	COMM	0	$0.0		0	$0.0	
	FARM	14	$2.0		14	$2.0	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		0	$0.0	
SAC 12	**TOTAL**	**14**	**$2.0**	**20**	**14**	**$2.0**	**20**
	COMM	0	$0.0		18	$1.3	
	FARM	0	$0.0		183	$14.0	
	SEMI-	0	$0.0		12	$3.5	
	RES	0	$0.0		352	$42.2	
SAC 13A	**TOTAL**	**0**	**$0.0**	**0**	**565**	**$61.0**	**1,400**

Appendix 2a: Sacramento Economic Data by Impact Area continued

Values in October 1998 Prices (In $ Millions) continued

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	0	$0.0		4	$4.1	
	FARM	0	$0.0		131	$7.4	
	SEMI-	0	$0.0		1	$0.1	
	RES	0	$0.0		81	$7.5	
SAC 13B	**TOTAL**	**0**	**$0.0**	**0**	**217**	**$19.1**	**440**
	COMM	0	$0.0		25	$4.5	
	FARM	0	$0.0		23	$2.0	
	SEMI-	0	$0.0		6	$1.6	
	RES	0	$0.0		245	$18.6	
SAC 14	**TOTAL**	**0**	**$0.0**	**0**	**299**	**$26.7**	**930**
	COMM	0	$0.0		0	$0.0	
	FARM	0	$0.0		11	$0.7	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		0	$0.0	
SAC 15	**TOTAL**	**0**	**$0.0**	**0**	**11**	**$0.7**	**10**
	COMM	0	$0.0		0	$0.0	
	FARM	0	$0.0		4	$0.7	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		0	$0.0	
SAC 16	**TOTAL**	**0**	**$0.0**	**0**	**4**	**$0.7**	**10**
	COMM	0	$0.0		0	$0.0	
	FARM	0	$0.0		0	$0.0	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		0	$0.0	
SAC 17A	**TOTAL**	**0**	**$0.0**	**0**	**0**	**$0.0**	**0**

Appendix 2a: Sacramento Economic Data by Impact Area continued

Values in October 1998 Prices (In $ Millions) continued

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	0	$0.0		0	$0.0	
	FARM	0	$0.0		5	$0.7	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		0	$0.0	
SAC 17B	**TOTAL**	**0**	**$0.0**	**0**	**5**	**$0.7**	**10**
	COMM	0	$0.0		2	$3.9	
	FARM	8	$0.3		20	$0.7	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		6	$1.4	
SAC 18	**TOTAL**	**8**	**$0.3**	**10**	**28**	**$6.0**	**50**
	COMM	0	$0.0		0	$0.0	
	FARM	25	$8.6		25	$8.6	
	SEMI-	0	$0.0		0	$0.0	
	RES	2	$0.5		2	$0.5	
SAC 19	**TOTAL**	**27**	**$9.1**	**40**	**27**	**$9.1**	**40**
	COMM	0	$0.0		0	$0.0	
	FARM	44	$4.0		44	$4.0	
	SEMI-	0	$0.0		0	$0.0	
	RES	15	$1.8		15	$1.8	
SAC 20	**TOTAL**	**59**	**$5.8**	**110**	**59**	**$5.8**	**110**
	COMM	0	$0.0		670	$1,085.0	
	FARM	0	$0.0		27	$3.5	
	SEMI-	0	$0.0		32	$17.5	
	RES	0	$0.0		7,347	$682.7	
SAC 21A	**TOTAL**	**0**	**$0.0**	**0**	**8,076**	**$1,788.7**	**27,000**

Appendix 2a: Sacramento Economic Data by Impact Area continued

Values in October 1998 Prices (In $ Millions) continued

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	0	$0.0		0	$0.0	
	FARM	0	$0.0		16	$3.1	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		2	$0.3	
SAC 21B	**TOTAL**	**0**	**$0.0**	**0**	**18**	**$3.4**	**50**
	COMM	0	$0.0		0	$0.0	
	FARM	0	$0.0		57	$6.3	
	SEMI-	0	$0.0		1	$0.1	
	RES	0	$0.0		26	$2.9	
SAC 21C	**TOTAL**	**0**	**$0.0**	**0**	**84**	**$9.3**	**170**
	COMM	0	$0.0		13	$2.0	
	FARM	12	$0.9		121	$15.2	
	SEMI-	0	$0.0		2	$0.4	
	RES	0	$0.0		176	$23.3	
SAC 21D	**TOTAL**	**12**	**$0.9**	**20**	**312**	**$40.9**	**810**
	COMM	0	$0.0		281	$1,020.4	
	FARM	0	$0.0		97	$11.6	
	SEMI-	0	$0.0		21	$13.9	
	RES	0	$0.0		8,843	$1,288.5	
SAC 22	**TOTAL**	**0**	**$0.0**	**0**	**9,242**	**$2,334.4**	**29,400**
	COMM	1,219	$1,860.2		1,313	$1,931.5	
	FARM	0	$0.0		0	$0.0	
	SEMI-	81	$50.2		92	$56.1	
	RES	16,045	$2,298.0		17,591	$2,492.0	
SAC 23	**TOTAL**	**17,345**	**$4,208.4**	**53,110**	**18,996**	**$4,479.6**	**58,230**

