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SUTTER-BUTTE MAIN CANAL: INVESTIGATION REGARDING INFLOW FROM A FEATHER RIVER WEST LEVEE BREACH

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Prepared for: Sutter-Butte Flood Control Agency ***January 23, 2012***

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INTRODUCTION

The Sutter-Butte Main Canal conveys irrigation water from the Thermalito Afterbay to the Sutter Basin and there are sections of the canal where its alignment runs adjacent to the Feather River-Yuba City West Levee toe. In reach 26 thru 28 of the Feather River West Levee Project (FRWLP) (near Evans Reimer Road in Butte County), the 200-year water surface profile in the Feather River channel is lower than the landside ground elevation, but higher than the channel invert of the Main Canal. This Technical Memorandum (TM) investigates the scenario of a levee breach of the Feather River West Levee in reach 26-28, thereby flooding the Sutter-Butte Main Canal. The TM answers the following three questions:

1) What is the peak flow that can enter the Main Canal through the Feather River levee breach?
2) Where is the water conveyed?
3) Is there any flooding resulting from the levee breach?

At issue is whether SBFCA should improve reaches 26-28 to California Urban Levee Design Criteria standards for SB5 200-yr protection, or whether the consequences of non-accreditation are acceptable.

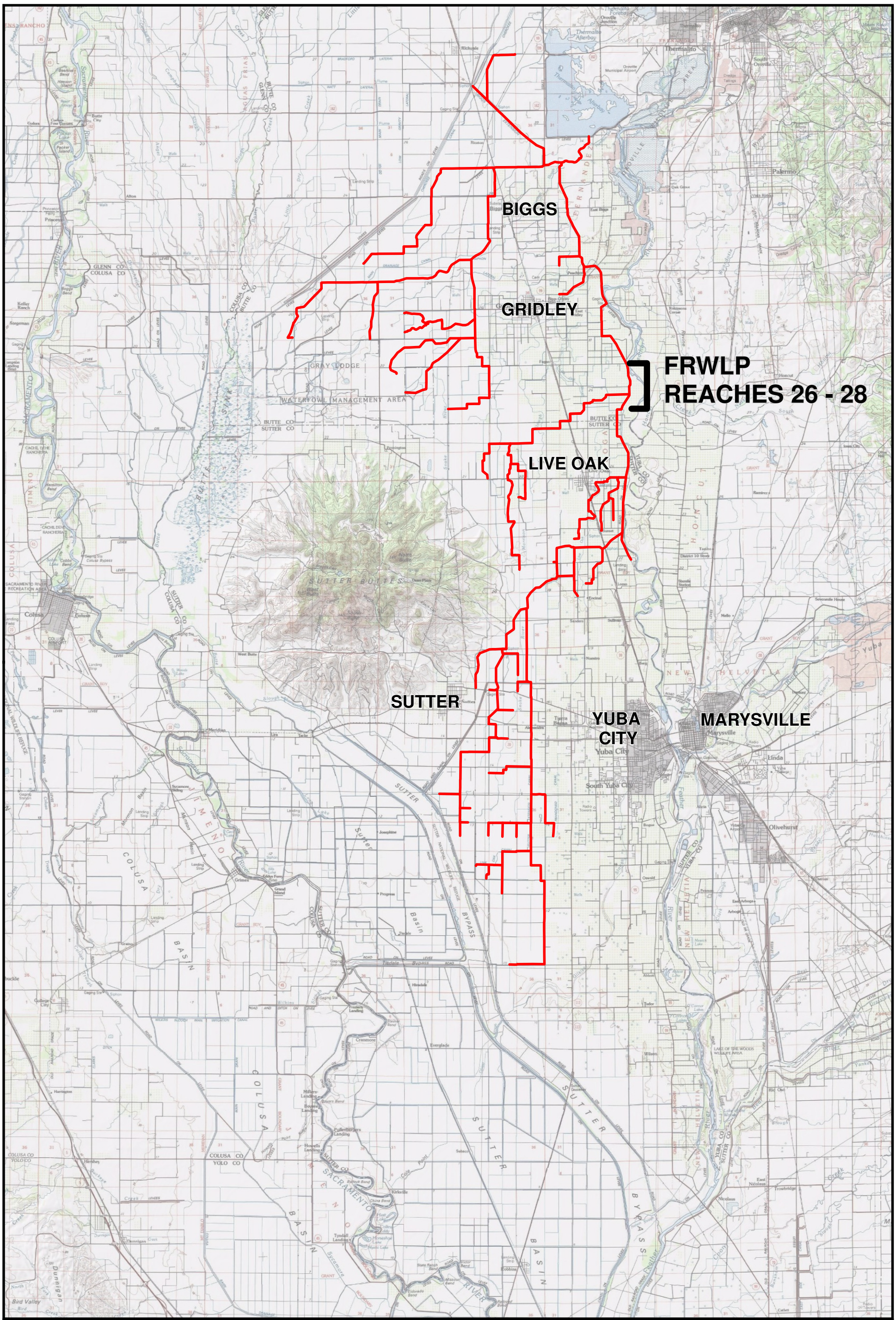
ANALYSIS

The Sutter-Butte Main Canal is operated by the Joint Water Districts – consisting of Richvale Irrigation District, Biggs/West Gridley Water District, Butte Water District, and Sutter Extension Water District. The Main Canal delivers Feather River water supply to all four districts that are located generally south and west of Lake Oroville and the Feather River along the eastern side of the Sacramento Valley. The diversion for the canal was originally located at the headgate in FRWLP reach 40/41, but following the construction of the State Water Project's Oroville Dam and related downstream facilities, the canal began taking supply directly from the Thermalito Afterbay. The canal route runs roughly north to south, with major turnouts to each of the four districts' internal distribution systems. Figure 1 shows the Main Canal along with its major turnouts and laterals. The canal is approximately 17 miles long and is predominately unlined. The existing operating capacity ranges from approximately 1,600 cubic feet per second (cfs) at the