Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh

25th Annual Progress Report
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Chapter 3:
DSM2 Geometry Investigations

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3 DSM2 Geometry Investigations

3.1 Introduction

Since the DSM2 Project Work Team (PWT) recalibrated DSM2 to flow, stage, and EC in 1999, new flow data have been collected (Nader-Tehrani, 2001). This chapter summarizes investigations to validate DSM2 with the new flow data and explore geometry changes to DSM2 to better model Delta hydrodynamics.

3.2 Franks Tract Representation

From April 2002 through September 2002, the U.S. Geological Survey (USGS) collected 10-minute flow data at six locations surrounding Franks Tract (Figure 3.1) to better understand tidal flow across Franks Tract. In addition, a superficial survey of channel openings to Franks Tract was conducted by USGS. Based upon this data, the Delta Modeling Section first validated DSM2 with the new flow data, then experimented with various representations of Franks Tract using the new flow information in order to improve upon DSM2.

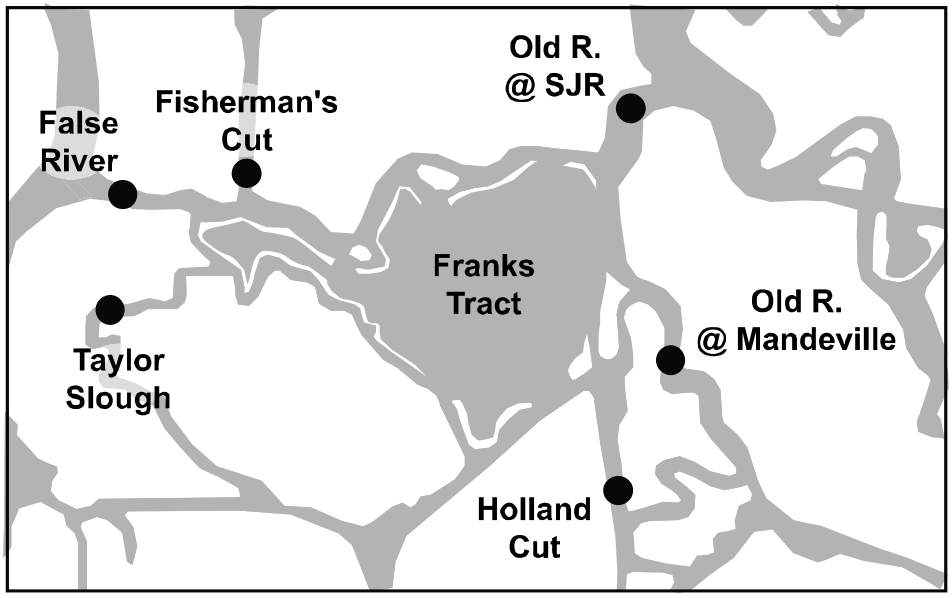

Figure 3.1: Locations of Flow Data Collected by USGS, April 2002 – September 2002.

3.3 DSM2 Validation with New 2002 USGS Flow Data

DSM2 flow results from the historical April 2002 through September 2002 simulation were compared to the field data collected by USGS. Figure 3.2 shows the 15-minute DSM2-simulated flows and the 10-minute USGS measured flows over the period of May 1, 2002 through May 5, 2002 at the six locations in Figure 3.1. This period, although short in comparison to the five months for the study, is typical of the results at these locations. Figure 3.3 shows the 24.75-hour twice-averaged (filtered) flow data at the same locations over the duration of the data sampling period. Included in Figure 3.3 for later comparison are the filtered flow values for Alternative 3g, which is described and discussed later. For the current configuration of Franks Tract and the surrounding channels, DSM2 tends to underestimate the peak tidal flows at Holland Cut, Old River at Mandeville Island, and False River. In comparison, the DSM2-simulated tidal flows in Taylor Slough and Fisherman's Cut exceed those measured, although the magnitude of the flows here is significantly less than at the other locations studied. At the Old River site near the San Joaquin River, DSM2 tends to match the peak ebb flow, but significantly overestimates the peak flood flow. As a result, the average flow calculated by DSM2 here was consistently approximately 3,000 cfs higher than the measured flow in the upstream direction (Figure 3.3).

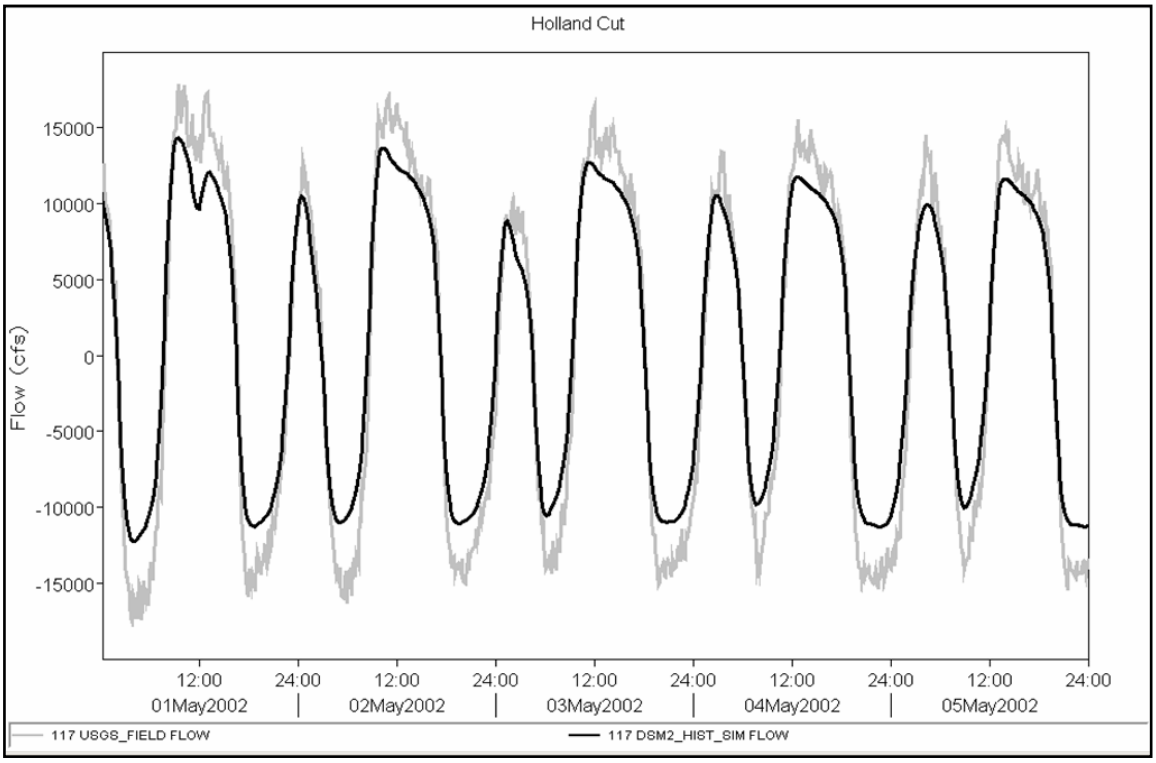

Figure 3.2a: DSM2 Generated Flow (Current Geometry) and USGS Field Data, Holland Cut, May 1 – May 5, 2002.