Appendix 2a: Sacramento Economic Data by Impact Area continued

Values in October 1998 Prices (In $ Millions) continued

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	14	$18.1		52	$60.7	
	FARM	0	$0.0		0	$0.0	
	SEMI-	2	$0.3		8	$9.1	
	RES	1,374	$178.9		3,376	$449.7	
SAC 24	**TOTAL**	**1,390**	**$197.3**	**4,550**	**3,436**	**$519.5**	**10,880**
	COMM	3,626	$5,219.9		4,010	$5,738.8	
	FARM	0	$0.0		0	$0.0	
	SEMI-	321	$249.4		346	$261.2	
	RES	71,732	$8,265.5		79,422	$9,045.5	
SAC 25	**TOTAL**	**75,679**	**$13,734.8**	**237,430**	**83,778**	**$15,045.5**	**262,880**
	COMM	0	$0.0		0	$0.0	
	FARM	0	$0.0		44	$7.3	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		27	$3.2	
SAC 26	**TOTAL**	**0**	**$0.0**	**0**	**71**	**$10.5**	**160**
	COMM	0	$0.0		20	$1.6	
	FARM	0	$0.0		46	$12.2	
	SEMI-	0	$0.0		1	$0.1	
	RES	0	$0.0		121	$12.4	
SAC 27	**TOTAL**	**0**	**$0.0**	**0**	**188**	**$26.3**	**460**
	COMM	11	$2.4		11	$2.4	
	FARM	123	$18.7		123	$18.7	
	SEMI-	2	$0.4		2	$0.4	
	RES	169	$16.3		169	$16.3	
SAC 28	**TOTAL**	**305**	**$37.8**	**710**	**305**	**$37.8**	**710**

Appendix 2a: Sacramento Economic Data by Impact Area continued

Values in October 1998 Prices (In $ Millions) continued

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	0	$0.0		0	$0.0	
	FARM	8	$2.0		8	$2.0	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		0	$0.0	
SAC 29A	**TOTAL**	**8**	**$2.0**	**20**	**8**	**$2.0**	**20**
	COMM	0	$0.0		0	$0.0	
	FARM	0	$0.0		4	$0.3	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		0	$0.0	
SAC 29B	**TOTAL**	**0**	**$0.0**	**0**	**4**	**$0.3**	**10**
	COMM	0	$0.0		0	$0.0	
	FARM	1	$0.2		1	$0.2	
	SEMI-	0	$0.0		0	$0.0	
	RES	10	$1.7		10	$1.7	
SAC 30	**TOTAL**	**11**	**$1.9**	**40**	**11**	**$1.9**	**40**
	COMM	0	$0.0		3	$0.3	
	FARM	0	$0.0		31	$5.9	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		5	$0.4	
SAC 31	**TOTAL**	**0**	**$0.0**	**0**	**39**	**$6.6**	**60**
	COMM	0	$0.0		1	$0.1	
	FARM	0	$0.0		0	$0.0	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		10	$1.3	
SAC 32	**TOTAL**	**0**	**$0.0**	**0**	**11**	**$1.4**	**30**

Appendix 2a: Sacramento Economic Data by Impact Area continued

Values in October 1998 Prices (In $ Millions) continued

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	0	$0.0		9	$2.3	
	FARM	0	$0.0		154	$26.0	
	SEMI-	0	$0.0		2	$0.6	
	RES	0	$0.0		247	$33.1	
SAC 33	**TOTAL**	**0**	**$0.0**	**0**	**412**	**$62.0**	**1,010**
	COMM	8	$3.1		8	$3.1	
	FARM	68	$8.7		68	$8.7	
	SEMI-	0	$0.0		0	$0.0	
	RES	12	$1.7		12	$1.7	
SAC 34	**TOTAL**	**88**	**$13.5**	**120**	**88**	**$13.5**	**120**
	COMM	109	$36.8		109	$36.8	
	FARM	25	$2.5		25	$2.5	
	SEMI-	8	$0.8		8	$0.8	
	RES	333	$24.9		333	$24.9	
SAC 35	**TOTAL**	**475**	**$65.0**	**1,130**	**475**	**$65.0**	**1,130**
	COMM	0	$0.0		4	$0.5	
	FARM	0	$0.0		0	$0.0	
	SEMI-	2	$0.2		2	$0.2	
	RES	1	$0.7		6	$1.0	
SAC 36	**TOTAL**	**3**	**$0.9**	**0**	**12**	**$1.7**	**20**
	COMM	0	$0.0		32	$5.1	
	FARM	0	$0.0		5	$0.2	
	SEMI-	0	$0.0		2	$0.2	
	RES	0	$0.0		77	$4.6	
SAC 37	**TOTAL**	**0**	**$0.0**	**0**	**116**	**$10.1**	**260**