upstream end to approximately 500 cfs at the downstream end. Operation and maintenance (O&M) of the Main Canal is conducted by the Joint Water Districts Board, which includes representatives of each of the four districts. The Main Canal operates as the backbone of a gravity irrigation distribution system, with check dams at regular intervals used to maintain water surface levels at sufficient heights to allow gravity diversions to adjacent users.

According to Joint Water District staff, the Main Canal's irrigation season runs from April through January and there are two peak periods; 1) for the irrigation of rice land and 2) for the irrigation of wildlife habitat during the duck hunting season. During the irrigation season, the canal is kept full of water, with its water surface near the top of the canal banks by raising and lowering the check dams as needed. The check dams are removed when the canal is not in use for irrigation purposes and although the Main Canal is not operated as a drainage facility, drainage water does make its way into the canal at times. During the irrigation season, the Main Canal travels over the East Interceptor Canal via three different flumes so that it can supply water to southern farm fields. However, during the non-irrigation season, the flume boxes are opened so that all drainage flows spill into the E. Interceptor, which flows to the Wadsworth Canal.

This analysis utilizes the SBFCA Design Water Surface Profiles[(1)] (dated September, 2011) for the 200-year water surface elevations in the Feather River. The section of the Main Canal analyzed for this study is located just south of Evans Reimer Road (project design station 1674+37; Reach 28) to just south of Chandon Avenue (design station 1769+00; Reach 26). Figure 2 shows an overview of the subject area along with the relevant Feather River HEC-RAS cross sections that were utilized for the Design Water Surface Profiles.

Cross sections of the Main Canal (looking downstream) were cut from CVFED LiDAR data[(2)] at each of the HEC-RAS cross sections (see Figures 4 thru 12). The cross sections also show the 200-year water surface, the Feather River right overbank area and the Feather River West levee.



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0 1 2 4 Miles

NOVEMBER 28, 2011

SUTTER BUTTE FLOOD CONTROL AGENCY

SUTTER-BUTTE MAIN CANAL AND MAJOR LATERALS

FIGURE

1

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SUTTER BUTTE FLOOD CONTROL AGENCY

SUTTER-BUTTE MAIN CANAL
NEAR EVANS REIMER RD.