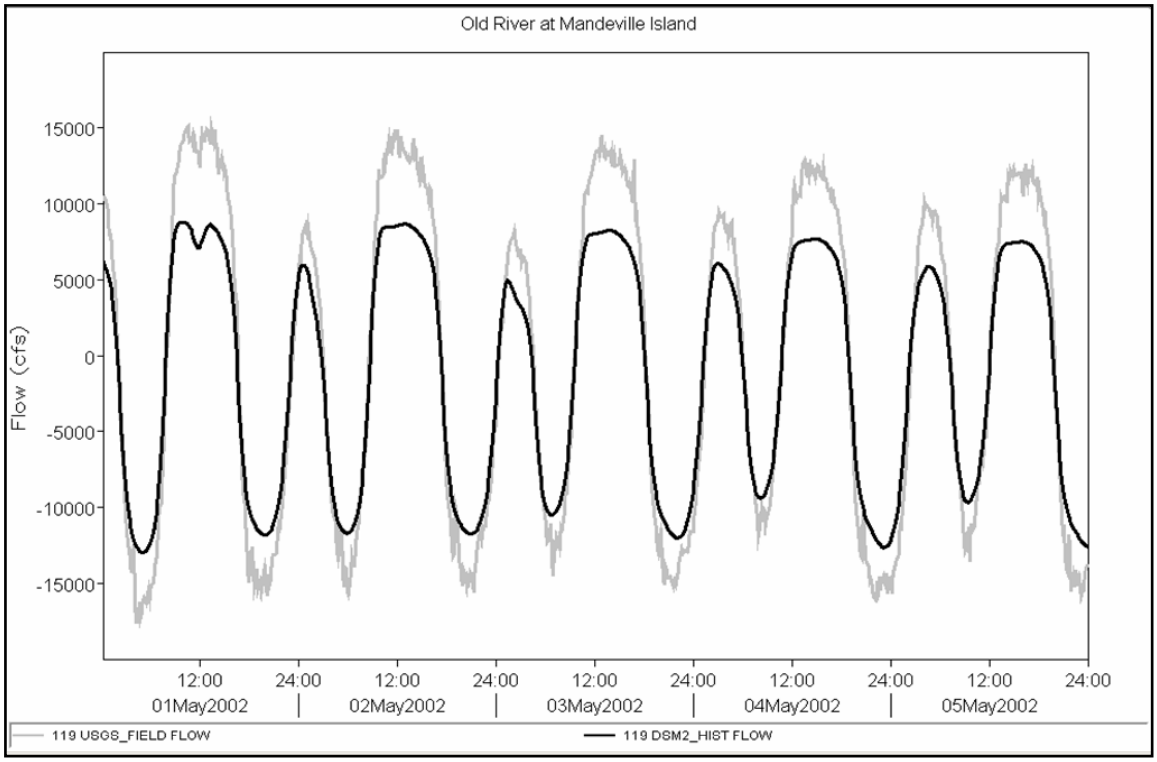

Figure 3.2b: DSM2 Generated Flow (Current Geometry) and USGS Field Data, Old River at Mandeville Island, May 1 – May 5, 2002.

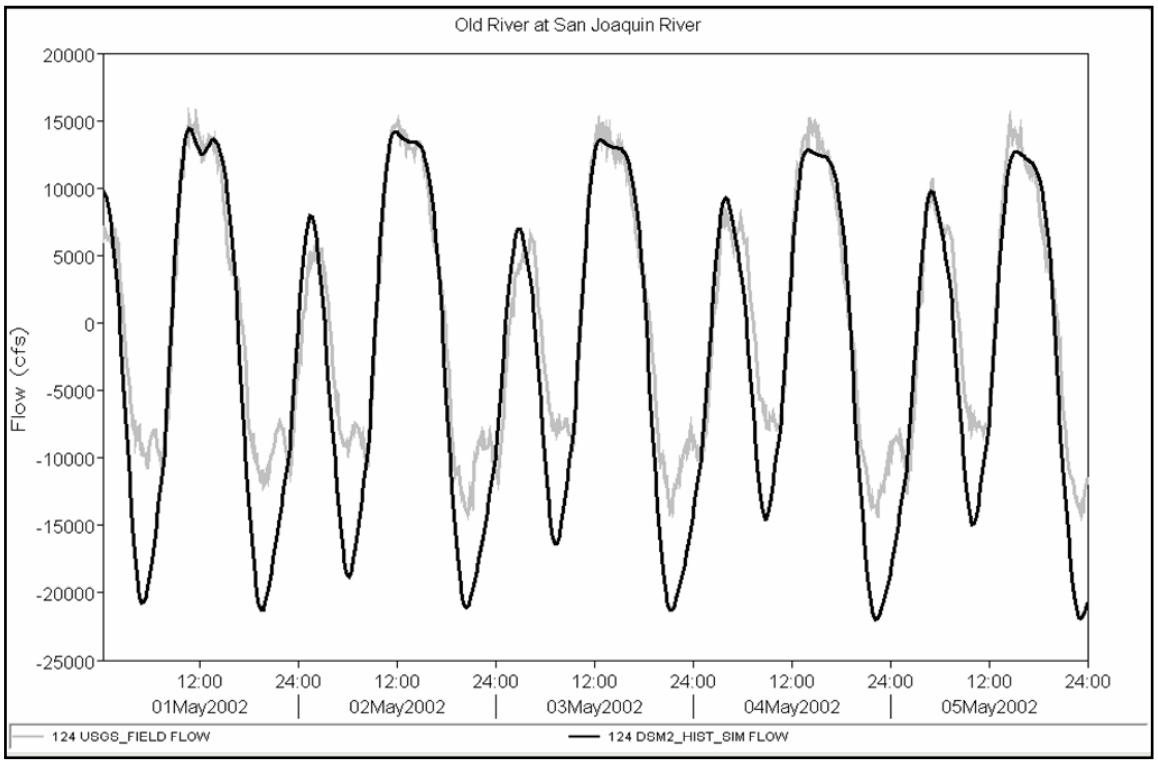

Figure 3.2c: DSM2 Generated Flow (Current Geometry) and USGS Field Data, Old River at San Joaquin River, May 1 – May 5, 2002.

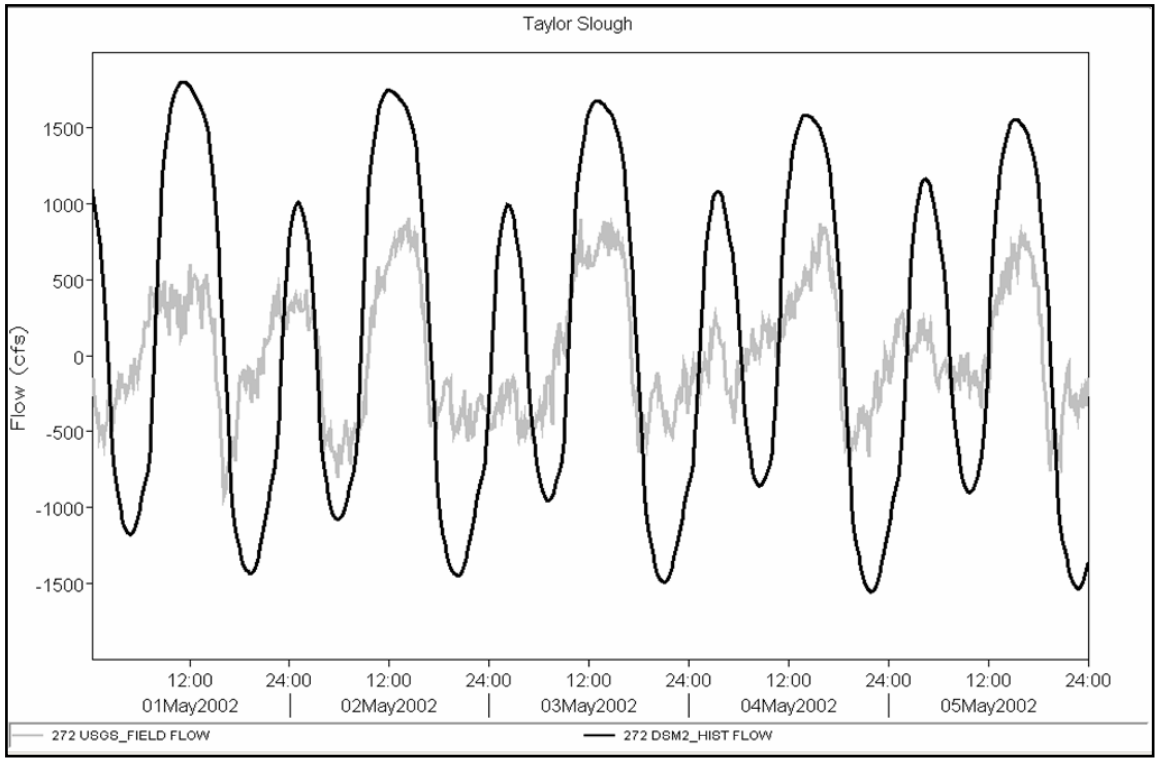

Figure 3.2d: DSM2 Generated Flow (Current Geometry) and USGS Field Data, Taylor Slough, May 1 – May 5, 2002.