Appendix 2a: Sacramento Economic Data by Impact Area continued

Values in October 1998 Prices (In $ Millions) continued

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	0	$0.0		0	$0.0	
	FARM	0	$0.0		0	$0.0	
	SEMI-	0	$0.0		0	$0.0	
	RES	10	$0.6		10	$0.6	
SAC 38	**TOTAL**	**10**	**$0.6**	**30**	**10**	**$0.6**	**30**
	COMM	16	$2.7		16	$2.7	
	FARM	78	$13.4		78	$13.4	
	SEMI-	3	$0.9		3	$0.9	
	RES	178	$14.0		178	$14.0	
SAC 39	**TOTAL**	**275**	**$31.0**	**750**	**275**	**$31.0**	**750**
	COMM	1	$0.1		1	$0.1	
	FARM	3	$0.1		3	$0.1	
	SEMI-	0	$0.0		0	$0.0	
	RES	2	$0.4		2	$0.4	
SAC 40	**TOTAL**	**6**	**$0.6**	**10**	**6**	**$0.6**	**10**
	COMM	3	$0.6		3	$0.6	
	FARM	9	$0.7		9	$0.7	
	SEMI-	0	$0.0		0	$0.0	
	RES	31	$3.2		31	$3.2	
SAC 41	**TOTAL**	**43**	**$4.5**	**110**	**43**	**$4.5**	**110**
	COMM	5,775	$7,440.6		9,118	$11,463.1	
	FARM	1,477	$216.3		3,795	$472.2	
	SEMI-	513	$338.6		868	$539.9	
	RES	95,464	$11,324.9		146,303	$16,875.9	
SAC BASIN TOTALS	**TOTAL**	**103,229**	**$19,320.4**	**314,940**	**160,084**	**$29,351.1**	**486,160**

Appendix 2b: San Joaquin Economic Data by Impact Area

Values in October 1998 Prices (In $ Millions)

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	3	$1.4		9	$2.3	
	FARM	31	$3.2		51	$9.3	
	SEMI-	0	$0.0		2	$0.1	
	RES	10	$3.5		32	$9.2	
SJ 1	**TOTAL**	**44**	**$8.1**	**80**	**94**	**$20.9**	**190**
	COMM	0	$0.0		0	$0.0	
	FARM	41	$8.7		41	$8.7	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		0	$0.0	
SJ 2	**TOTAL**	**41**	**$8.7**	**60**	**41**	**$8.7**	**60**
	COMM	0	$0.0		1	$42.8	
	FARM	5	$1.8		160	$22.3	
	SEMI-	0	$0.0		3	$0.5	
	RES	0	$0.0		39	$4.4	
SJ 3	**TOTAL**	**5**	**$1.8**	**10**	**203**	**$70.0**	**370**
	COMM	2	$17.4		2	$17.4	
	FARM	34	$5.8		34	$5.8	
	SEMI-	0	$0.0		0	$0.0	
	RES	1	$0.1		1	$0.1	
SJ 4	**TOTAL**	**37**	**$23.3**	**50**	**37**	**$23.3**	**50**
	COMM	2	$26.0		3	$145.5	
	FARM	21	$4.2		45	$5.8	
	SEMI-	2	$0.0		2	$0.0	
	RES	28	$2.3		48	$3.6	
SJ 5	**TOTAL**	**53**	**$32.5**	**130**	**98**	**$154.9**	**240**

Appendix 2b: San Joaquin Economic Data by Impact Area continued

Values in October 1998 Prices (In $ Millions)

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	1	$0.1		1	$0.1	
	FARM	180	$20.2		180	$20.2	
	SEMI-	1	$0.2		1	$0.2	
	RES	104	$7.5		104	$7.5	
SJ 6A	**TOTAL**	**286**	**$28.0**	**590**	**286**	**$28.0**	**590**
	COMM	5	$4.9		5	$4.9	
	FARM	133	$8.9		133	$8.9	
	SEMI-	0	$0.0		0	$0.0	
	RES	5	$0.7		5	$0.7	
SJ 6B	**TOTAL**	**143**	**$14.5**	**220**	**143**	**$14.5**	**220**
	COMM	1	$0.1		1	$0.1	
	FARM	113	$11.8		113	$11.8	
	SEMI-	0	$0.0		0	$0.0	
	RES	4	$0.3		4	$0.3	
SJ 7	**TOTAL**	**118**	**$12.2**	**170**	**118**	**$12.2**	**170**
	COMM	16	$12.0		16	$12.0	
	FARM	357	$45.1		357	$45.1	
	SEMI-	0	$0.0		0	$0.0	
	RES	26	$2.1		26	$2.1	
SJ 8	**TOTAL**	**399**	**$59.2**	**590**	**399**	**$59.2**	**590**
	COMM	1	$0.3		1	$0.3	
	FARM	195	$14.9		195	$14.9	
	SEMI-	0	$0.0		0	$0.0	
	RES	15	$1.7		15	$1.7	
SJ 9	**TOTAL**	**211**	**$16.9**	**330**	**211**	**$16.9**	**330**

Appendix 2b: San Joaquin Economic Data by Impact Area continued

Values in October 1998 Prices (In $ Millions)

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	1	$0.4		1	$0.4	
	FARM	59	$7.2		99	$12.8	
	SEMI-	0	$0.0		0	$0.0	
	RES	1	$0.3		3	$0.4	
SJ 10	**TOTAL**	**61**	**$7.9**	**70**	**103**	**$13.6**	**160**
	COMM	0	$0.0		0	$0.0	
	FARM	58	$2.2		58	$2.2	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		0	$0.0	
SJ 11	**TOTAL**	**58**	**$2.2**	**90**	**58**	**$2.2**	**90**
	COMM	0	$0.0		0	$0.0	
	FARM	0	$0.0		15	$1.6	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		0	$0.0	
SJ 12	**TOTAL**	**0**	**$0.0**	**0**	**15**	**$1.6**	**20**
	COMM	0	$0.0		0	$0.0	
	FARM	9	$0.5		12	$0.6	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		0	$0.0	
SJ 13	**TOTAL**	**9**	**$0.5**	**10**	**12**	**$0.6**	**10**
	COMM	0	$0.0		0	$0.0	
	FARM	0	$0.0		0	$0.0	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		0	$0.0	
SJ 14	**TOTAL**	**0**	**$0.0**	**0**	**0**	**$0.0**	**0**

