TECHNICAL REPORT
FOR
HYDRAULIC ANALYSIS RESULTS

Cache Creek
between
County Road 94B and Interstate 5
Yolo County, California

April 2002

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I. Introduction

This report describes the focused results of a hydraulic analysis of Cache Creek between Road 94B and I-5. Figure 1 shows the study area. In March 1995, flooding occurred to the north and south of Cache Creek, upstream of I-5. The flooding was the result of water overtopping the natural bank of Cache Creek. Flooding downstream of I-5 overtopped the levee, but was contained by flood fighting on the levee crown.

In February 1998, flooding occurred north and south of Cache Creek, upstream of I-5. The flooding was the result of water overtopping the natural bank of Cache Creek.

As a result of these floods, Yolo County retained the services of MBK Engineers to evaluate the recent flood events and proposed alternatives to reduce flood frequency in the subject reach.

II. Hydrology

Limited historical runoff data is available for the Cache Creek basin. For this investigation, 60 years of runoff data was utilized for evaluating flow frequencies and magnitudes. Although this length of record is much better than the length of record for many rivers in California, it is still considered a relatively short period of time. It is important to understand that this study is based on past events that we assume will be equaled in the future; however, significantly greater flood flows may occur.

The computer program HEC-1 was used for the Cache Creek Basin model. Discharge hydrographs were developed for the without-project condition for Cache Creek for the 50-, 100-, 200-, and 500-year flood events. Historical flood stages and cross sections were used to verify the channel capacity of Cache Creek.

A detailed hydrology study was performed and is included as part of the US Army Corps' Draft Feasibility Report for Lower Cache Creek, City of Woodland and Vicinity, March 2001. For the hydraulic study, flows developed, in the hydrology study were input at Road 94B. Tabulated below are the peak flows and associated frequency.

Table 1
Road 94B
Estimated Cache Creek Peak Flood Flow & Frequency

Return Period (years)	Peak Flow (cfs)
10	31,500
50	53,290
100	63,683
200	70,085
500	78,595

The Yolo gage is downstream of RD 94B and does not represent flows fully contained by Cache Creek. Natural banks between RD 94B and Yolo begin to overtop between 36,000 to 38,000 cfs. Flow data for the USGS gage located at Yolo was utilized to reconstruct historical flood events in 1995 and 1998. For comparison, historical flows at the Yolo gage are tabulated below in Table 2.

Table 2
Cache Creek Historic Flows at Yolo [1]

Location	Date	Flood Peak (cfs)	3-Day Flow Volume (ac-ft)
Cache Creek at Yolo	25 Feb 58	41,400	102,230
	23 Dec 64	26,200	79,360
	6 Jan 65	37,800	97,420
	24 Jan 70	34,600	125,720
	27 Jan 83	33,000	86,800
	17 Feb 86	26,100	111,870
	9 Jan 95	32,000	121,980
	9 Mar 95	36,400	113,260
	3 Feb 98	34,300	109,690

[1] As reported by USGS. Volumes are based on gage data which may not account for overbank flow. Data has not been adjusted for Indian Valley Reservoir.

III. Hydraulics

Topographic data was obtained using the Corps' April 2000 aerial topography for the base condition. Additional topography was obtained from County annual coverage flight for the years of 1996, 1998 and 2001.

Hydraulic modeling and floodplain delineations were conducted on Cache Creek in the subject reach. Water-surface profiles and overbank flood depths were developed for the existing (pre-project) conditions for Cache Creek using the HEC-RAS computer program.

HEC-RAS is a computer program that can model one-dimensional, unsteady flow for open channel hydraulics. The study reach extended from the Cache Creek settling basin to Road 94B. Cross sections for the model used the survey data to develop sections spaced about 500 feet apart. Overbank or levee failure flows were modeled as inflow to storage areas for possible later input.

Manning's "n" values ranged from .04 to .052 for overbank and from .032 to .042 for channel. Contraction and expansion loss coefficients ranged from 0.1 to 0.3 for gradual transitions to 0.3 to 0.5 for some bridge crossing sections.

Model Calibration for the March 1995 Event

The model was calibrated to the March 6-12, 1995, flood event to determine the existing hydraulic conditions in the creek. The model was calibrated such that the maximum flow and stage observations were replicated within reasonable accuracy and overbank flooding occurred where it was observed for the event. The calibration was performed by changing the Manning's "n" values (a measure of roughness or resistance to flow in the channel and overbank areas) for several sections of the creek and rerunning the model until the best match of the observed data was determined. Figure 2 shows the March 1995 profile.