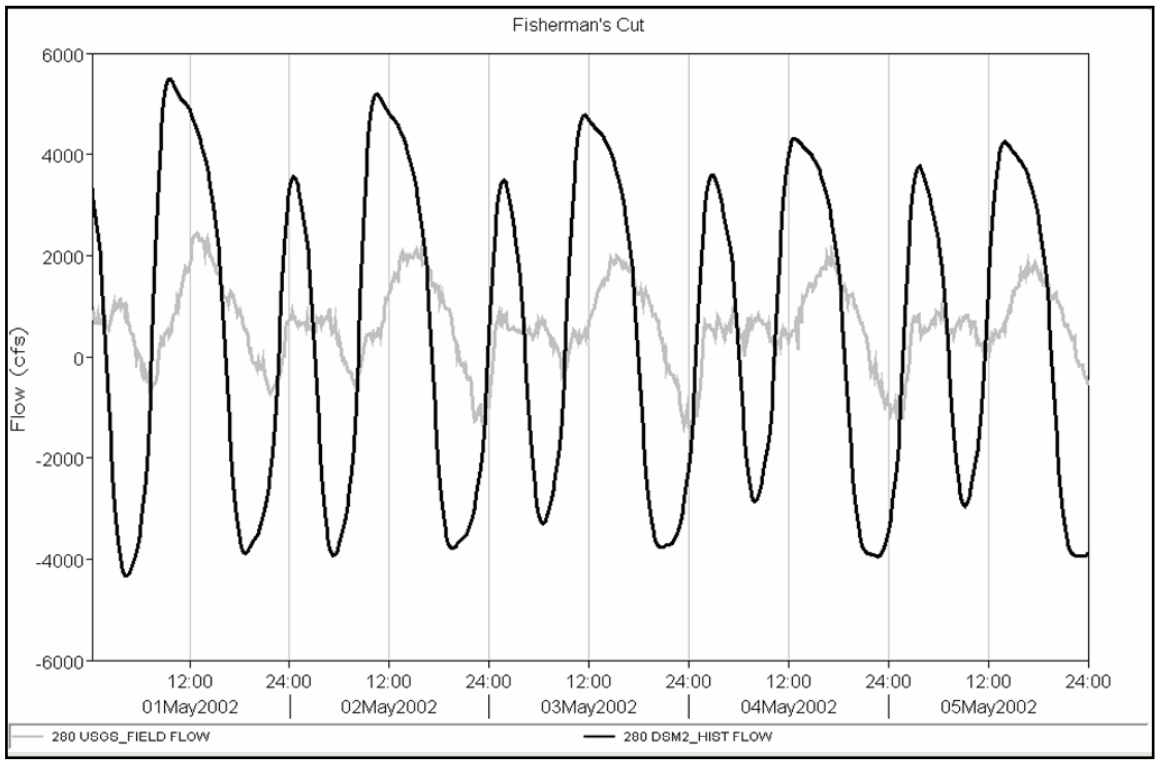

Figure 3.2e: DSM2 Generated Flow (Current Geometry) and USGS Field Data, Fisherman's Cut, May 1 – May 5, 2002.

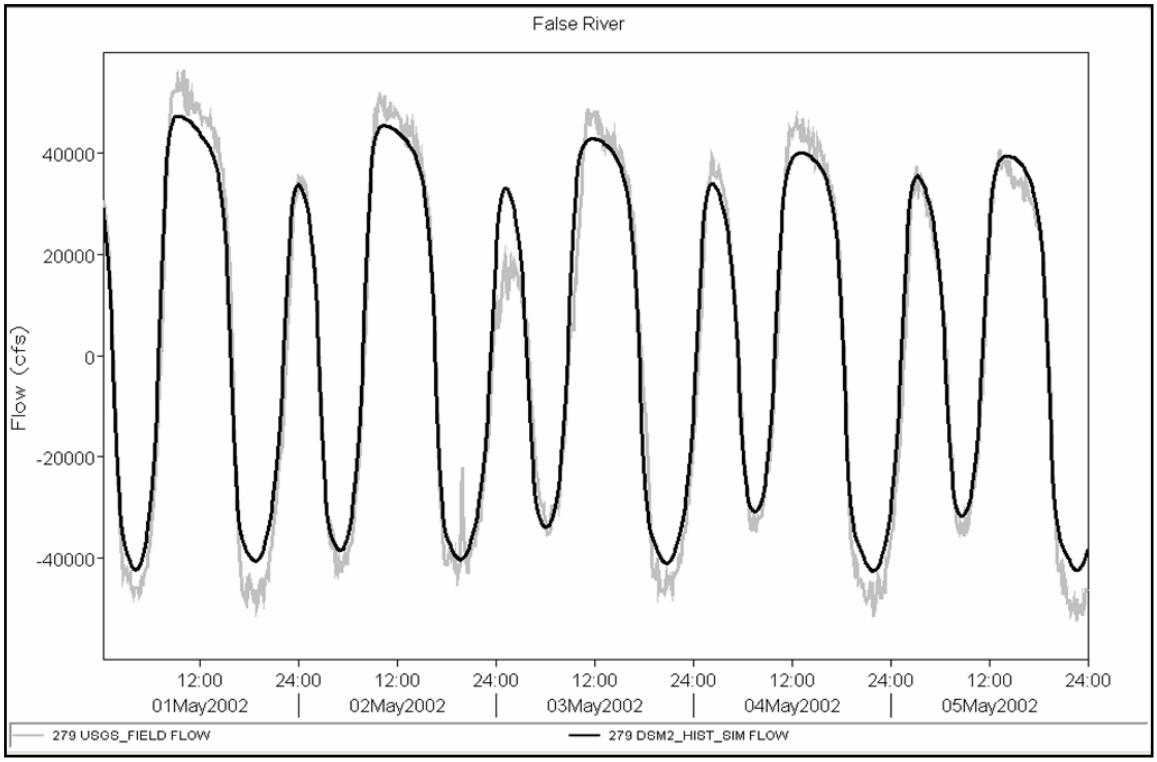

Figure 3.2f: DSM2 Generated Flow (Current Geometry) and USGS Field Data, False River, May 1 – May 5, 2002.

In general, for a given location, differences in between DSM2 and field-measured average flow tended to be about the same magnitude for the duration of the study period. DSM2 consistently overestimated average flow in the downstream direction at Holland Cut (about 1,000 cfs) and at False River (about 2,000 cfs). DSM2 overestimated average flow in the upstream direction at Old River at Mandeville Island (about 1,000 cfs), while average flow values at Taylor Slough and Fisherman's Cut were approximately the same.

The error in DSM2 flows in Old River near the San Joaquin River is consistent with the hypothesis that DSM2 underestimates the tidal flood flow across Franks Tract, though to what extent is unknown. It was believed that modifying DSM2 geometry to improve the flow simulated here would improve the simulation of flow elsewhere. Therefore, a series of changes to the representation of Franks Tract in DSM2 were tested by comparing simulated flows in Old River near the San Joaquin River to the measured values.