Appendix 2b: San Joaquin Economic Data by Impact Area continued

Values in October 1998 Prices (In $ Millions)

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	2	$1.4		2	$1.4	
	FARM	189	$26.6		189	$26.6	
	SEMI-	0	$0.0		0	$0.0	
	RES	16	$1.2		16	$1.2	
SJ 15	**TOTAL**	**207**	**$29.2**	**350**	**207**	**$29.2**	**350**
	COMM	15	$50.9		15	$50.9	
	FARM	499	$115.6		499	$115.6	
	SEMI-	1	$0.1		1	$0.1	
	RES	180	$11.7		180	$11.7	
SJ 16	**TOTAL**	**695**	**$178.3**	**1,410**	**695**	**$178.3**	**1,410**
	COMM	923	$539.3		930	$552.7	
	FARM	196	$17.2		200	$17.5	
	SEMI-	60	$17.7		62	$21.2	
	RES	8,599	$784.0		9,378	$921.9	
SJ 17	**TOTAL**	**9,778**	**$1,358.2**	**31,260**	**10,570**	**$1,513.3**	**34,070**
	COMM	0	$0.0		0	$0.0	
	FARM	124	$21.9		124	$21.9	
	SEMI-	0	$0.0		0	$0.0	
	RES	5	$0.3		5	$0.3	
SJ 18	**TOTAL**	**129**	**$22.2**	**210**	**129**	**$22.2**	**210**
	COMM	0	$0.0		1	$0.1	
	FARM	0	$0.0		47	$11.7	
	SEMI-	0	$0.0		1	$0.2	
	RES	0	$0.0		2	$0.1	
SJ 19	**TOTAL**	**0**	**$0.0**	**0**	**51**	**$12.1**	**80**

Appendix 2b: San Joaquin Economic Data by Impact Area continued

Values in October 1998 Prices (In $ Millions)

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	0	$0.0		1	$0.1	
	FARM	7	$0.5		13	$1.5	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		2	$0.3	
SJ 20	**TOTAL**	**7**	**$0.5**	**10**	**16**	**$1.9**	**30**
	COMM	0	$0.0		0	$0.0	
	FARM	0	$0.0		3	$2.4	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		0	$0.0	
SJ 21	**TOTAL**	**0**	**$0.0**	**0**	**3**	**$2.4**	**0**
	COMM	12	$27.6		95	$423.8	
	FARM	28	$7.6		220	$49.1	
	SEMI-	1	$8.1		5	$11.2	
	RES	204	$14.2		1,771	$131.9	
SJ 22	**TOTAL**	**245**	**$57.5**	**720**	**2,091**	**$616.0**	**5,850**
	COMM	0	$0.0		0	$0.0	
	FARM	35	$6.7		35	$6.7	
	SEMI-	0	$0.0		0	$0.0	
	RES	5	$0.6		5	$0.6	
SJ 23	**TOTAL**	**40**	**$7.3**	**70**	**40**	**$7.3**	**70**
	COMM	0	$0.0		0	$0.0	
	FARM	1	$0.3		1	$0.3	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		0	$0.0	
SJ 24	**TOTAL**	**1**	**$0.3**	**0**	**1**	**$0.3**	**0**

Appendix 2b: San Joaquin Economic Data by Impact Area continued

Values in October 1998 Prices (In $ Millions)

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	3	$87.4		3	$87.4	
	FARM	10	$2.6		10	$2.6	
	SEMI-	4	$11.7		4	$11.7	
	RES	15	$5.3		15	$5.3	
SJ 25	**TOTAL**	**32**	**$107.0**	**60**	**32**	**$107.0**	**60**
	COMM	1	$0.4		1	$0.4	
	FARM	150	$36.7		203	$48.3	
	SEMI-	4	$1.9		5	$2.6	
	RES	131	$19.8		163	$24.6	
SJ 26	**TOTAL**	**286**	**$58.8**	**690**	**372**	**$75.9**	**880**
	COMM	0	$0.0		0	$0.0	
	FARM	14	$7.4		14	$7.4	
	SEMI-	1	$0.8		1	$0.8	
	RES	4	$0.4		4	$0.4	
SJ 27	**TOTAL**	**19**	**$8.6**	**30**	**19**	**$8.6**	**30**
	COMM	6	$14.2		6	$14.2	
	FARM	114	$11.4		114	$11.4	
	SEMI-	1	$0.2		1	$0.2	
	RES	67	$9.5		67	$9.5	
SJ 28	**TOTAL**	**188**	**$35.3**	**400**	**188**	**$35.3**	**400**
	COMM	3	$0.5		3	$0.5	
	FARM	39	$4.4		39	$4.4	
	SEMI-	1	$0.0		1	$0.0	
	RES	5	$1.4		5	$1.4	
SJ 29	**TOTAL**	**48**	**$6.3**	**70**	**48**	**$6.3**	**70**