Recalibration for the February 1998 Event

After the model was calibrated for the March 1995 event, the February 1-6, 1998 event was modeled to determine if any hydraulic conditions had changed since the March 1995 event to cause an increase in the number of observed flooded areas. Specifically, changes in the roughness (Manning's n) in several sections of the channel were considered. Again, the flow and stage values were replicated within reasonable accuracy and the regions of overbank flooding were reproduced by the model. Figure 3 shows the February 1998 profile.

IV. Alternatives

Two alternatives were developed to compare against the non-project condition. These alternatives consisted of vegetation removal within the flood channel and sediment removal within the channel. The elements for each alternative are described below.

A. Vegetation Removal

The calibration results for the March 1995 and February 1998 flood events showed an increase in Manning's n values by approximately 6% between Interstate 5 and River Station 650+00 and by 15% between River Station 650+00 and Road 94b. This indicates an increased roughness in the main channel and overbank areas of Cache Creek between March 1995 and February 1998, which is most likely due to significant growth in the vegetation in the creek and its overbank areas. Comparison of aerial photography over this period shows a lateral increase in vegetation growth.

To test the sensitively of n values and model the effects of hypothetical vegetation removal, n values were increased and decreased by 10%. Table 3 shows the effect of potential vegetation removal within the channel and banks.

Table 3

Cache Creek Calculated January 1995 Water Surface Elevations
1,000' Downstream of I-5 to RD 94B
Sensitivity Analysis Results

Location	Existing Condition	10% Reduction in N-Value		10% Increase in N-Value	
	W.S.	W.S.	Diff (ft)	W.S.	Diff (ft)
Upstream of I-5 Station 585+30	80.17	79.98	-0.19	80.38	+0.21
At Bend near RD 18B	84.07	83.32	-0.75	84.85	+0.78
Near RD 96A Station 720+00	87.88	87.13	-0.75	88.66	+0.78
At RD 94B Station 847+00	91.83	91.13	-0.70	92.39	+0.56

Typical vegetation clearing to accomplish the reduction in water surface elevations, shown in Table 3, would consist of removal of dense stands of vegetation present in the winter from December thru March. This would include removal of arundo (arundo donax, giant reed), tamarisk (tamarix s.p., salt cedar) lower tree limb removal, and debris removal.

B. Sediment Removal

Changes in sediment accumulation in the study area were evaluated by comparison of aerial topography from November 1996 and April 2001. The aerial topography was taken at 2-foot contour intervals with black & white rectified orthographic photography. Sediment bars were identified for each year. Area and volume calculation were tabulated for each year and compared. Figure 4 shows the respective sediment bar location for each year. The results show a decrease in sediment accumulation in the study area. This would indicate that sediment is not a significant factor for increases in water surface elevations.

To further evaluate sediment effects, the base hydraulic model was modified to remove sediment bars. Additional cross-sections were added to define the sediment bars. The bars were then skimmed to the low water line and then the hydraulic model was rerun. Comparisons between the models show no significant change in water surface elevations (plus or minus 0.10 feet).

C. No Project

The no-project alternative consists of doing nothing in the project reach. Vegetation will continue to grow with increased density under a natural process.

Based on the hydraulic analysis, this may mean more frequent overtopping. It was noted during a field review that vegetation is also contributing to bank erosion. This will likely continue under the no-project alternative.

V. Conclusions

The hydraulic analysis shows that water surface elevations are sensitive to n-values. Subsequently, vegetation density and type is the primary component to reduce n-values. Vegetation control should concentrate in the main channel to maximize channel capacity. Vegetation in the overbank should be a second priority. Caution should be used not to increase existing erosion in problem areas due to vegetation removal. Site specific evaluations should be made to identify the extent and magnitude of vegetation removal. Removal of non-native plants, arundo, and tamarisk should have the highest property. Clearing lower tree limbs and debris will also help to increase channel capacity.

