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October 28, 2002

Ms. Kristy Chew
Siting Project Manager
California Energy Commission
1516 Ninth Street, MS-15
Sacramento, CA 95814

RE: Data Responses, Informal Set 6
Cosumnes Power Plant (01-AFC-19)

On behalf of the Sacramento Municipal Utility District, please find attached 12 copies and one original of the Informal Data Responses, Set 6, in response to Staff's Data Response and Issues Resolution Workshops that occurred in June.

Please call me if you have any questions.

Sincerely,

CH2M HILL

John L. Carrier, J.D.
Program Manager

c: Colin Taylor/SMUD
Kevin Hudson/SMUD
Steve Cohn/SMUD

COSUMNES POWER PLANT
(01-AFC-19)

INFORMAL DATA RESPONSE, SET 6

Submitted by

SACRAMENTO MUNICIPAL UTILITY DISTRICT (SMUD)

October 28, 2002

CH2MHILL

2485 Natomas Park Drive, Suite 600
Sacramento, California 95833-2937

Technical Area: Water and Soil Resources
CEC Authors: Richard Latteri, Philip Lowe, P.E., and Greg Peterson, P.E.
CPP Author: EJ Koford, Mark Tompkins, Steve Brock

BACKGROUND

The following questions were asked at the Data Response and Issues Resolution Workshop held on June 12, and conference call on June 14, 2002.

DATA REQUEST

W&SR-4. Please provide HEC 1 hydraulic calculations to show how flow will be accommodated.

Response: Attached are two technical memoranda from Mark Tompkins entitled:

- Rational Method Estimates of the 10-year and 100-year Discharges for the Clay Creek Watershed and Tributaries
- Clay Creek Encroachment Analysis

Rational Method Estimates of the 10-year and 100-year Discharges for the Clay Creek Watershed and Tributaries

PREPARED FOR: EJ Koford
John Carrier

PREPARED BY: Mark Tompkins
Jennifer Maio

DATE: October 23, 2002

Introduction

The California Energy Commission (CEC) requested estimates for the 10-year and 100-year peak discharges using the rational method for the following catchments and conditions:

- Entire Clay Creek watershed above the project site excluding the proposed power plant
- Entire Clay Creek watershed above the project site including the proposed power plant
- East Clay Creek tributary that will be diverted around the CPP
- West Clay Creek tributary that will be diverted around the CPP

Discharge Estimates

We estimated the 10-year and 100-year peak discharges for the four Clay Creek catchment scenarios using the rational method (as described in Dunne and Leopold, 1978). The Clay Creek drainage basin upstream of the project site and the "east " and "west" tributaries to Clay Creek (the drainages immediately east and west of the existing access road from Clay East Road to the proposed project site) were delineated on the United States Geological Survey (USGS) Goose Creek Quadrangle. Figure 1 is a map of the Clay Creek watershed and Figure 2 is a map of the "east" and "west" tributary watersheds. Both maps show the watershed boundaries and the principal flow path for each watershed. Each drainage area was measured using a planimeter. The catchment lengths were measured from the project site (for the entire Clay Creek watershed) and from each tributary's confluence with Clay Creek (for the tributaries) to the drainage divide following the principal channel. The relief of each catchment was determined by taking the difference between the elevation at the project site or confluence and the elevation at the drainage divide. A summary of the drainage area, catchment length, relief, and slope for the entire catchment and both tributaries is provided in Table 1. The average annual rainfall for the Rancho Seco Power Plant (RSP) was calculated as 16.72 inches by computing the mean of the total annual rainfall recorded by the East Bay Municipal Water District at Clay Ranch from 1931 through 1980.

TABLE 1
Catchment Summary Table

Catchment	Drainage Area (acres)	Catchment Length (ft)	Relief (ft)	Slope
Drainage basin upstream of project site	2,944	13,800	120	0.00087
East tributary to Clay Creek	125	6,000	100	0.017
West tributary to Clay Creek	195	8,600	120	0.014