Appendix 2b: San Joaquin Economic Data by Impact Area continued

Values in October 1998 Prices (In $ Millions)

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	0	$0.0		70	$439.6	
	FARM	0	$0.0		140	$14.0	
	SEMI-	0	$0.0		14	$2.5	
	RES	0	$0.0		4,178	$489.7	
SJ 30A	**TOTAL**	**0**	**$0.0**	**0**	**4,402**	**$945.8**	**15,160**
	COMM	0	$0.0		27	$86.2	
	FARM	0	$0.0		18	$2.9	
	SEMI-	0	$0.0		2	$7.1	
	RES	0	$0.0		44	$4.0	
SJ 30B	**TOTAL**	**0**	**$0.0**	**0**	**91**	**$100.2**	**180**
	COMM	0	$0.0		34	$51.9	
	FARM	0	$0.0		36	$3.3	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		772	$110.2	
SJ 30C	**TOTAL**	**0**	**$0.0**	**0**	**842**	**$165.4**	**2,820**
	COMM	11	$5.7		11	$5.7	
	FARM	211	$22.5		211	$22.5	
	SEMI-	2	$0.1		2	$0.1	
	RES	63	$7.4		63	$7.4	
SJ 31	**TOTAL**	**287**	**$35.7**	**530**	**287**	**$35.7**	**530**
	COMM	0	$0.0		433	$376.5	
	FARM	0	$0.0		0	$0.0	
	SEMI-	0	$0.0		47	$12.0	
	RES	0	$0.0		5,820	$416.2	
SJ 32	**TOTAL**	**0**	**$0.0**	**0**	**6,300**	**$804.7**	**20,840**

Appendix 2b: San Joaquin Economic Data by Impact Area continued

Values in October 1998 Prices (In $ Millions)

Area at Risk	Land Use Code	100 Year FEMA Zone			Total Area (Includes 100 Year & Outside 100 Year)		
		Number of Parcels	Value Of Structure & Content	Population at Risk	Number of Parcels	Value Of Structure & Content	Population at Risk
	COMM	0	$0.0		0	$0.0	
	FARM	0	$0.0		13	$2.0	
	SEMI-	0	$0.0		0	$0.0	
	RES	0	$0.0		5	$0.6	
SJ 33	**TOTAL**	**0**	**$0.0**	**0**	**18**	**$2.6**	**40**
	COMM	1	$2.4		1	$2.4	
	FARM	33	$5.8		33	$5.8	
	SEMI-	3	$0.1		3	$0.1	
	RES	32	$5.4		32	$5.4	
SJ 34	**TOTAL**	**69**	**$13.7**	**160**	**69**	**$13.7**	**160**
	COMM	5	$4.5		5	$4.5	
	FARM	77	$13.7		77	$13.7	
	SEMI-	1	$0.2		1	$0.2	
	RES	20	$3.2		20	$3.2	
SJ 35	**TOTAL**	**103**	**$21.6**	**180**	**103**	**$21.6**	**180**
	COMM	1,014	$796.9		1,678	$2,324.1	
	FARM	2,963	$435.4		3,732	$561.6	
	SEMI-	82	$41.1		158	$70.8	
	RES	9,540	$882.9		22,824	$2,175.9	
SAN JOAQUIN TOTAL	**TOTAL**	**13,599**	**$2,156.3**	**38,550**	**28,392**	**$5,132.4**	**86,510**

Appendix 3a: Sacramento Land Use and Acreage of Agricultural Areas

Area at Risk	Major Crop Land Uses							Misc. Crop Land Uses			Non-Crop			Total Acres
	Corn	Rice	Almonds-Walnuts	Cotton	Tomato	Grapes	Pasture	Field Crops	Truck Crops	Fruit & Nut	Native Veg.	Idle Land	Urban Area	
SAC 1	150	40	7,990	0	0	0	4,580	2,900	350	2,090	18,380	1,200	6,440	44,120
SAC 2	730	390	24,050	0	0	0	2,120	8,060	0	6,660	14,370	250	620	57,250
SAC 3	350	0	940	0	140	0	420	2,100	180	460	190	250	70	5,100
SAC 4A	340	12,200	1,560	0	0	0	380	1,620	10	50	400	0	200	16,760
SAC 4B	220	13,220	420	0	690	0	300	1,150	560	600	780	170	340	18,450
SAC 4C	390	8,370	980	0	1,370	0	550	4,510	780	1,240	1,620	870	760	21,440
SAC 5A	90	180	150	0	300	0	10	610	80	180	940	90	1,150	3,780
SAC 5B	1,910	11,880	600	0	3,820	0	2,550	16,690	3,510	620	2,730	2,620	640	47,570
SAC 5C	1,150	22,270	440	0	4,200	0	1,250	14,800	1,390	40	850	990	110	47,490
SAC 5D	190	2,770	60	0	1,320	0	0	2,870	360	370	520	120	50	8,630
SAC 6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
SAC 7	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
SAC 8A	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
SAC 8B	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
SAC 9	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
SAC 10A	0	0	0	0	0	0	0	0	0	0	90	0	1,420	1,510
SAC 10B	0	420	700	0	0	0	170	130	0	8,580	370	150	820	11,340
SAC 11A	40	1,860	150	0	0	0	200	220	100	710	1,570	410	4,660	9,920