FIGURE
2

Figure 3. Main Canal Cross Section at River Station (RS) 47.55

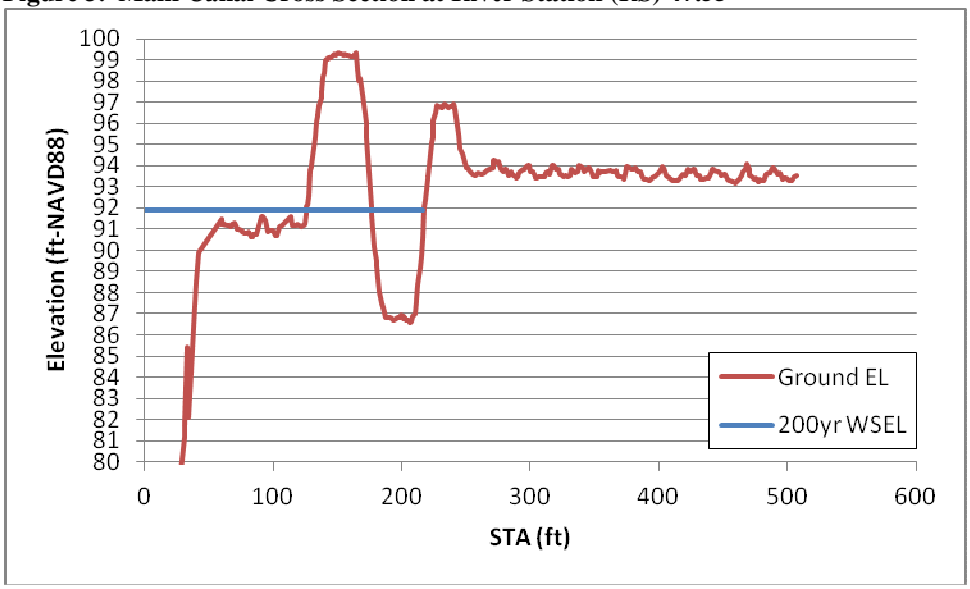


Figure 4. Main Canal Cross Section at RS 47.2

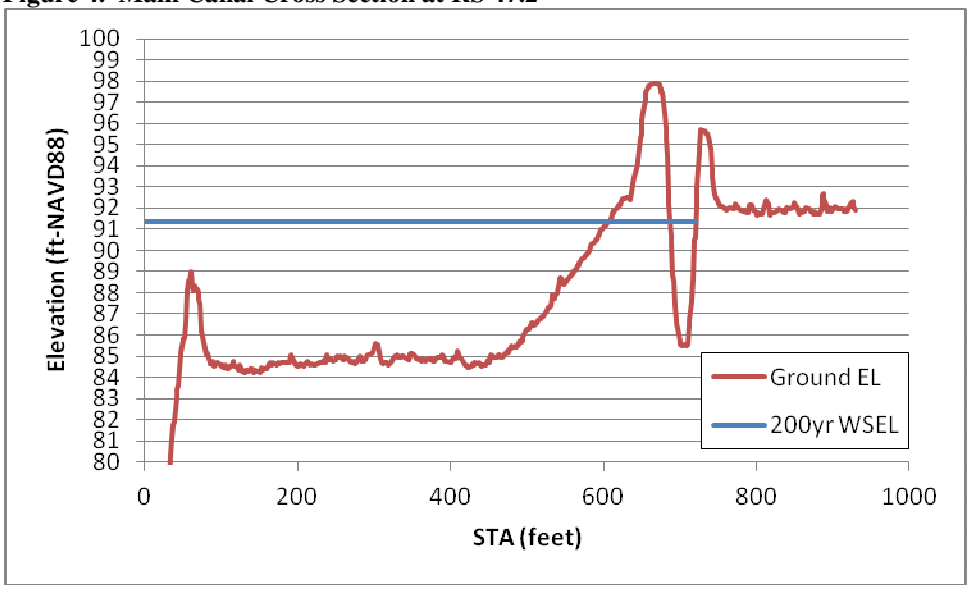