The rational method employs the following equation to calculate the peak discharge:

$$Q = CIA$$

where Q is the peak discharge in cubic feet per second (cfs); C is the rational runoff coefficient; I is the rainfall intensity in inches per hour (in/hr); and A is the drainage area in acres (ac). The rational runoff coefficient was determined to be 0.41 for the undeveloped catchment areas during the 100-year storm and 0.30 during the 10-year storm. These coefficients are suitable for undeveloped pasture / range land with an average slope of zero to two percent (Chow, 1988). The land use and topography within the undeveloped portion of the Clay Creek basin upstream of the project site and within both the east and west tributary basins reflected this description. The rational runoff coefficient was determined to be 0.70 for the area of the catchment covered by the existing RSP and the proposed power plant during both the 100-year and the 10-year events. The coefficient represents the midpoint of the range of rational runoff coefficients established for industrial areas, which range from 0.50 to 0.90 (Dunne and Leopold, 1978). The rational runoff coefficient for the Clay Creek basin upstream of the project site was determined by calculating a weighted average of the coefficients for each watershed component.

To estimate the rainfall intensity, it was first necessary to estimate the time of concentration for each basin. This was calculated by dividing the catchment length by the velocity of flow through the catchment.

$$Time\ of\ concentration = \frac{Catchment\ length}{v}$$

We assumed channelized flow through each catchment, and therefore applied the Manning's equation to calculate velocity:

$$v = \frac{1.49\left[\frac{A}{wp}\right]^{2/3} S^{1/2}}{n}$$

where v is the water velocity (ft/s); A is the area (ft^2); wp is the wetted perimeter (ft); S is the slope; and n is the Manning resistance coefficient (Dunne and Leopold, 1978). For the entire drainage basin, the channel width was assumed to be 10 ft, the flow depth was assumed to be 1 ft, and the Manning's n was assumed to be 0.05. For the tributaries, the channel width was assumed to be 20 ft, the flow depth was assumed to be 6 inches, and the Manning's n was assumed to be 0.07 (these values reflect the swale-like nature of the tributary channels). It should be noted that the time of concentration calculated for the west tributary is approximately the same as that calculated for the entire watershed. Given that the west tributary is a broad grassy swale that enters Clay Creek at the downstream end of the watershed, this finding is reasonable. The time of concentration calculated for each catchment was then applied to Intensity-Duration-Frequency (IDF) relationships developed for Sacramento County (SCWRD and CSDUDES, 1996). Using the IDF relationships, the rainfall intensities for the 10-year and 100-year events were determined for each catchment. Table 2 summarizes the input parameters and results of the rational method determined for each catchment scenario.

TABLE 2
Rational Method Summary

Catchment Scenario	Drainage Area (acres)	10-Year Rational Runoff Coefficient	100-Year Rational Runoff Coefficient	Time of Concentration (hr)	10-Year Rainfall Intensity (in/hr)	100-Year Rainfall Intensity (in/hr)	10-Year Discharge (cfs)	100-Year Discharge (cfs)
Drainage basin without proposed power plant	2,944	0.32[1]	0.43[1]	1.6	0.62	0.96	591	1,213
Drainage basin with proposed power plant	2,944	0.33[1]	0.43[1]	1.6	0.62	0.96	596	1,218
East Tributary	125	0.30	0.41	1.0	0.77	1.21	29	62
West Tributary	194	0.30	0.41	1.6	0.62	1.01	36	80

[1] Weighted average for undeveloped and developed areas.

As presented in Table 2, it is not anticipated that the construction of the proposed power plant would generate a significant increase in discharge. The results of this hydrologic analysis suggest that the rate of discharge would only increase 5 cfs, from 591 to 596 cfs, for the 10-year event and 5 cfs, from 1,213 to 1,218 cfs, for the 100-year event as a result of the proposed power plant construction.

References

Chow, V.T., D.R. Maidment, and L.W. Mays. 1988. Applied Hydrology. McGraw Hill, Inc. New York. 572 pages.

Dunne, T. and L.B. Leopold. 1978. Water in Environmental Planning. W.H. Freeman and Company. New York, 817 pp.

Sacramento County Water Resources Division (SCWRD) and City of Sacramento Department of Utilities Division of Engineering Services (CSDUDES). 1996. Volume 2 of the Sacramento City/County Drainage Manual: Hydrology Standards.