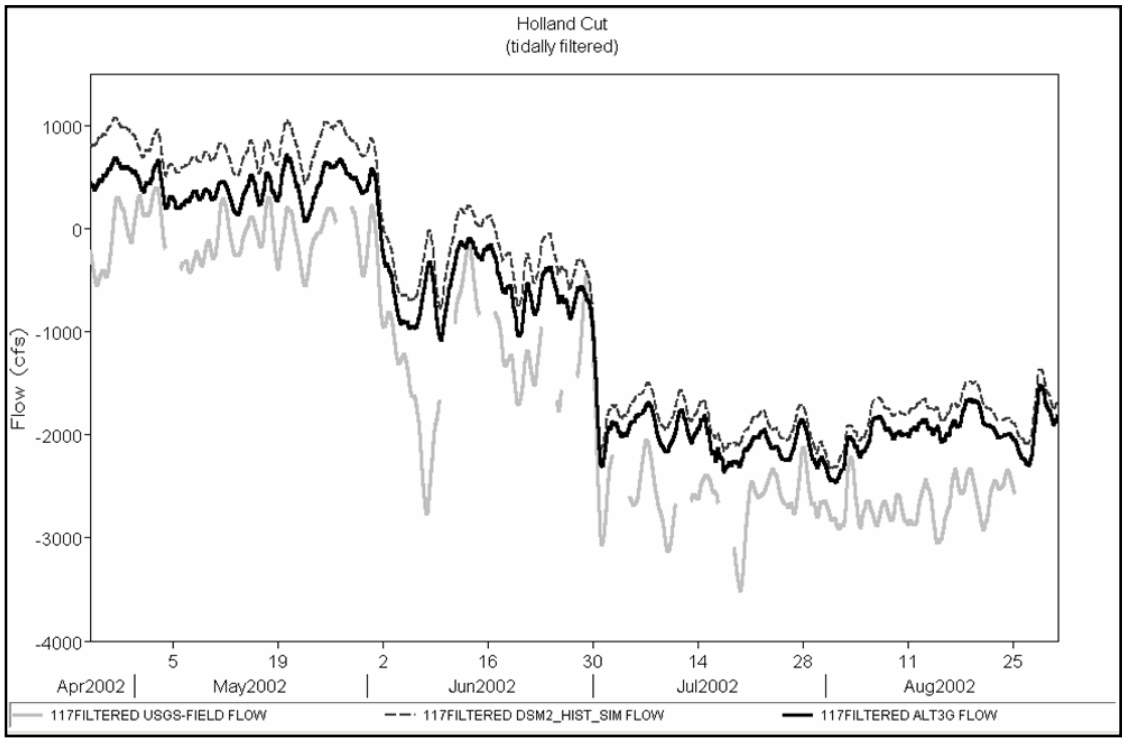

Figure 3.3a: Filtered Daily Average Flow: DSM2 Generated Flow for Existing, Alt 3g, and USGS Field Data, Holland Cut, 2002.

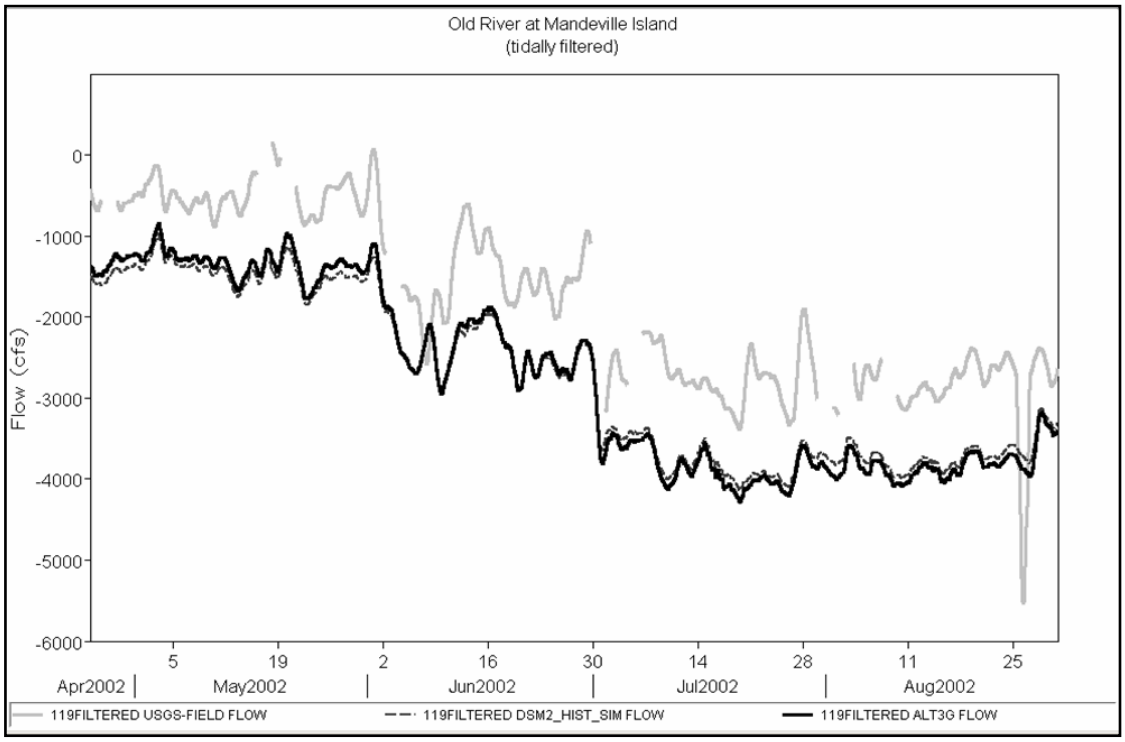

Figure 3.3b: Filtered Daily Average flow: DSM2 Generated Flow for Existing Alt 3g, and USGS Field Data, Old River at Mandeville Island, 2002.

Figure 3.3c: Filtered Daily Average Flow: DSM2 Generated Flow for Existing, Alt 3g, and USGS Field Data, Old River at San Joaquin River, 2002.

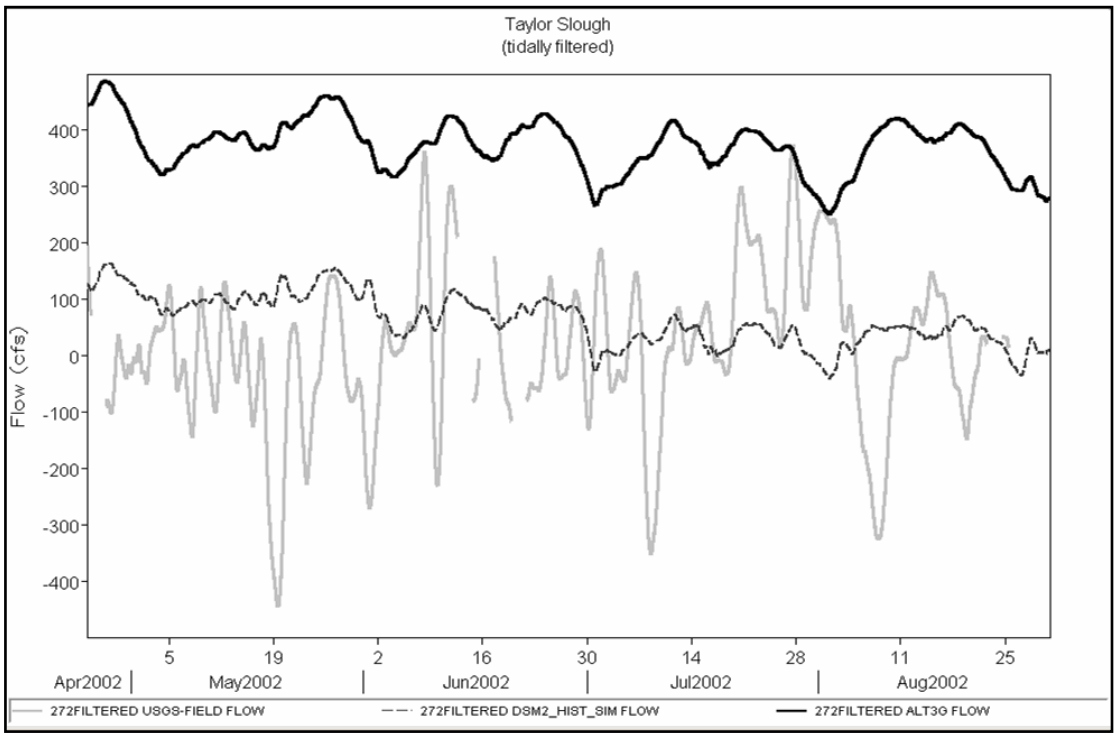

Figure 3.3d: Filtered Daily Average Flow: DSM2 Generated Flow for Existing, Alt 3g, and USGS Field Data, Taylor Slough, 2002.