Figure 5. Main Canal Cross Section at RS 47.04

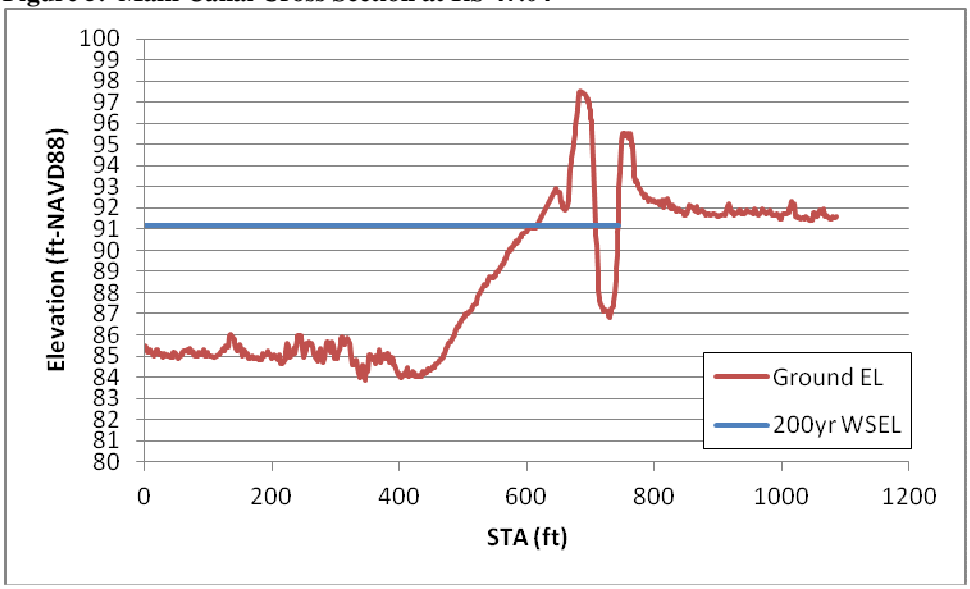


Figure 6. Main Canal Cross Section at RS 46.69

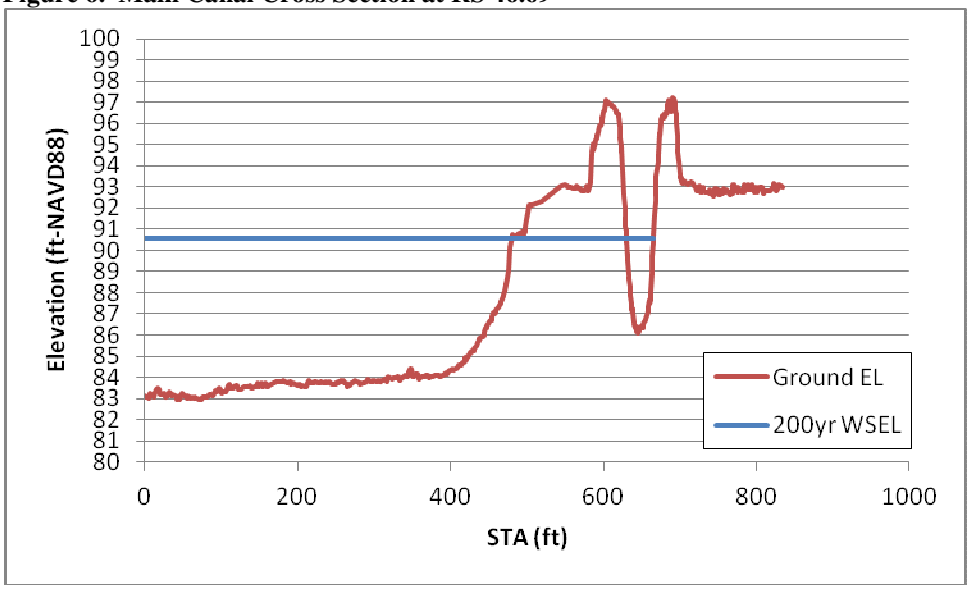


Figure 7. Main Canal Cross Section at RS 46.53

