OFFICE MEMO

TO:	Tara Smith	**DATE:**	July 8, 2004
FROM:	Michael Mierzwa / Jim Wilde Bob Suits	**SUBJECT:**	Short- and Long-Term DOC Forecasts at Delta Export Locations with Pumpout of Flooded Jones Tract

This memo supercedes the memo of the same subject dated July 6, 2004 and incorporates feedback from Art Hinojosa of the Operations Compliance and Studies Section.

Findings

Short-term (July 5 – July 18, 2004) and long-term (through the end of 2004) forecasts of dissolved organic carbon (DOC) at Delta export locations have been conducted using DSM2. Using Delta operational forecasts from DWR Operations and Maintenance (O&M), modeling indicates that, in the first two weeks of Jones Tract pumping at 700 cfs, DOC should remain constant or slightly decrease at Clifton Court Forebay, Tracy Pumping Plant, Old River at Rock Slough, and the Los Vaqueros intake. The closing of the levee breach is seen as beneficial at all locations in the short-term, resulting in a net decrease in DOC coming off of Jones Tract, even considering the subsequent water pumped off under an increasing DOC in Jones Tract. In contrast, the long-term DOC forecast shows the possibility that, if high DOC growth rates in Jones Tract are assumed (0.50 grams of carbon per m^2 of surface area per day), DOC may sharply rise in September and October to about 6 mg/L at the Los Vaqueros Intake, 8 mg/L at Tracy Pumping Plant, and 7 mg/L in Clifton Court Forebay. The cessation of the Jones Tract pump-out, assumed to span from July 5 through October 5, 2004 at a pumping rate of 735 cfs, should result in DOC quickly returning to levels at all export locations that would have occurred without the levee breach. It should be stressed that all of the above findings and the analysis that follows are subject to inaccuracies in any forecast of Delta operations as well as the accuracy of DSM2.

Short-Term DOC Forecast Assumptions and Methodology

DSM2 was used to simulate Delta hydrodynamics and DOC under four Delta conditions from four periods: January 1, 2003 up to the levee breach of June 3, 2004 in order to establish initial Delta conditions, during the breach and filling of Jones Tract to reproduce DOC patterns associated with altered flow patterns and establish an initial DOC level in Jones Tract, during the period the breach remained to simulate growth of DOC in Jones Tract and the injection of DOC into Middle River from Jones Tract, and during the first two weeks of the anticipated pumping of 700 cfs from Jones Tract into Middle River. A second simulation that assumed no levee breach and island flooding was conducted for reference purposes.

Delta Hydrodynamics

In conducting the above described study, historical Delta inflows, exports, and installation/operation of Delta structures were used by DSM2 to simulate historical Delta hydrodynamics from January 1, 2003 through June 27, 2004, including the effects of the June 3, 2004 Middle River levee breach at Upper Jones Tract and subsequent flooding of Jones Tract. O&M's Delta hydrologic conditions forecast for June 28, 2004 through July 18, 2004 then provided the information needed to extend the DSM2 historical simulation to a forecast of Delta flows and water levels through July 18, 2004. Figure 1 presents the daily average Delta inflows and exports over the period of June 1, 2004 through July 18, 2004. The Delta Cross Channel operation and temporary barrier installation/operation for the simulation are presented in Table 1. The historical boundary tide at Martinez was used for the historical simulation, while the Adjusted Astronomical Tide was used in the forecast[1].

In order to indicate the possible accuracy of modeled hydrodynamics, Figures 2 and 3 show DSM2-simulated and USGS field-measured flow in Middle River near the levee breach and Old River at Highway 4 for the period of June 1, 2004 through Jun 17, 2004. As the figures indicate, DSM2-generated flows at these two locations generally reproduced measured flows, including during and immediately after the levee breach. DSM2 simulated the initial break by the sudden opening of a gate connected to a reservoir. The size of the opening was restricted due to instability issues with modeling a sudden sizable diversion from a channel. Figure 4 shows the modeled water level in Jones Tract after the levee breach and indicates that, according to the DSM2 simulation, the filling of Jones Tract took approximately three days. The flooded Jones Tract itself was modeled as a reservoir with surface area of 522,000,000 ft^2 and volume of 150,000 acre-feet at 0 mean sea level. Pumping from Jones Tract was assumed to be 700 cfs located at Middle River at the Santa Fe Railroad.