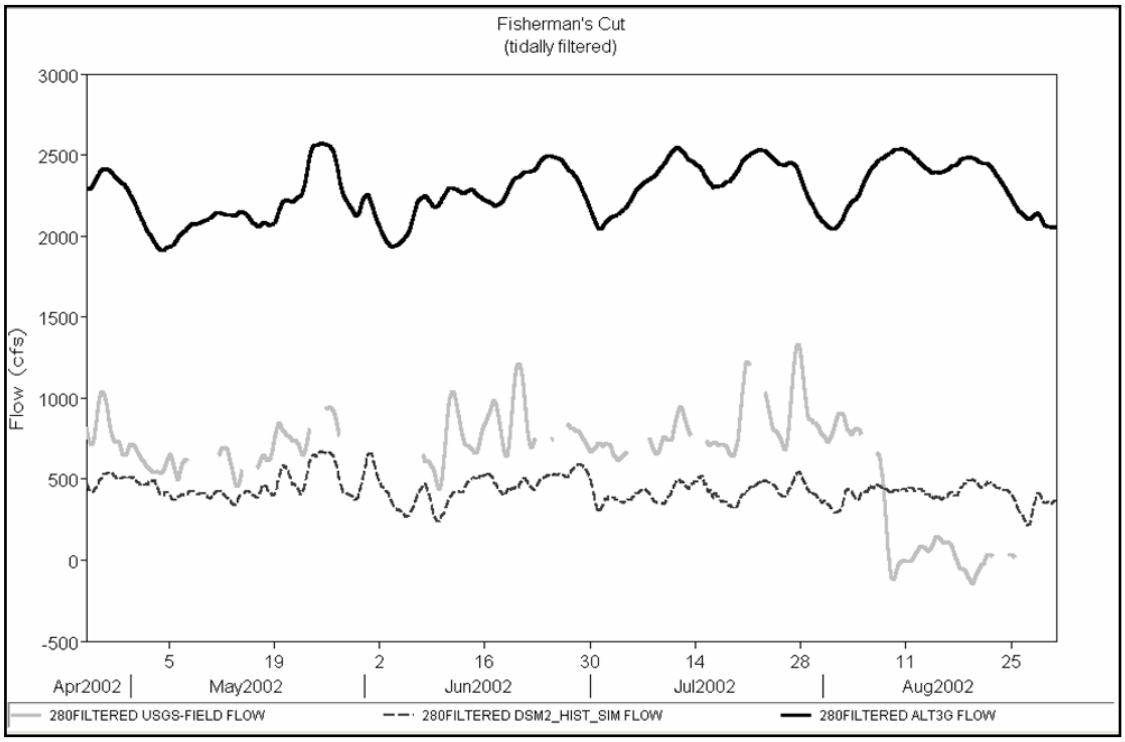

Figure 3.3e: Filtered Daily Average Flow: DSM2 Generated Flow for Existing, Alt 3g, and USGS Field Data, Fisherman's Cut, 2002.

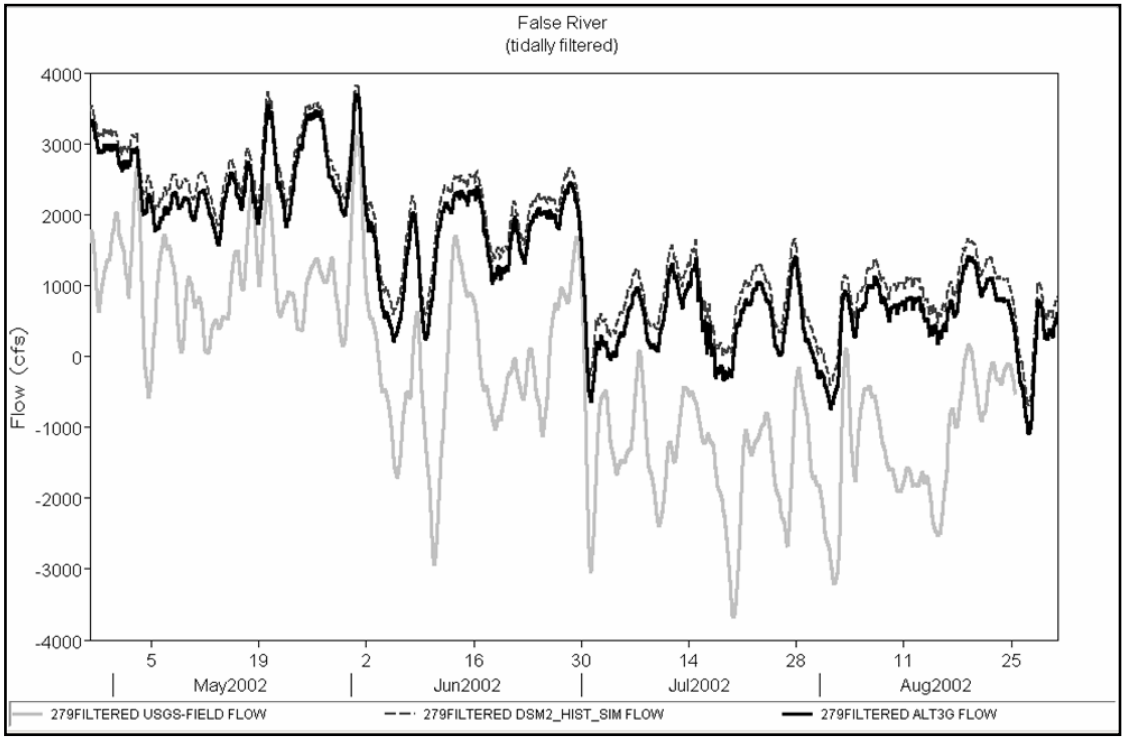

Figure 3.3f: Filtered Daily Average Flow: DSM2 Generated Flow for Existing, Alt 3g, and USGS Field Data, False River, 2002.

3.4 Experimenting with Changes to Franks Tract Representation

The current configuration of Franks Tract in DSM2 consists of an open area with surface area of 141,786,000 sq. ft. (3,255 acres) hydraulically connected to Delta channels at six locations (Figure 3.4 and Table 1). Flow into and out of the open area is determined by an orifice flow equation: $Q = CA\sqrt{2g\Delta h}$ where Q is flow, (CA) is the "flow coefficient", A is the flow cross-sectional area, and Δh is the difference in stage. Flow coefficients can vary by flow direction (inflow and outflow). The source of the current flow coefficients for Franks Tract in DSM2 is not well documented, but the values most likely came from examining topographic maps and navigation charts and do not change for direction of flow (Table 3.1).

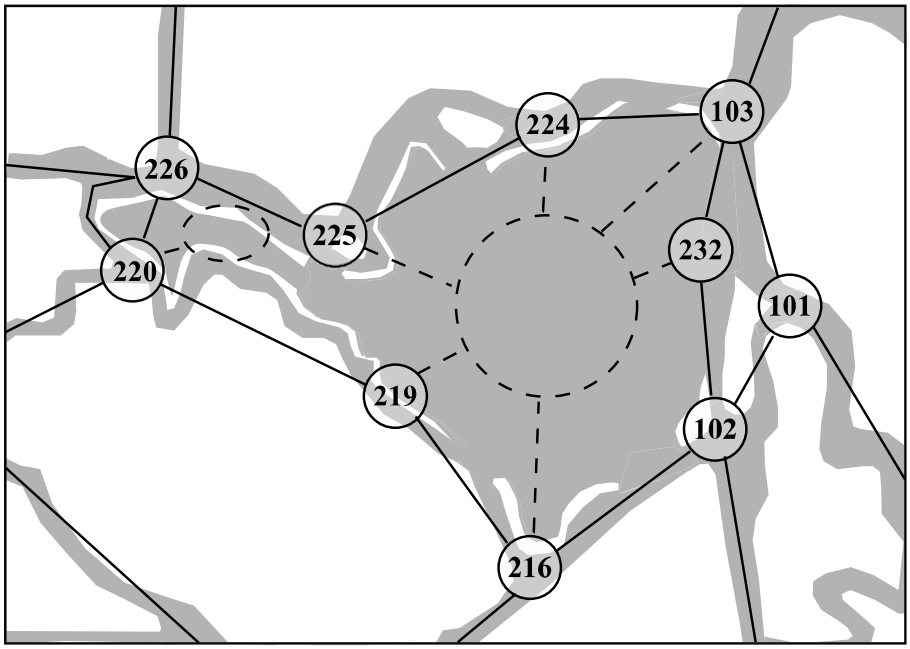

Figure 3.4 Current DSM2 Representation of Franks Tract.