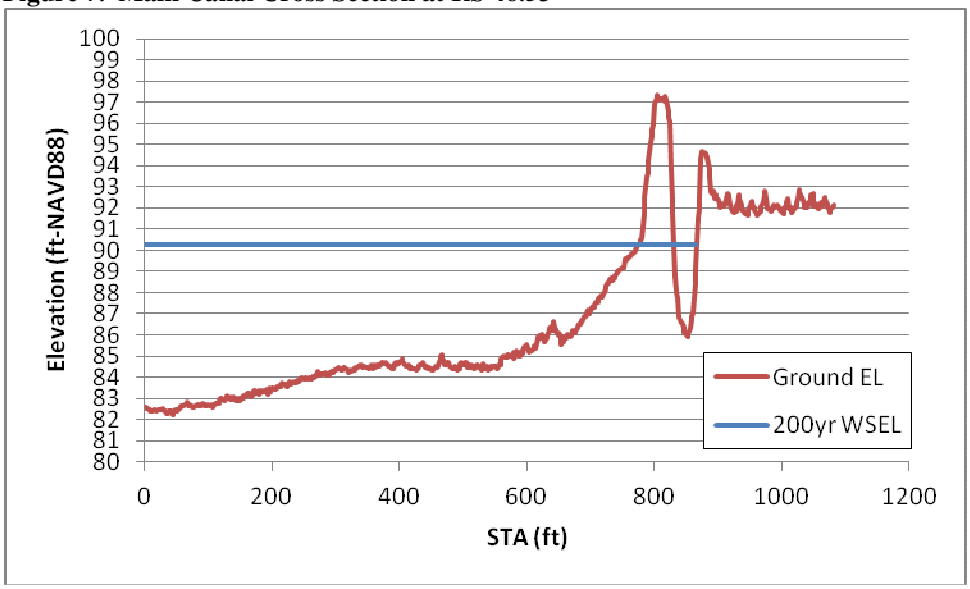


Figure 8. Main Canal Cross Section at RS 46.45

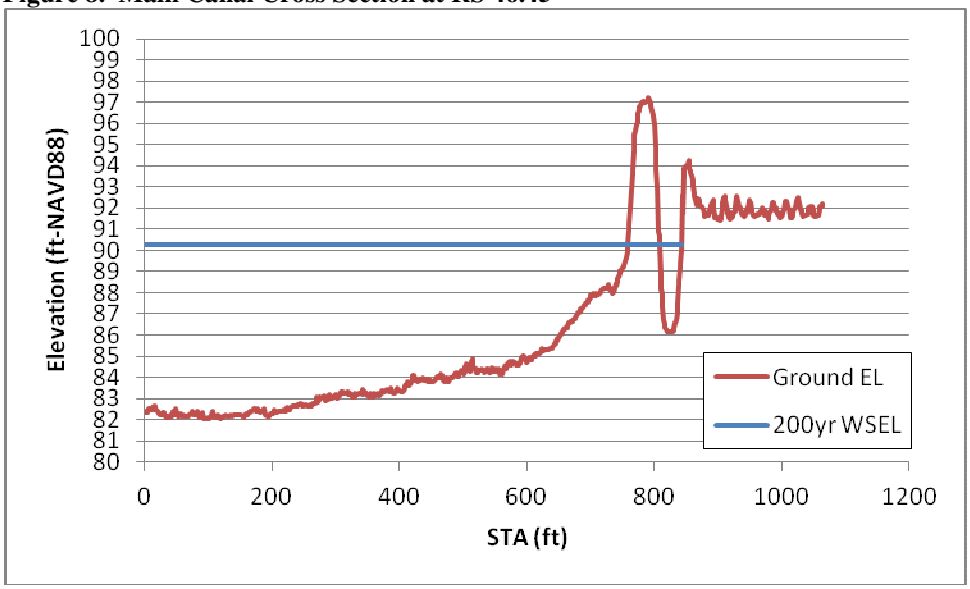


Figure 9. Main Canal Cross Section at RS 46.2

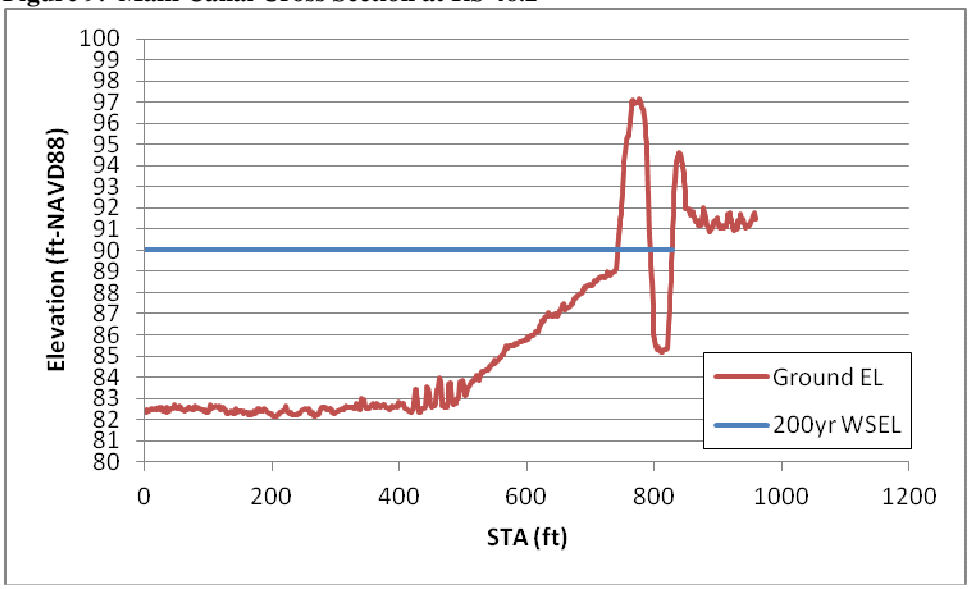