Appendix 3a: Sacramento Land Use and Acreage of Agricultural Areas continued

Area at Risk	Major Crop Land Uses							Misc. Crop Land Uses			Non-Crop			Total Acres
	Corn	Rice	Almonds-Walnuts	Cotton	Tomato	Grapes	Pasture	Field Crops	Truck Crops	Fruit & Nut	Native Veg.	Idle Land	Urban Area	
SAC 11B	0	1,320	1,250	0	0	0	720	140	220	4,930	2,760	860	700	12,900
SAC 12	0	0	1,410	0	0	0	370	160	20	190	390	0	100	2,640
SAC 13A	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
SAC 13B	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
SAC 14	80	0	60	0	1,400	0	340	1,090	170	0	290	40	160	3,630
SAC 15	40	290	0	0	350	0	300	730	220	0	110	0	10	2,050
SAC 16	60	50	170	0	1,390	0	130	890	340	0	170	0	10	3,210
SAC 17A	0	1,130	0	0	0	0	0	1,240	0	0	140	250	700	3,460
SAC 17B	1,070	2,530	0	0	0	0	290	1,920	0	0	220	680	280	6,990
SAC 18	1,170	0	0	0	740	0	720	3,720	10	0	140	40	170	6,710
SAC 19	0	0	2,970	0	230	0	0	2,550	0	100	150	190	10	6,200
SAC 20	370	0	330	0	1,300	0	150	3,040	140	60	450	90	140	6,070
SAC 21A	270	0	10	0	0	30	610	2,820	210	70	1,000	1,640	6,430	13,090
SAC 21B	300	0	0	0	300	200	600	1,190	0	40	360	0	40	3,030
SAC 21C	460	0	0	0	740	230	600	3,310	130	50	140	150	60	5,870
SAC 21D	2,050	0	40	0	4,280	210	2,990	12,190	420	0	750	160	410	23,500
SAC 22	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
SAC 23	0	0	0	0	0	0	0	0	0	0	150	0	6,390	6,540

Appendix 3a: Sacramento Land Use and Acreage of Agricultural Areas continued

Area at Risk	Major Crop Land Uses							Misc. Crop Land Uses			Non-Crop			Total Acres
	Corn	Rice	Almonds-Walnuts	Cotton	Tomato	Grapes	Pasture	Field Crops	Truck Crops	Fruit & Nut	Native Veg.	Idle Land	Urban Area	
SAC 24	0	0	0	0	0	0	0	0	0	0	40	20	820	880
SAC 25	250	0	0	0	0	0	230	1,030	100	10	2,930	140	35,770	40,460
SAC 26	350	0	0	0	630	1,050	370	1,660	40	340	230	10	60	4,740
SAC 27	1,610	0	0	0	1,210	1,120	210	2,720	0	1,870	200	30	260	9,230
SAC 28	2,280	0	0	0	1,760	1,580	5,720	4,750	50	590	8,460	1,260	1,330	27,780
SAC 29A	890	0	0	0	0	0	2,840	1,440	0	0	1,330	10	40	6,550
SAC 29B	0	0	0	0	0	0	1,230	90	0	0	60	10	0	1,390
SAC 30	2,410	0	0	0	660	0	1,830	2,070	0	0	2,490	40	40	9,540
SAC 31	2,180	0	10	0	2,120	620	870	5,200	0	450	230	60	80	11,820
SAC 32	230	0	0	0	170	140	110	530	0	1,230	120	10	30	2,570
SAC 33	5,320	0	0	0	1,150	20	1,200	6,130	0	1,910	480	70	350	16,630
SAC 34	680	0	0	0	0	20	290	760	0	470	50	0	50	2,320
SAC 35	7,260	0	0	0	0	130	50	3,560	0	280	1,010	20	540	12,850
SAC 36	0	0	0	0	0	0	0	0	0	90	650	40	30	810
SAC 37	110	0	0	0	0	0	50	110	0	0	20	40	140	470
SAC 38	5,230	0	0	0	310	0	150	2,450	10	260	280	40	90	8,820
SAC 39	2,470	0	0	0	1,500	1,500	90	1,580	400	160	320	80	490	8,590
SAC 40	1,250	0	0	0	210	0	210	580	0	20	350	920	20	3,560
SAC 41	620	0	0	0	0	0	530	4,160	410	0	400	2,610	80	8,810