Modifications to the representation of Franks Tract were explored with the goal of first using more realistic opening dimensions into Franks Tract (Alternative 1a), then trying to better simulate flow across the open area as indicated by better simulation of flow in Old River near the San Joaquin River (Alternatives 1d, 2d, and 3g). Table 3.1 lists how the different alternatives varied in simulating connections between Franks Tract and the surrounding channels.

The flow coefficients (Table 3.1) are the only difference between the existing DSM2 description of Franks Tract and Alternative 1a. Alternative 1d attempts to account for the effects of the remnants of an island levy, now a submerged berm, that runs along the east side of Franks Tract (Figure 3.5) by restricting flow between the open area and nodes 232 and 102 on the east side. An additional node, 234, was added and then connected to nodes 232 and 102 by shallow, wide channels. Egeria densa in the southern part of Franks Tract was represented by replacing 1/3 of the open reservoir with wide channels with a higher roughness coefficient (see Figure 3.6 for Alternative 2d). Finally, Franks Tract was simulated by replacing the entire open area with four wide channels, with the southern channels again with roughness coefficients indicative of Egeria (Figure 3.7 for Alternative 3g). Table 3.1 summarizes the hydraulic connections of Frank Tract

to surrounding channels for these alternatives. For Alternative 3g , a minor modification was made in Holland Cut's channel geometry near Franks Tract after the configuration in Franks Tract was set.

Table 3.1: Characteristics of Connections of Franks Tract to Surrounding Channels under Various Alternative DSM2 Descriptions.

Node	(Coefficient*Area) for Nodes Connected to Open Area in Franks Tract (ft^2)									
	Existing		Alt 1a		Alt 1d		Alt 2d		Alt 3g	
	in	out	in	out	in	out	in	out	in	out
103	3000	3000	1300	1300	1300	1300	1300	1300	channel	
232	3000	3000	3000	3000			3000	3000		
234					3000	3000				
102									channel	
216	2000	2000	3000	3000	3000	3000	channel			
219	2000	2000	9000	9000	9000	9000	channel		channel	
225	2000	2000	11000	11000	11000	11000	11000	11000	channel	
224	3000	3000	13500	13500	13500	13500	13500	13500		

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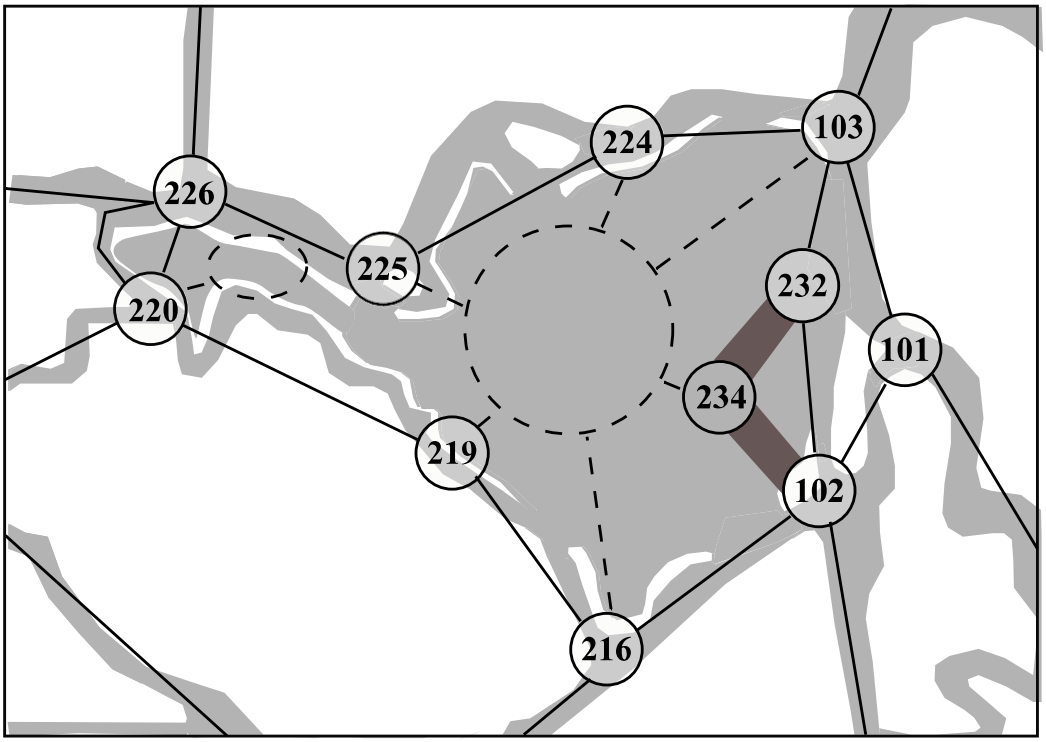

Figure 3.5: DSM2 Representation of Franks Tract for Alternative 1d (simulation of submerged berm on east end).

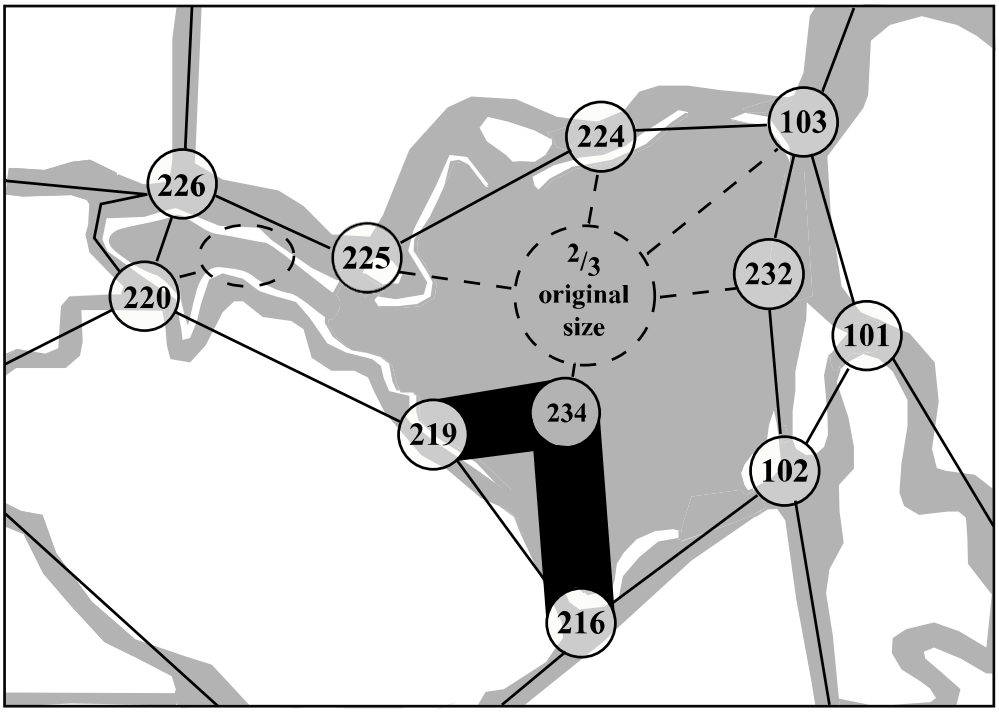

Figure 3.6: DSM2 Representation of Franks Tract for Alternative 2d (simulation of southern portion by wide channels).