Figure 10. Main Canal Cross Section at RS 45.98

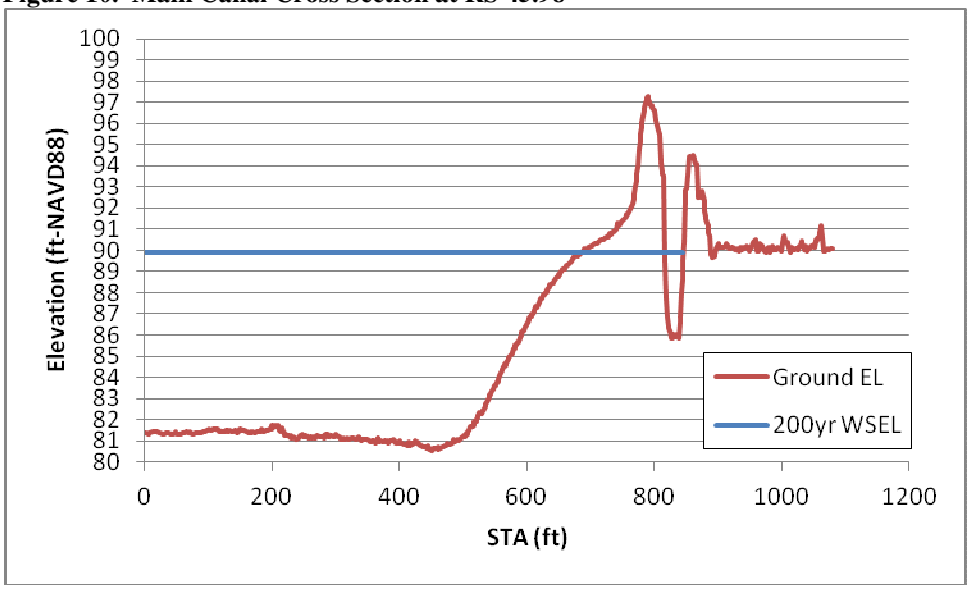


Figure 11. Main Canal Cross Section at RS 45.71

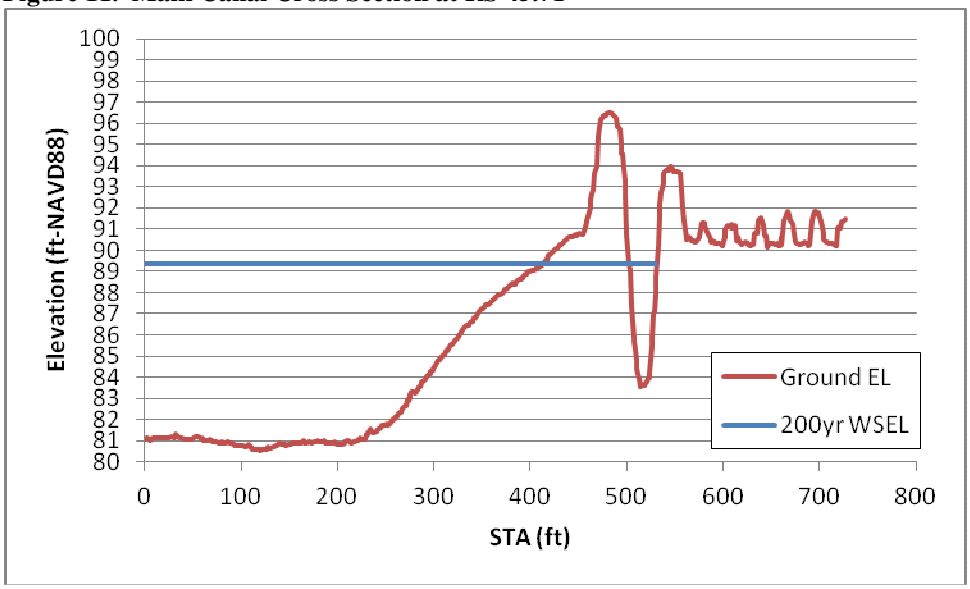
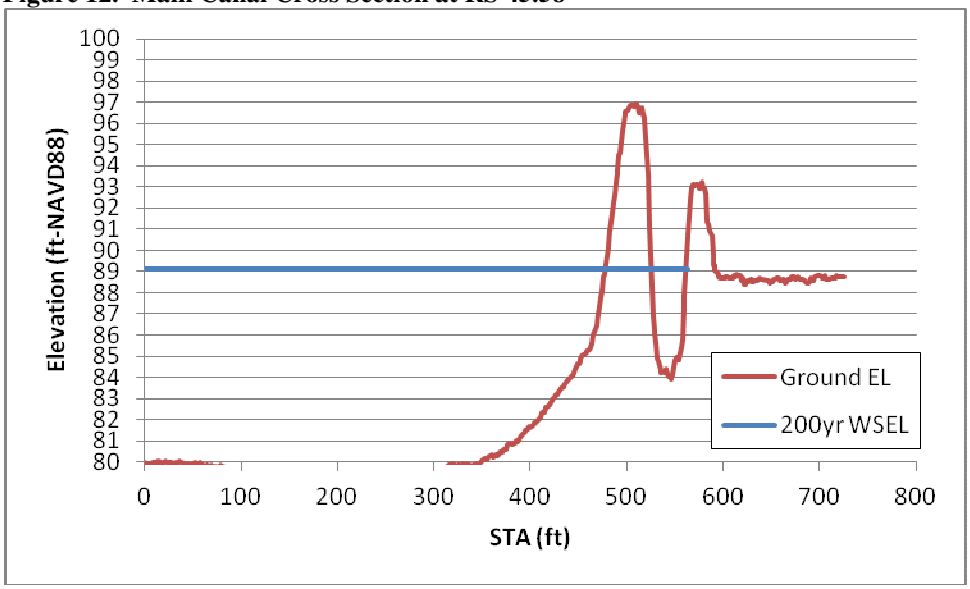