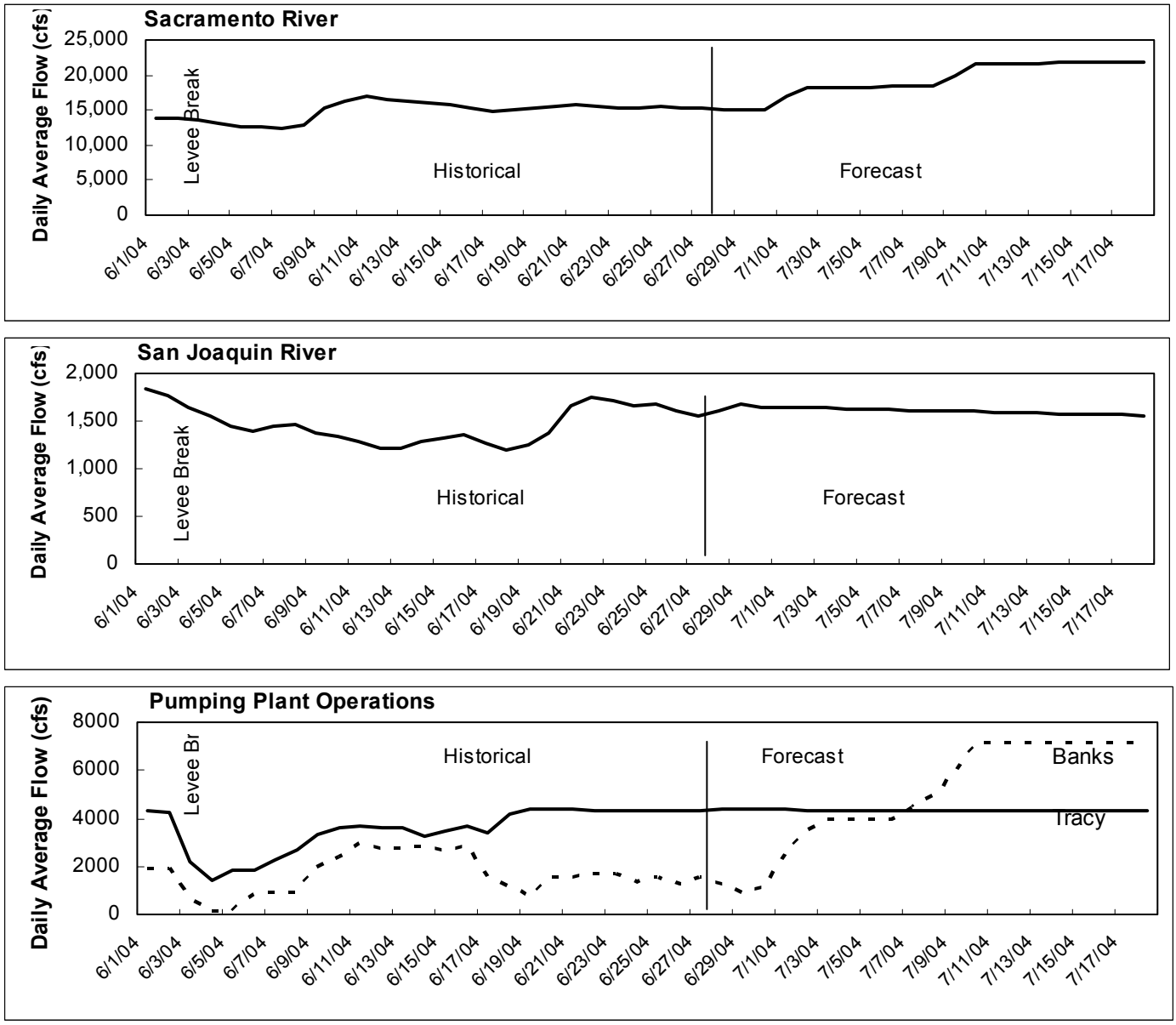

Figure 1. Delta Inflows and Exports During Historical and Short-Term Forecast Periods.

Date	Delta Cross Channel	Old River at Head	Middle and Old River Temporary Barriers	Grantline Canal Temporary Barrier
June 1	Closed	Out	Installed, gates tied open	Boat ramp in, gates tied open
June 2	Closed	Out	Installed, gates operating	Boat ramp in, gates tied open
June 3 - June 4	Open	Out	Installed, gates operating	Boat ramp in, gates tied open
June 5 - June 8	Open	Out	Installed, gates operating	Weir installed, gates tied open
June 9 - July 18	Open	Out	Installed, gates operating	Installed, gates operating

Table 1. Installation / Operation of Delta Structures from June 1, 2004 through July 18, 2004.