Appendix 3b: San Joaquin Land Use and Acreage of Agricultural Areas

Area at Risk	Major Crop Land Uses							Misc. Crop Land Uses			Non-Crop			Total Acres
	Corn	Rice	Almonds-Walnuts	Cotton	Tomato	Grapes	Pasture	Field Crops	Truck Crops	Fruit & Nut	Native Veg.	Idle Land	Urban Area	
SJ 1	40	0	580	100	0	0	680	140	90	60	7,010	60	1,410	10,170
SJ 2	1,140	0	450	990	0	600	3,300	1,860	530	0	2,860	1,700	170	13,600
SJ 3	200	0	40	460	0	780	1,240	0	0	0	2,450	20	40	5,230
SJ 4	10	0	280	3,410	220	380	1,500	1,760	220	100	2,440	110	300	10,730
SJ 5	20	0	90	2,320	40	650	1,770	1,690	340	0	14,380	270	580	22,150
SJ 6A	600	430	610	12,710	620	890	10,130	7,260	1,040	1,070	16,300	290	710	52,660
SJ 6B	1,230	0	40	9,900	1,010	230	11,580	2,890	410	100	6,300	1,340	480	35,510
SJ 7	800	0	1,610	2,160	0	80	1,820	820	0	280	4,090	0	250	11,910
SJ 8	1,870	0	4,890	2,490	0	6,190	1,640	1,210	30	1,480	1,960	1,470	970	24,200
SJ 9	1,100	0	2,170	2,850	0	270	1,530	780	0	20	240	210	360	9,530
SJ 10	750	0	220	2,810	0	220	4,230	2,950	0	80	1,720	720	330	14,030
SJ 11	40	0	0	3,900	1,260	0	2,840	930	230	0	1,360	100	120	10,780
SJ 12	0	0	0	5,960	5,020	0	1,550	1,990	560	0	750	0	80	15,910
SJ 13	0	0	0	0	0	0	1,850	0	0	0	6,610	260	0	8,720
SJ 14	0	0	0	0	0	0	1,780	0	0	0	1,400	0	0	3,180
SJ 15	1,150	0	0	0	0	420	2,440	890	180	0	5,430	540	150	11,200

Appendix 3b: San Joaquin Land Use and Acreage of Agricultural Areas continued

Area at Risk	Major Crop Land Uses							Misc. Crop Land Uses			Non-Crop			Total Acres
	Corn	Rice	Almonds-Walnuts	Cotton	Tomato	Grapes	Pasture	Field Crops	Truck Crops	Fruit & Nut	Native Veg.	Idle Land	Urban Area	
SJ 16	12,33	3,720	8,060	11,390	5,340	2,150	26,800	12,820	2,010	2,590	35,020	6,270	4,850	133,350
SJ 17	910	610	2,300	220	910	0	1,740	730	130	880	910	400	6,180	15,920
SJ 18	2,360	0	590	0	0	680	2,650	390	100	880	3,500	180	530	11,860
SJ 19	1,680	0	0	0	0	0	3,380	80	0	0	1,910	50	130	7,230
SJ 20	20	0	20	0	100	0	490	600	0	0	190	0	20	1,440
SJ 21	380	0	0	0	0	0	100	350	0	0	130	0	20	980
SJ 22	3,450	0	5,000	0	120	880	1,160	500	90	570	2,230	60	2,170	16,230
SJ 23	520	0	0	0	0	0	4,470	50	70	0	1,420	0	20	6,550
SJ 24	200	0	20	0	200	0	0	120	10	0	100	20	0	670
SJ 25	390	0	960	0	0	80	200	120	0	50	2,450	70	210	4,530
SJ 26	1,500	0	1,090	0	730	720	4,220	3,960	820	40	660	60	740	14,540
SJ 27	370	0	0	0	260	0	370	440	0	0	210	0	230	1,880
SJ 28	610	0	40	0	1,730	0	3,850	3,130	530	0	550	10	920	11,370
SJ 29	850	0	130	0	720	0	1,700	890	440	0	160	0	170	5,060
SJ 30A	880	0	210	0	110	0	2,680	2,990	2,450	150	1,670	50	4,840	16,030
SJ 30B	160	0	300	0	0	10	80	180	60	0	190	30	500	1,510
SJ 30C	570	0	200	0	90	90	1,350	460	300	0	220	30	990	4,300
SJ 31	3,180	0	190	0	2,690	1,090	7,930	9,970	4,750	70	850	130	1,260	32,110

Appendix 3b: San Joaquin Land Use and Acreage of Agricultural Areas continued

Area at Risk	Major Crop Land Uses							Misc. Crop Land Uses			Non-Crop			Total Acres
	Corn	Rice	Almonds-Walnuts	Cotton	Tomato	Grapes	Pasture	Field Crops	Truck Crops	Fruit & Nut	Native Veg.	Idle Land	Urban Area	
SJ 32	0	0	0	0	0	0	0	110	0	0	80	0	3,830	4,020
SJ 33	240	0	60	0	90	150	210	400	250	0	80	30	20	1,530
SJ 34	770	0	20	0	210	0	1,990	1,840	200	0	340	0	840	6,210
SJ 35	240	0	40	0	1,150	0	1,260	890	2,700	0	90	40	80	6,490
TOTAL-SJ	40,550	4,760	30,170	61,660	22,620	16,550	116,500	66,160	18,560	8,430	128,230	14,490	34,500	563,190