Figure 12. Main Canal Cross Section at RS 45.58



A failure of the FRWL would allow water to enter the Main Canal. However, the flow through the breach would be limited by the carrying capacity of the canal. In order to determine how much water would be conveyed for breaks at various locations in reaches 26-28, normal depth flow calculations were performed using the 200-year surface elevation at multiple locations along the Main Canal. For the calculations, it was assumed that all Main Canal check dams are removed. If a breach were to occur before January 31 while the canal is in operation and the check dams are not removed, then water would flow from the Main Canal into the Feather River channel since the Main Canal is kept full during the irrigation season. The flow calculations are summarized in Table 1. The complete calculations are included in Attachment A.

Table 1. Main Canal 200-yr Flow Calculation Summary

HEC-RAS Cross Section	200-year Water Surface Elevation (NAVD88)	Resulting Water Depth in Main Canal (ft)	Canal Flow Rate (cfs)
47.55	91.92	5.1	390
47.2	91.37	5.9	360
47.04	91.15	4.3	270
46.69	90.56	4.5	290
45.58	89.11	4.4	290

CONCLUSION

Based upon the 200-year water surface elevations and the corresponding open channel flow calculations, a breach along this section of the Feather River West Levee would be fully contained by the Main Canal, and would not cause flooding. Approximately 300 to 400 cfs would enter the Main Canal during a 200-year levee breach scenario. The water depth in the canal would be more than 4-feet below the top of the canal banks and it would not be high enough to escape the Main Canal channel. The 400 cfs flow rate is within the nominal operating capacity of the canal, and therefore could safely be conveyed southwest to the Main Canal spillways at the E. Interceptor canal. If a levee break were to occur prior to January 31st when the canal is in operation, then water would flow from the Main Canal into the Feather River channel.

REFERENCES

1. Peterson Brustad, Inc., *Revised Design Water Surface Profiles for the Feather River West Levee Rehabilitation Project*, September 2011.

2. California Department of Water Resources, LiDAR Datasets for the San Joaquin River Basin, Central Valley Floodplain Evaluation and Delineation Program (CVFED), March 2010 deliverable.

ATTACHMENT 1

Main Canal Open Channel Flow Calculations

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Open Channel Flow Calculation
Sutter-Butte Main Canal at Feather River RS 45.58

November 30, 2011

Equations:

Flow Rate, Q (cfs): $Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$ (Manning's Eq.)

where:
n = Manning's Roughness Coefficient
A = Cross Sectional Flow Area (sq. ft)
R = Hydraulic Radius (ft)
S = Channel Slope (ft/ft)

Bottom Width =	21	ft
Left Slope =	0.582143	ft/ft
Right Slope =	0.582143	ft/ft
Water Depth =	4.36	ft
n =	0.02	
S =	0.0002	ft/ft

Computations:

Cross Sectional Flow Area =	124.2145	sq. ft
Wetted Perimeter =	38.33243	ft
Hydraulic Radius =	3.240455	ft
Flow Velocity =	2.31	ft/s
Q =	286.5812	cfs