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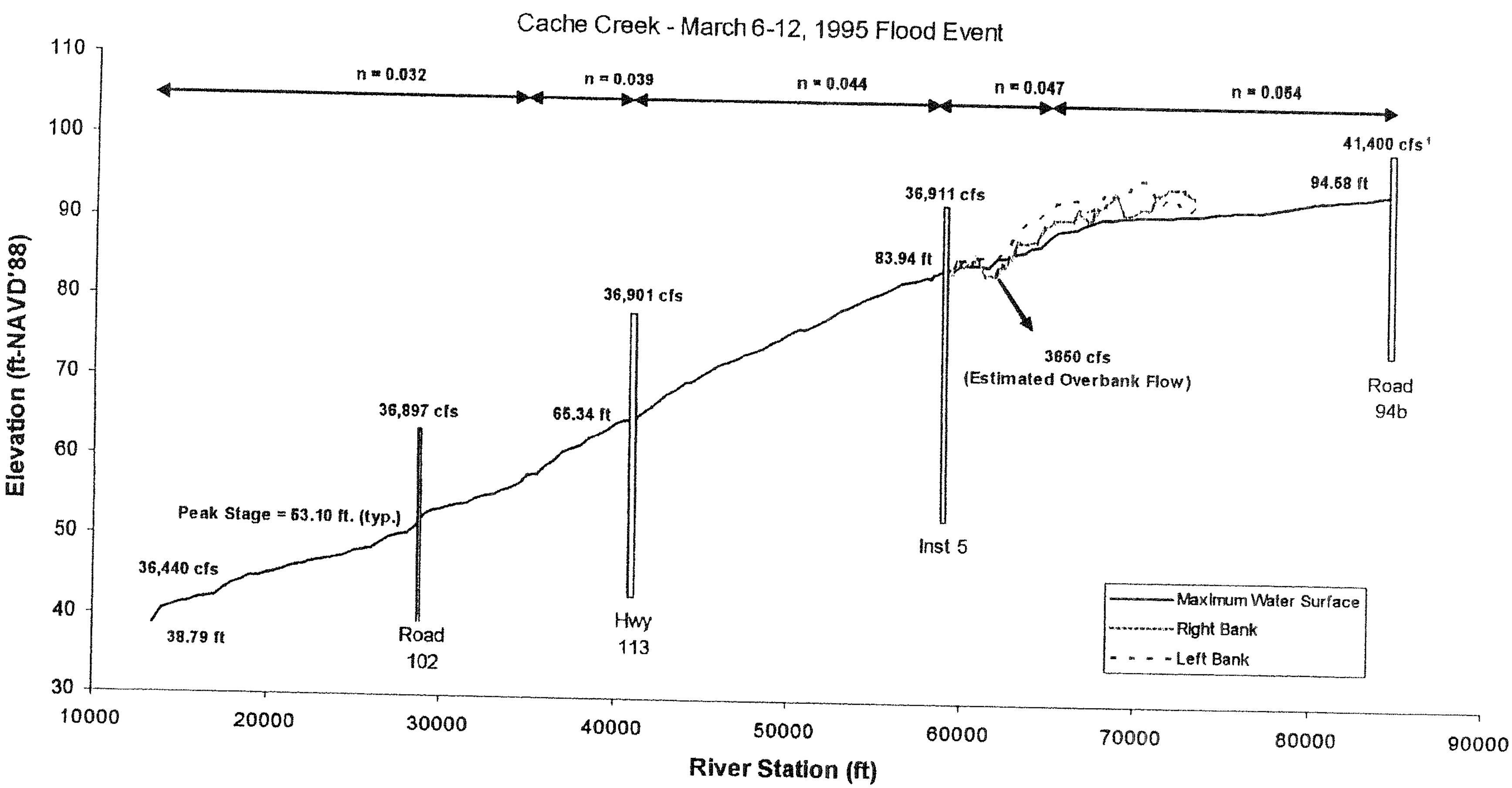