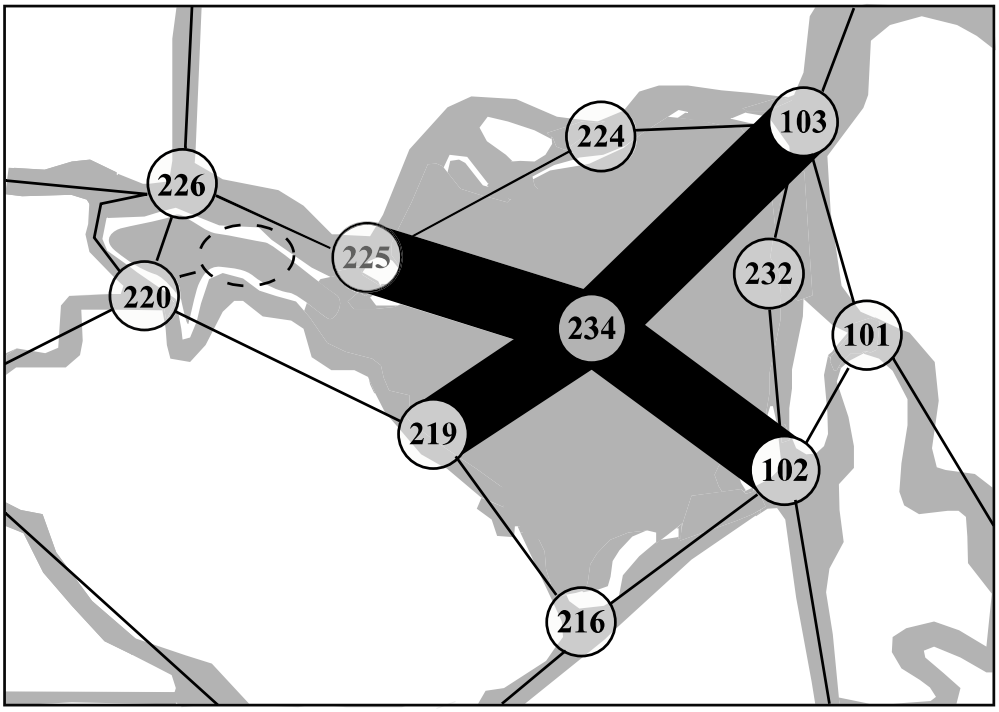

Figure 3.7: DSM2 Representation of Franks Tract for Alternative 3g (simulation of entire flooded area by wide channels).

DSM2 simulations of these alternatives at Old River near the San Joaquin River for the May 1-5, 2002 period are shown in Figure 3.8. As mentioned before, the measured instantaneous flow and averaged measured flow in Old River near the San Joaquin River were used as an indication of the effectiveness of a representation of Franks Tract in DSM2.

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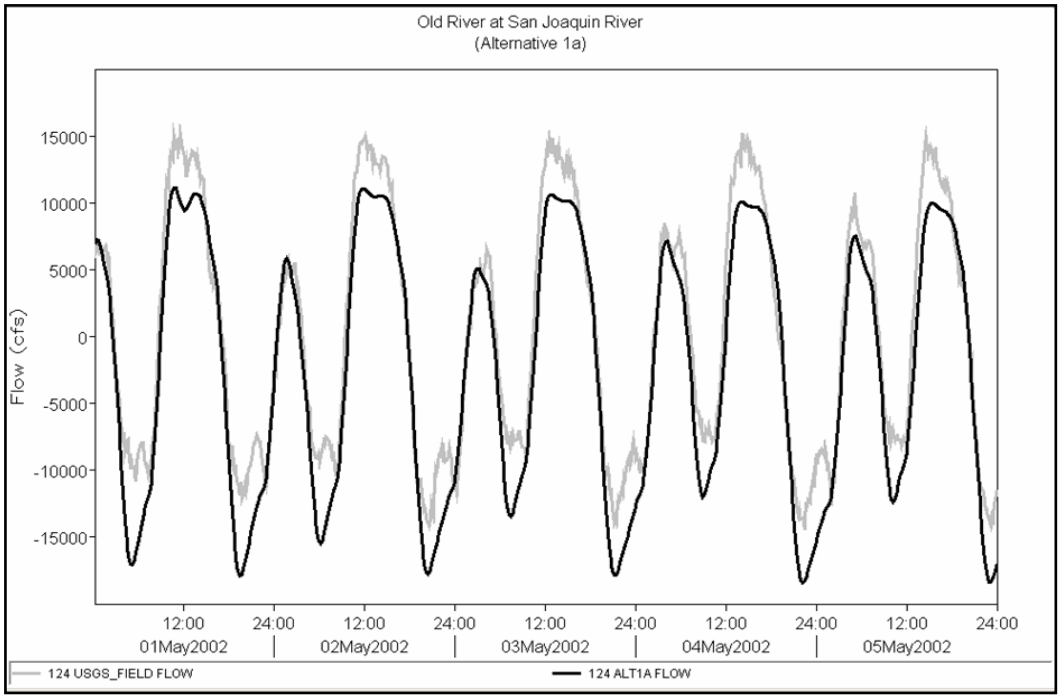

Figure 3.8a: DSM2 Alt 1a Generated Flow and USGS Field Data, Old River at San Joaquin River, May 1 – May 5, 2002.

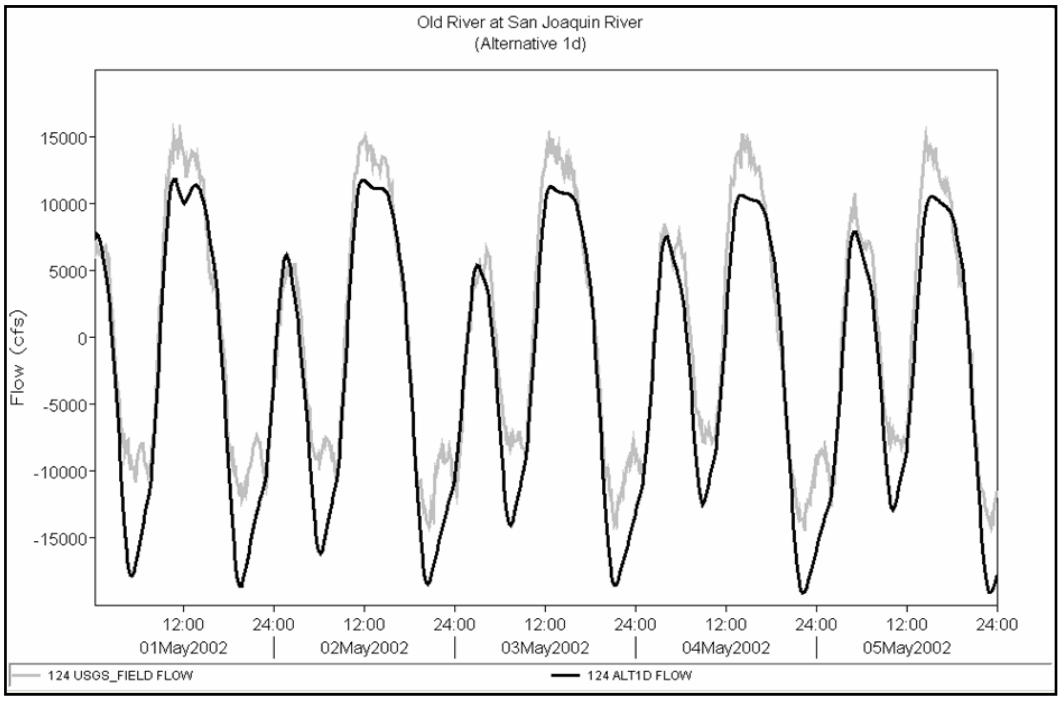

Figure 3.8b: DSM2 Alt 1d Generated Flow and USGS Field Data, Old River at San Joaquin River, May 1 – May 5, 2002.