Notes:
1. Channel dimensions obtained from CVFED Initial Post-Processed LiDAR data; March 2010 deliverable.
2. Manning's Roughness Coefficient = 0.02 for "Open Channel; Earth, clean, after weathering"

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Open Channel Flow Calculation
Sutter-Butte Main Canal at Feather River RS 46.69

November 30, 2011

Equations:

Flow Rate, Q (cfs): $Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$ (Manning's Eq.)

where:
n = Manning's Roughness Coefficient
A = Cross Sectional Flow Area (sq. ft)
R = Hydraulic Radius (ft)
S = Channel Slope (ft/ft)

Bottom Width =	18	ft
Left Slope =	0.40164	ft/ft
Right Slope =	0.40164	ft/ft
Water Depth =	4.46	ft
n =	0.02	
S =	0.0002	ft/ft

Computations:

Cross Sectional Flow Area =	129.8059	sq. ft
Wetted Perimeter =	41.93331	ft
Hydraulic Radius =	3.095533	ft
Flow Velocity =	2.24	ft/s
Q =	290.4844	cfs

Notes:
1. Channel dimensions obtained from CVFED Initial Post-Processed LiDAR data; March 2010 deliverable.
2. Manning's Roughness Coefficient = 0.02 for "Open Channel; Earth, clean, after weathering"

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Open Channel Flow Calculation
Sutter-Butte Main Canal at Feather River RS 47.04

November 30, 2011

Equations:

Flow Rate, Q (cfs): $Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$ (Manning's Eq.)

where:
n = Manning's Roughness Coefficient
A = Cross Sectional Flow Area (sq. ft)
R = Hydraulic Radius (ft)
S = Channel Slope (ft/ft)

Bottom Width =	20.5	ft
Left Slope =	0.5786	ft/ft
Right Slope =	0.5786	ft/ft
Water Depth =	4.25	ft
n =	0.02	
S =	0.0002	ft/ft

Computations:

Cross Sectional Flow Area =	118.3426	sq. ft
Wetted Perimeter =	37.47247	ft
Hydraulic Radius =	3.158121	ft
Flow Velocity =	2.27	ft/s
Q =	268.3891	cfs

Notes:
1. Channel dimensions obtained from CVFED Initial Post-Processed LiDAR data; March 2010 deliverable.
2. Manning's Roughness Coefficient = 0.02 for "Open Channel; Earth, clean, after weathering"

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Open Channel Flow Calculation
Sutter-Butte Main Canal at Feather River RS 47.2

November 30, 2011

Equations:

Flow Rate, Q (cfs): $Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$ (Manning's Eq.)

where:
n = Manning's Roughness Coefficient
A = Cross Sectional Flow Area (sq. ft)
R = Hydraulic Radius (ft)
S = Channel Slope (ft/ft)

Bottom Width =	14	ft
Left Slope =	0.57135	ft/ft
Right Slope =	0.57135	ft/ft
Water Depth =	5.87	ft
n =	0.02	
S =	0.0002	ft/ft

Computations:

Cross Sectional Flow Area =	142.4879	sq. ft
Wetted Perimeter =	37.66518	ft
Hydraulic Radius =	3.783013	ft
Flow Velocity =	2.56	ft/s
Q =	364.4806	cfs

Notes:
1. Channel dimensions obtained from CVFED Initial Post-Processed LiDAR data; March 2010 deliverable.
2. Manning's Roughness Coefficient = 0.02 for "Open Channel; Earth, clean, after weathering"

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Open Channel Flow Calculation
Sutter-Butte Main Canal at Feather River RS 47.55

November 30, 2011

Equations:

Flow Rate, Q (cfs): $Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$ (Manning's Eq.)

where:
n = Manning's Roughness Coefficient
A = Cross Sectional Flow Area (sq. ft)
R = Hydraulic Radius (ft)
S = Channel Slope (ft/ft)

Bottom Width =	20.9	ft
Left Slope =	0.541	ft/ft
Right Slope =	0.541	ft/ft
Water Depth =	5.12	ft
n =	0.02	
S =	0.0002	ft/ft

Computations:

Cross Sectional Flow Area =	155.4635	sq. ft
Wetted Perimeter =	42.4203	ft
Hydraulic Radius =	3.664836	ft
Flow Velocity =	2.50	ft/s
Q =	389.3462	cfs

Notes:
1. Channel dimensions obtained from CVFED Initial Post-Processed LiDAR data; March 2010 deliverable.
2. Manning's Roughness Coefficient = 0.02 for "Open Channel; Earth, clean, after weathering"

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