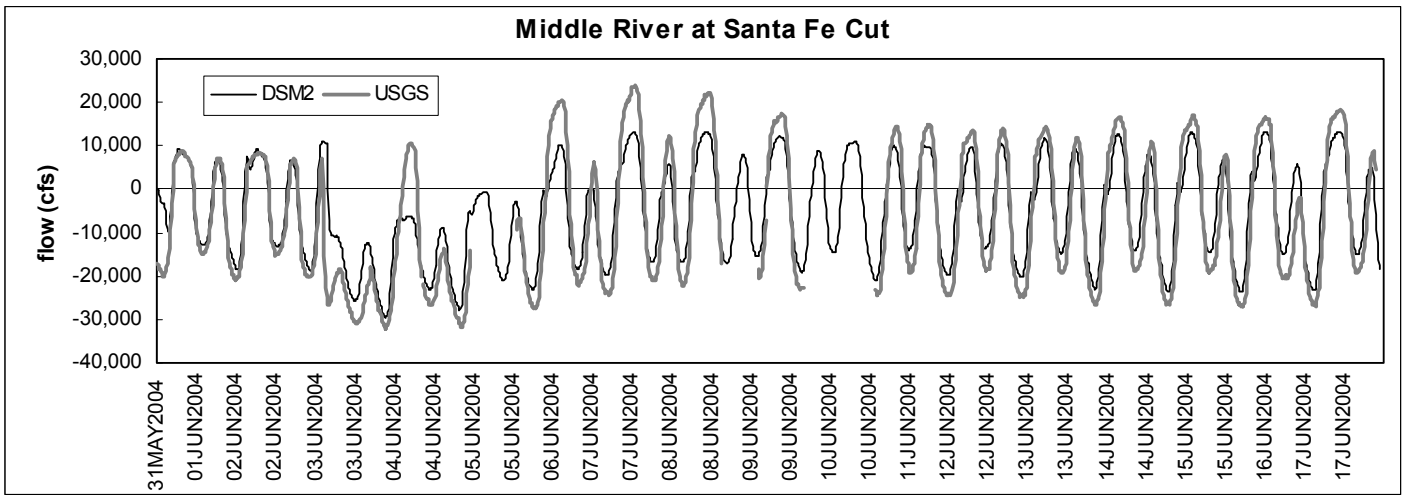

Figure 2. DSM2-Generated and Field Measured Flow, Middle River at Santa Fe Cut, June 1 – July 18, 2004.