FIGURE 1
CONSUMNES POWER PLANT
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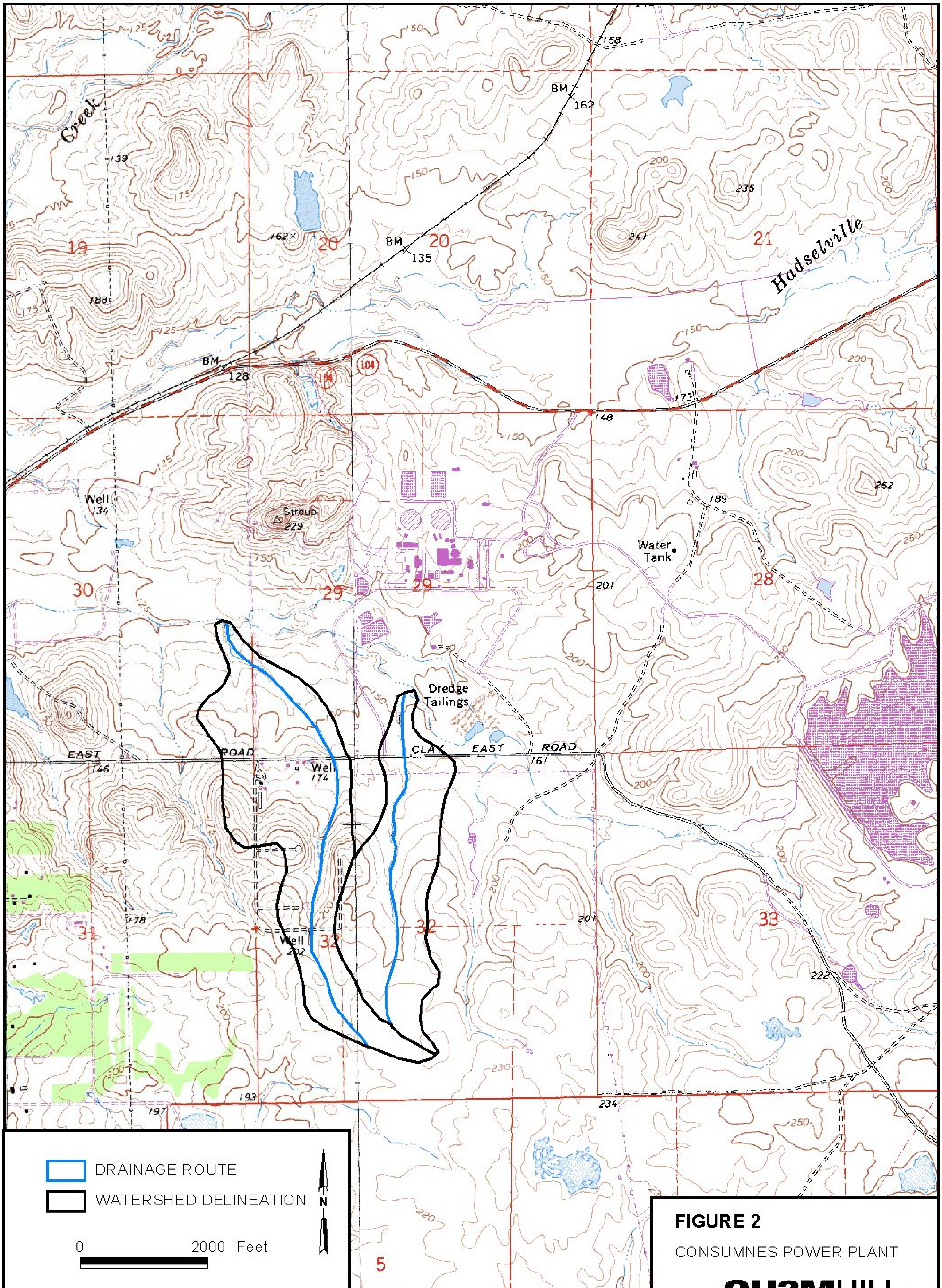

FIGURE 2

CONSUMNES POWER PLANT

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Clay Creek Encroachment Analysis

PREPARED FOR: EJ Koford
John Carrier

PREPARED BY: Mark Tompkins
Jennifer Maio

DATE: October 23, 2002

Introduction

The California Energy Commission (CEC) requested estimates of the flow depths and velocities at the boundary of the CPP for the 10-year and 100-year peak discharges. The CEC also requested a comparison of project water surface elevations with and without encroachment by the CPP. This document describes the analyses used to generate those estimates and summarizes the results of each analysis.