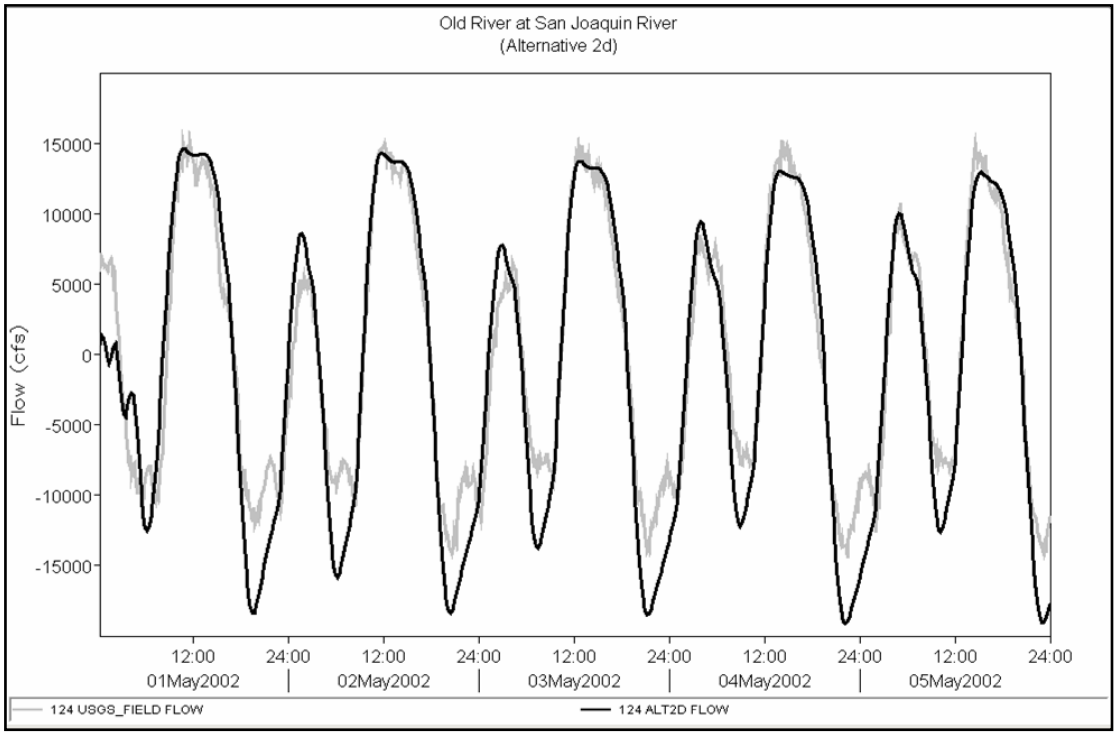

Figure 3.8c: DSM2 Alt 2d Generated Flow and USGS Field Data, Old River at San Joaquin River, May 1 – May 5, 2002.

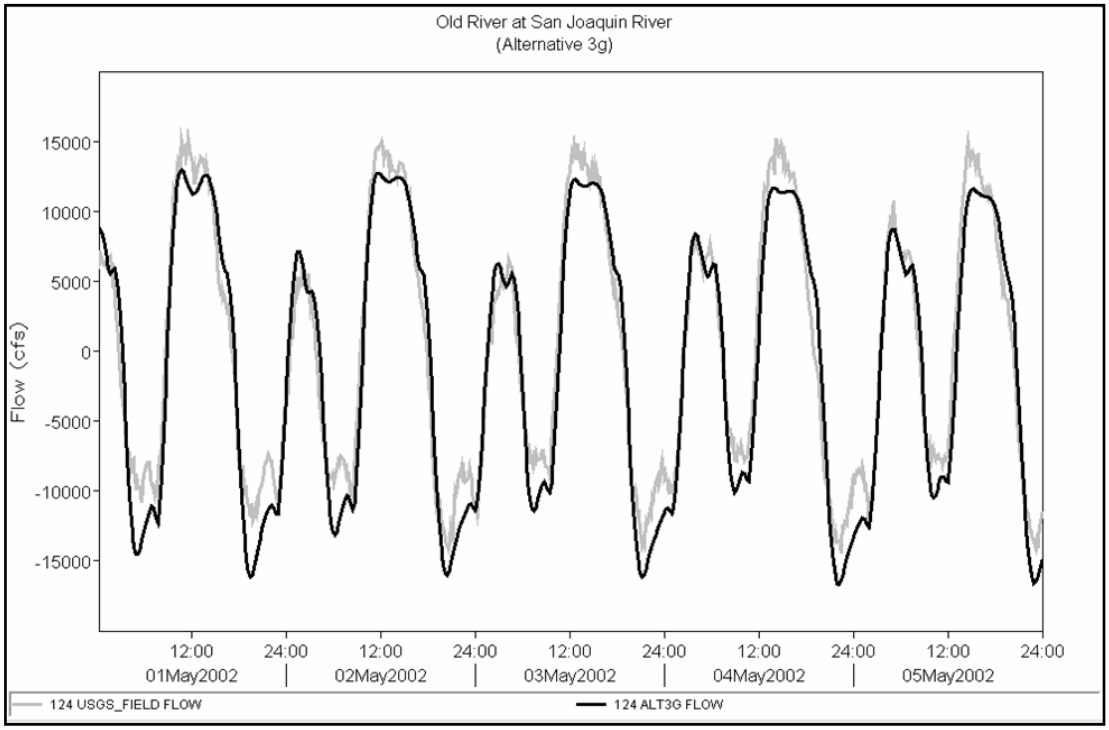

Figure 3.8d: DSM2 Alt 3g Generated Flow and USGS Field Data, Old River at San Joaquin River, May 1 – May 5, 2002.

3.5 Experimenting with Changes to Surrounding Channels

Alternative 3g included minor changes to several irregular cross sections in Holland Cut. Early on in the study, it was clear that improving the simulation of flow in Holland Cut, Fisherman's Cut, and Taylor Slough would not significantly affect the flow across Franks Tract, which is the primary concern. After the configuration of Franks Tract as a series of shallow, wide channels was shown to be best at recreating flows in lower Old River, Alternative 3g was formulated combining the characterization of Franks Tract as channels and modifying the geometry in Holland Cut. Therefore, only Alternative 3g is shown with this feature in an alternative.

3.6 Average Flows under Alternative 3g

The filtered DSM2-simulated flows at the six study locations are presented in Figure 3.3 along with the filtered field data and the DSM2-simulated flows from the current geometry description. As Figure 3.8d shows, DSM2-simulated average flow under Alternative 3g was much closer to field-measured flow at the Old River at San Joaquin River site; however, modeled average flow remains about 1,000 cfs too high in the upstream direction. At Holland Cut and False River, minor improvements in flow resulted and Old River at Mandeville Island experienced little change in flow. At Taylor Slough and Fisherman's Cut, average flow under Alternative 3g significantly increased in the direction towards Franks Tract, presumably as a result of inducing more tidal flow upstream into Franks Tract. As a result, the error in average flows in these two channels significantly increased.

3.7 Delta EC under Alternative 3g

Historic Delta EC conditions were simulated under Alternative 3g. These results, not presented here, varied only slightly from the EC modeled by the current DSM2 geometry, including Franks Tract. The Delta dispersion coefficients downstream of Franks Tract were viewed as limiting any improvement in EC that may occur. Thus, substantial improvements in modeled EC, even with improved flows, may rely on a recalibration of the dispersion coefficients in QUAL west of Franks Tract.

3.8 Discussion

To date, Alternative 3g is an indication of the possible improvement in DSM2-simulated flow at the six locations studied by USGS that can be accomplished without an extensive recalibration of DSM2 beyond the local area of Franks Tract.

To improve DSM2's performance in flow beyond what is presented here in Alternative 3g will require a recalibration of the Manning's n values in HYDRO. To take advantage of improved simulation of flows to improve the accuracy of simulated EC, a subsequent recalibration of the dispersion factors in QUAL would be needed.

3.9 Reference

Nader-Tehrani, P. (2001). "Chapter 2: DSM2 Calibration and Validation." *Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh. 22nd Annual Progress Report to the State Water Resources Control Board.* California Department of Water Resources, Office of State Water Project Planning. Sacramento, CA.