1) Based on USGS estimated flow at Yolo

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2450 Alhambra Boulevard, 2nd Floor
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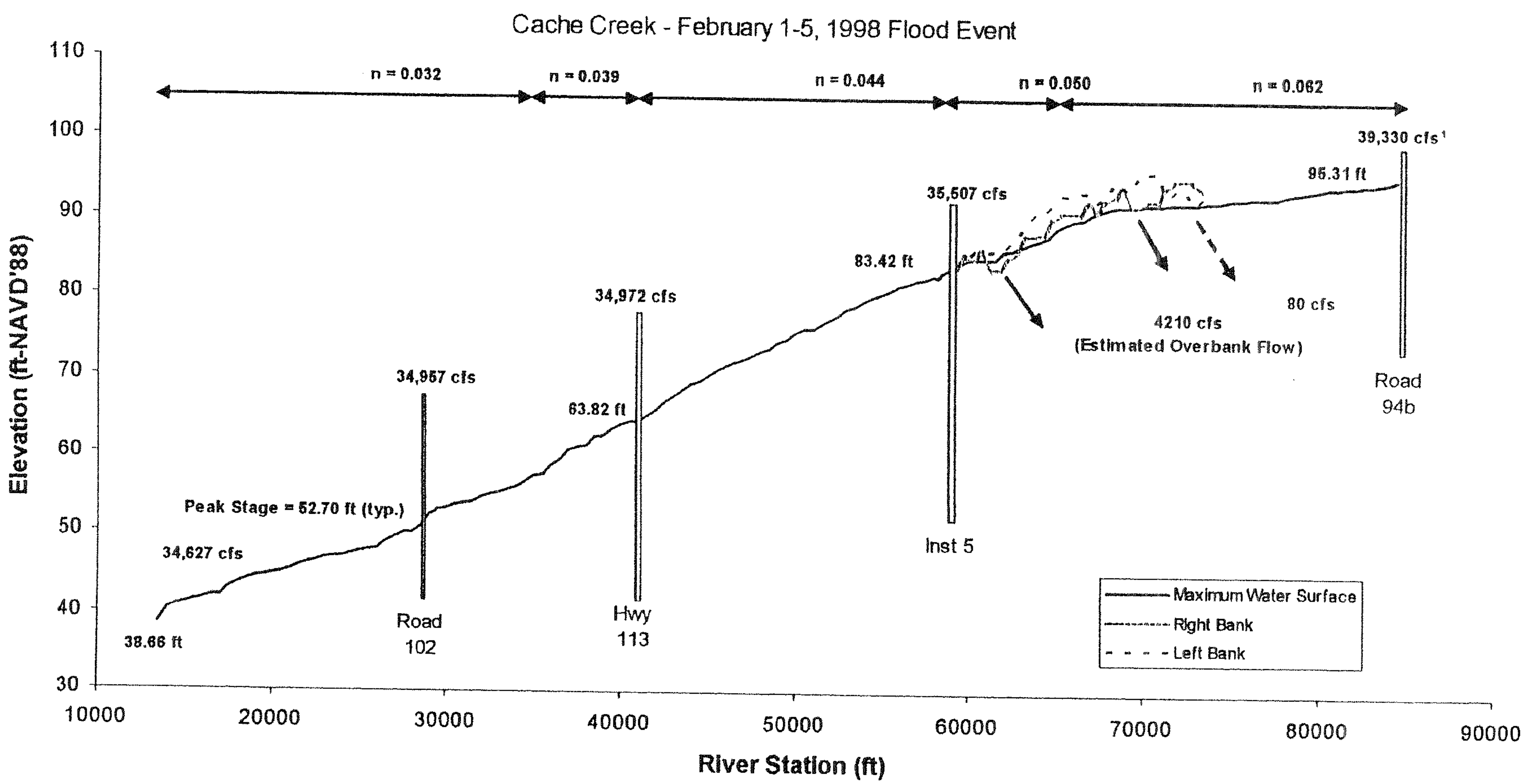
Phone: (916) 456-4400 • Fax: (916) 456-0253

Cache Creek

March 1995
HEC-RAS Profile

DATE: April 2002

FIGURE 2



1) Based on USGS estimated flow at Yolo and oral testimony of overbank flow

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Cache Creek

Febuary 1998
HEC-RAS Profile

FIGURE
3

Graval Bar ID	[redacted]		11-26-96 AREA	11-26-96 VOLUME	Change In Area	Change In Volume
	(ft²)	(cubic yards)	(ft²)	(cubic yards)	(ft²)	(cubic yards)
A	3324.090	7055.073	4057.230	8414.996	-733.140	-1359.922
B	5427.370	10723.579	3157.680	5970.939	2269.690	4752.640
C	5816.460	11004.419	5949.600	10795.219	-133.140	209.201
D	6035.680	12294.904	9239.730	16302.990	-3204.050	-4008.087
Total	20603.600	41077.975	22404.240	41484.143	-1800.640	-406.169

Image Source: 2001 Cartwright Aerial Base Photo

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Cache Creek

SEDIMENT BAR ANALYSIS

SCALE: 1" = 1000'
JOB NUMBER: 1417.2
REQUESTED BY: MF
DRAWN BY: JH,MB
DATE: April 2002

FIGURE 4