Boundary Flow Depths and Velocities

The Hydrologic Engineering Center – River Analysis System (HEC-RAS) model of the CPP project site was used to predict post-development flow depths and velocities at the CPP boundary for the 10-year and the 100-year discharges. The 10-year and 100-year discharges were calculated using the rational method in *Technical Memorandum 5: Rational Method Estimates of the 10-year and 100-year Discharges for the Clay Creek Watershed and Tributaries*. The details of the HEC-RAS model are presented in *Technical Memorandum 1: Clay Creek 100-Year Discharge.*

First, the CPP site boundaries were entered as "blocked obstructions" in the appropriate cross sections of the HEC-RAS model for the CPP site. Next, the HEC-RAS flow distribution capability was used to determine flow depths and velocities adjacent to the blocked obstructions (i.e. at the site boundaries). The flow distribution routine in HEC-RAS divides flow through a cross section into a specified number of cells and then applies Manning's equation using local hydraulic geometry to determine the flow depth and average velocity through each cell. Figure 1 is an example velocity distribution for cross section 2214 (note the blocked obstruction from Station 0 to Station 928). Depths and velocities predicted at the CPP boundary for the 10-year and 100-year discharge are summarized in Table 1 and Table 2, respectively.

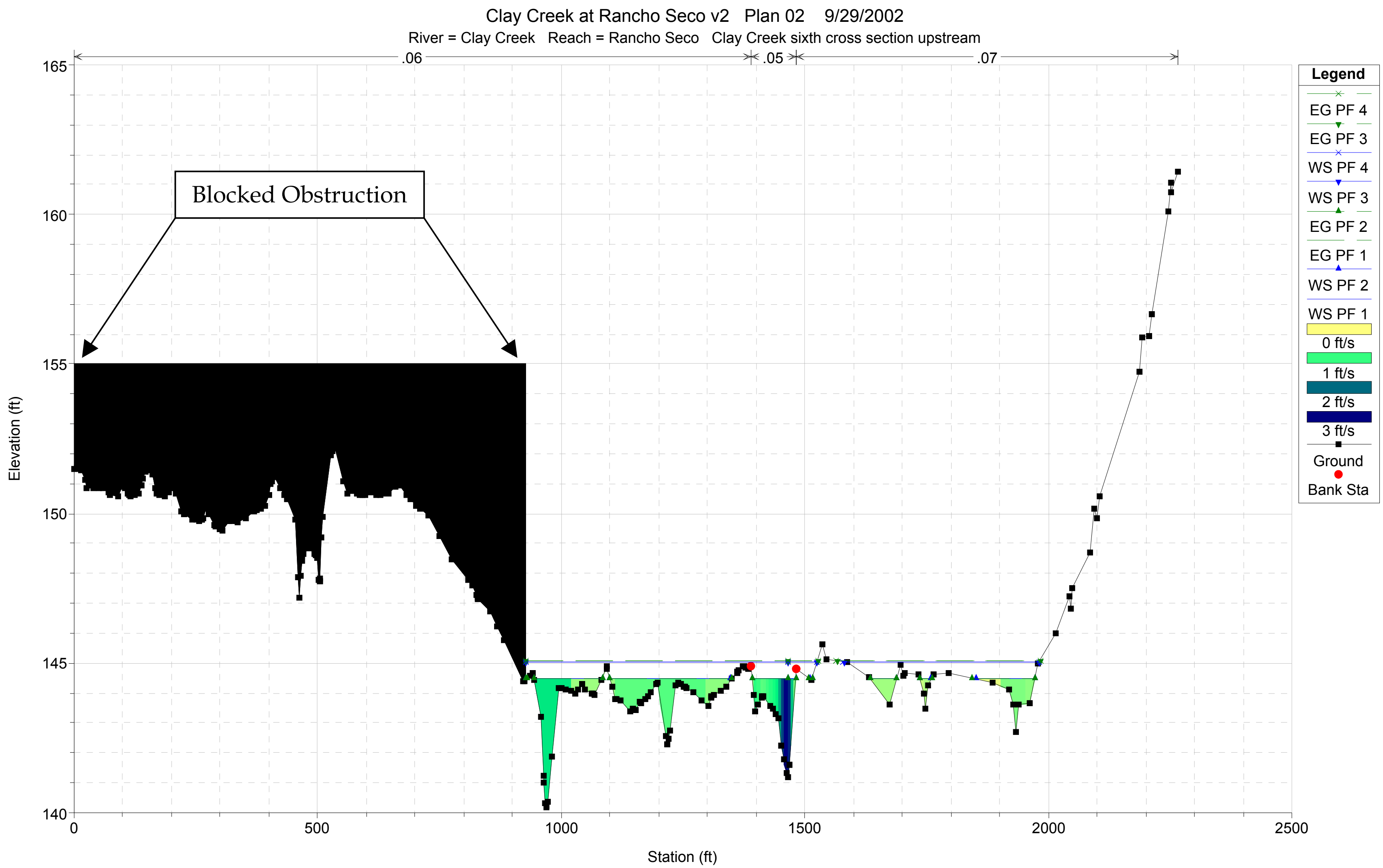


Figure 1: Velocity distribution for cross section 2214 showing the CPP boundary as a blocked obstruction.

TABLE 1
Depths and Velocities at CPP Boundary
10-year Discharge (596 cfs)

Cross Section	CPP Boundary Station (feet from left bank)	Flow Depth at CPP Boundary (feet)	Velocity at CPP Boundary (feet/second)
1240	503	0.47	0.89
1537	672	0.87	0.59
1907	858	0.07	0.82
2214	883	0.16	0.27
2338	1053	1.07	1.56
2861	1485	0.23	0.50
3069	1515	1.54	1.69
3311	1136	0.90	1.25

TABLE 2
Depths and Velocities at CPP Boundary
100-year Discharge (1218 cfs)

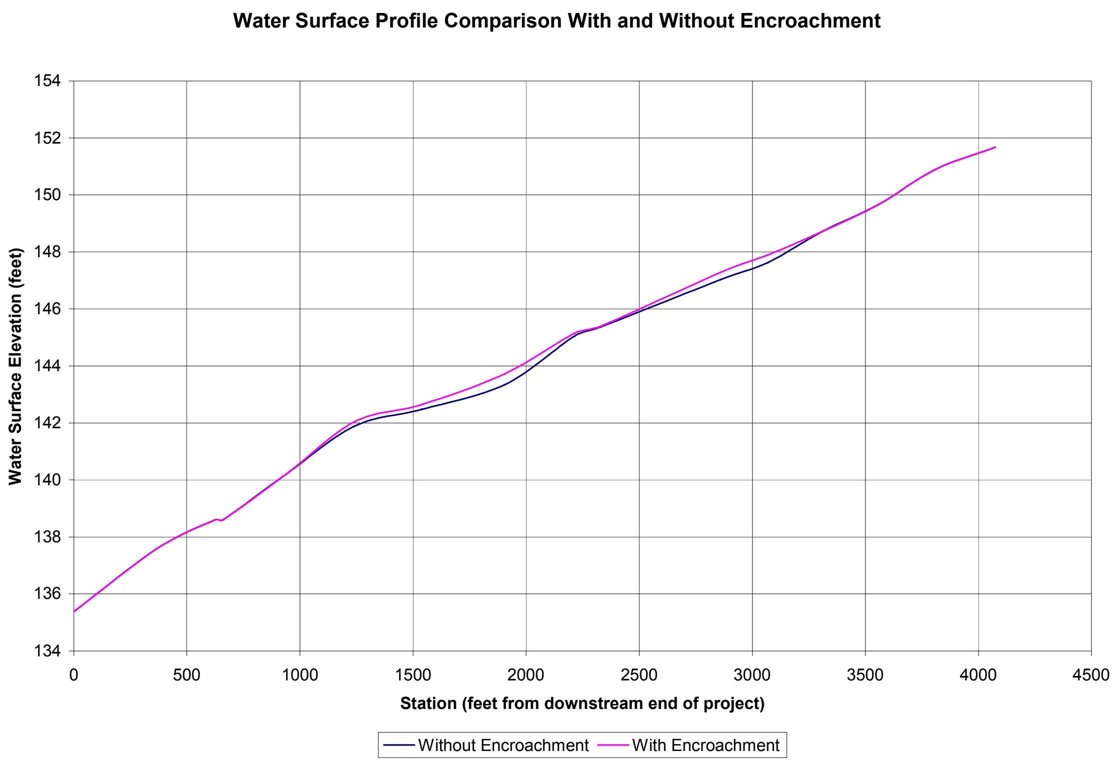
Cross Section	CPP Boundary Station (feet from left bank)	Flow Depth at CPP Boundary (feet)	Velocity at CPP Boundary (feet/second)
1240	503	0.56	0.92
1537	672	1.51	0.94
1907	858	0.89	3.01
2214	883	0.44	0.51
2338	1053	1.61	2.28
2861	1485	0.77	1.03
3069	1515	2.09	2.10
3311	1136	0.0	0.0