Appendix 4a: Impact Area Flood Stage and Top of Levee

Impact Area	Description	Flood Stage (ft)	Top of Levee (ft)
\	Keswick Dam to Tehama Co. Line	204.30	NA
01b	Shasta Co. Line to S of Red Bluff	204.30	NA
02	Tehama to Old Ferry Bridge	158.54	NA
03	Sacramento; Butte Sink	87.92	92.20
04a	Colusa Basin (North)	106.70	110.30
04b	Colusa Basin (Mid)	87.92	92.20
04c	Colusa Basin (South)	68.11	71.91
05a	Colusa Basin (Colusa)	67.05	70.05
05b	Colusa Basin	58.50	62.00
05c	Colusa Basin	49.70	53.10
05d	Colusa Basin	43.75	47.75
06	N of Tisdale Bypass	49.95	53.95
07	Sutter Bypass, Wadsworth Canal	67.00	70.00
08a	Sutter Bypass, Feather River	44.70	51.20
08b	Sutter Bypass, South (Yuba City)	77.20	80.50
09	S. of Tisdale Bypass (Robbins)	37.80	42.40
10a	Marysville	74.03	77.03
10b		89.05	92.40
11a	E. of Feather River (Olivehurst)	77.20	80.50
11b	E of Feather River (N of Bear Rv)	77.20	80.50
12	Bear Creek; Dry Creek	92.22	98.22
13a	Rio Oso, East Nicholas	44.70	51.20
13b	Between Verona & Nicholas	43.85	48.60
14	Knights Landing	37.80	42.40
15	N bank Cache Creek	37.80	42.40
16	S bank Cache Creek	31.30	34.30
17a	SE Woodland; Yolo Bypass	31.30	34.30
17b		31.30	34.30
18	E of Davis; Yolo Bypass	31.30	34.30
19	Yolo Bypass, Sacramento Right	31.30	34.30
20	Yolo Bypass, Yolo Bypass	31.30	34.30
21a	Sacramento R, Yolo, Ship Channel	31.00	34.00
21b	Sacramento R, Yolo Bypass	25.30	28.30
21c	Sacramento R, Yolo Bypass	25.30	28.30
21d	Sacramento R, Yolo Bypass	25.30	28.30
22	Natomas; American Basin	34.90	40.75
23	American R, N Sacramento	39.73	44.43
24	American R, S Sacramento	102.00	105.00
25*	City of Sacramento	31.00 25.30	34.00 28.30
26	Yolo Bypass	25.30	28.30
27	Sacramento, W of Snodgrass Sl	25.30	28.30
28	Sacramento, E of Snodgrass Sl	25.30	28.30
29a	Lindsy Sl, Ulatis Cr, Cache Sl	17.4	23.65
29b		17.40	23.65
30	Lindsey Sl, Watson Hollow Drain	9.50	19.00
31	Miner, Cache, Steamboat & Sutter	9.50	19.00
32	Sacramento; Steamboat; Sutter	17.40	23.65
33	Sacramento; Steamboat Sl	15.00	18.00
34	Sacramento; Georgiana Sl	17.40	23.65
35	Brannan 1	9.50	19.00
36	Locke Area	15.00	18.00
37	Walnut Grove Area	15.00	18.00
38	Tyler 1	15.00	18.00
39	New Hope tract, Cosumnes R.	15.00	18.00
40	Sacramento, San Joaquin, 3-mile	9.50	19.00
41	Sherman 1	14.00	17.00

*See Note in Appendix 1

Appendix 4b: Zero Damage, Flood Stage, and Top-of levee Elevation for the San Joaquin Valley Impact Areas

Impact Area (1)	Zero damage (2)	Flood stage (3)	Top-of-levee (4)	Flood stage source (5)
SJ01	221	221	NA	
SJ02	165	165	NA	
SJ03	170	170	NA	
SJ04	158	158	NA	
SJ05	147	150.5	151.9	FEOM
SJ06a	145	150.5	151.2	FEOM
SJ06b	108	109	111.3	FEOM
SJ07	146	160.2	163.2	TOL-3
SJ08	181	182.6	185.6	TOL-3
SJ09	143	148.6	151.6	TOL-3
SJ10	105	106	107.2	FEOM
SJ11	101	106	106.1	FEOM
SJ12	101	106	106.1	FEOM
SJ13	75	80.8	83.8	TOL-3
SJ14	84	87.9	90.9	TOL-3
SJ15	75	76.7	79.7	TOL-3
SJ16	91	102.5	105.5	TOL-3
SJ17	185	185	NA	
SJ18	114	114	NA	
SJ19	45	56.4	59.4	TOL-3
SJ20	49	58.4	61.4	TOL-3
SJ21	30	39.8	42.8	TOL-3
SJ22	50	50.5	NA	FEOM
SJ23	25	36.4	39.4	TOL-3
SJ24	26	37.4	40.4	TOL-3
SJ25	45	60.7	NA	FEOM
SJ26	20	29	36.2	FEOM
SJ27	25	29	33.7	FEOM
SJ28	10	22	25	Estimated TOL as zero damage + 15 FS = TOL - 3
SJ29	12	24	27	Estimated TOL as zero damage + 15 FS = TOL - 3
SJ30a	13	25.6	28.6	TOL-3
SJ30b	15	27.1	30.1	TOL-3

Appendix 4b: Zero Damage, Flood Stage, and Top-of-levee Elevation for the San Joaquin Valley Impact Areas continued

Impact Area (1)	Zero damage (2)	Flood stage (3)	Top-of-levee (4)	Flood stage source (5)
SJ30c	15	28.6	31.6	TOL-3
SJ31	0	12	15	Estimated TOL as zero damage + 15 FS = TOL - 3
SJ32	5	13.6	16.6	TOL-3
SJ33	5	17	20	Estimated TOL as zero damage + 15 FS = TOL – 3
SJ34	5	17	20	Estimated TOL as zero damage + 15 FS = TOL – 3
SJ35	5	17	20	s zero damage + 15 FS = TOL – 3

[1]**FEOM –Flood Emergency Operations Manual (1994). California Department of Water Resources Division of Flood Management.**

Appendix 5
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