Project Water Surface Elevations

The HEC-RAS model was also used to calculate water surface profiles for the project site with and without encroachment for the 100-year discharge. This analysis showed only minor differences (maximum water surface elevation increase of 0.38 feet at cross section 1907) in water surface elevations along the encroachment (Table 3). The water surface profiles with and without encroachment are shown in Figure 1.

TABLE 3
Water Surface Profiles for the CPP Site with and without Encroachment
100-year discharge (1218 cfs)

Cross Section	Water Surface Elevation without Encroachment (feet)	Water Surface Elevation with Encroachment (feet)
0	135.38	135.38
367	137.59	137.59
625	138.60	138.60
660	138.60	138.60
938	140.20	140.20
1240	141.88	142.04
1537	142.47	142.64
1907	143.35	143.73
2214	145.05	145.15
2338	145.39	145.42
2861	147.03	147.29
3069	147.63	147.90
3311	148.72	148.72
3558	149.67	149.67
3811	150.90	150.90
4073	151.67	151.67


Water Surface Profile Comparison With and Without Encroachment
154
152
150
148
146
144
142
140
138
136
134
Water Surface Elevation (feet)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
Station (feet from downstream end of project)
Without Encroachment
With Encroachment

Interpretation of Encroachment Analysis Results

Given that the maximum predicted water surface elevation change for the 100-year flow due to the CPP site is only 0.38 feet (4.56 inches), it is unlikely that any significant new flooding will occur as a result of this project.

We also calculated the mechanical forces associated with the depths and velocities adjacent to the CPP site fill proposed to be within the 100-year floodplain to determine whether armoring should be considered to protect the fill material. We used the depth-slope approximation (Julien 1998) to calculate shear stress for the cell at each cross section adjacent to the CPP fill. We then converted shear stress values to mechanical forces. The mechanical forces for each cross section are presented in Table 4. Table 5 presents maximum recommended mechanical forces for a range of vegetative bank protection measures (Schiechtl and Stern 1994). The mechanical forces on the CPP fill predicted for a 100-year flow range from 0 to 1.22 pounds per square foot. Vegetative erosion protection similar to the types listed in Table 5 will likely be sufficient to withstand all the forces except at cross section 1907 immediately after construction. After three to four years, vegetative erosion protection will be sufficient at all locations on the CPP fill. Therefore, the final design of the CPP fill in the Clay Creek floodplain should include biodegradable erosion control fabric (at least in the vicinity of cross section 1907) to protect against erosion immediately after construction and vegetative erosion protection for long term erosion control.

TABLE 4
Velocities and mechanical force of flowing water adjacent to the structures proposed to be within the 100-year floodplain
Local slope of 0.0065 used in the calculation of mechanical forces using the depth slope approximation (Julien 1998).

Cross Section	CPP Boundary Station (feet from left bank)	Flow Depth at CPP Boundary (feet)	Velocity at CPP Boundary (feet/second)	Mechanical Forces (lbs / ft^2)
1240	503	0.56	0.92	0.37
1537	672	1.51	0.94	0.38
1907	858	0.89	3.01	1.22
2214	883	0.44	0.51	0.21
2338	1053	1.61	2.28	0.92
2861	1485	0.77	1.03	0.42
3069	1515	2.09	2.10	0.85
3311	1136	0.0	0.0	0.00

TABLE 5
Maximum permissible mechanical forces for vegetative erosion control
From Schiechtl and Stern (1994)

Construction Material	Post-Construction (lbs / ft^2)	After 3-4 Years (lbs/ft^2)
Turf	0.20	2.05
Wattle Fence	0.20	1.02
Willow Brush Layer	0.41	2.87
Reed Planting	0.10	0.61
Live Fascine	1.23	1.64

References

Julien, P.Y. 1998. Erosion and Sedimentation. Cambridge University Press. Cambridge, U.K. 280pp.

Schiechtl, H.M. and R. Stern. 1994. Watercourse Bioengineering Techniques. Blackwell Sciences. Cambridge, MA. 186 pp.