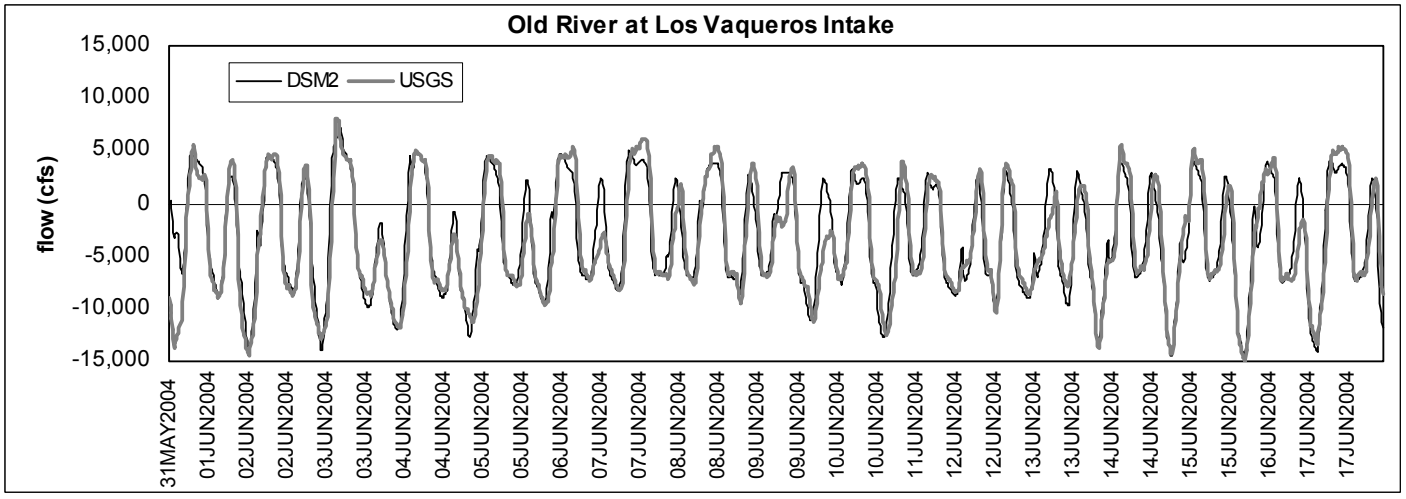

Figure 3. DSM2-Generated and Field Measured Flow, Old River at Los Vaqueros Intake, June 1 – July 18, 2004.

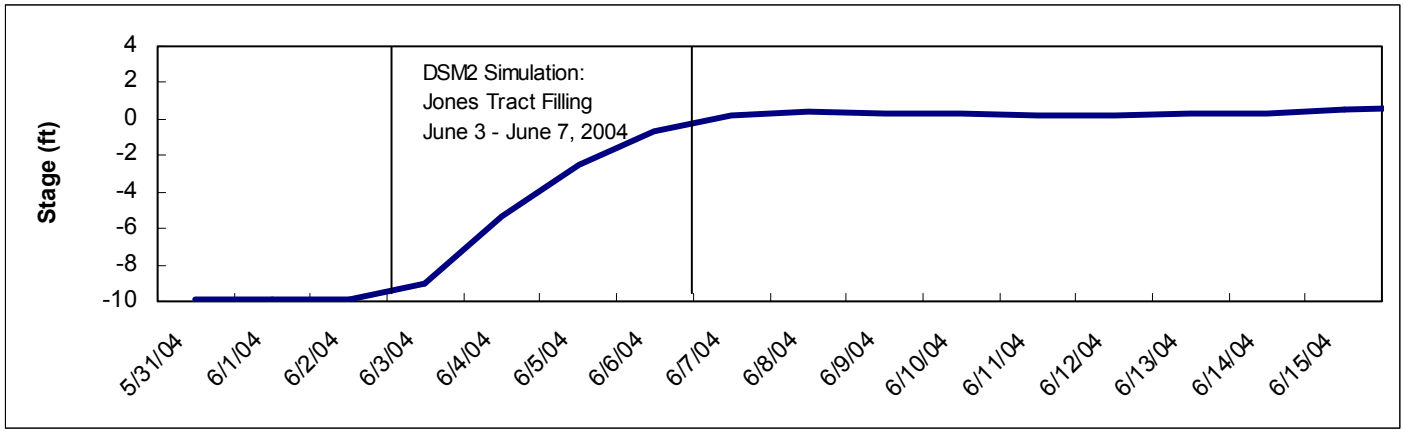

Figure 4. DSM2-Simulated Filling of Jones Tract after Levee Breach on June 3, 2004.

Delta DOC

Once Delta hydrodynamics were simulated for the study period, including the two-week forecast, DOC was modeled. At Delta boundaries, the average of monthly DOC derived for 16-year DWR planning studies[2] was used for both historical and forecast periods for the Sacramento River, the San Joaquin River, and the Mokelumne and Cosumnes rivers (Table 2). DOC at Martinez was assumed to be 0 mg/L. DOC associated with agricultural return flows was the same as used in DWR planning studies for all years[3] and described in a Municipal Water Quality Investigations report[4]. For the flooded Jones Tract, three DOC growth rates were simulated: 0.05, 0.25, and 0.50 grams DOC per m^2 surface area per day[4].

In order to indicate the possible accuracy of modeled DOC, Figure 5 presents calculated daily average DOC based upon measured UVA from Clifton Court Forebay by O&M, available for June 2004, with DSM2-simulated DOC. Generally good agreement is shown with field-based DOC falling within the modeled DOC associated with high and low DOC growth on Jones Tract.

The simulated daily average DOC during the historical period of June 1, 2004 through June 27, 2004 and continuing through the forecasted period of June 28, 2004 through July 18, 2004 is shown in Figures 5-8 for Clifton Court Forebay, Tracy Pumping Plant, Old River at Rock Slough, and Los Vaqueros Intake respectively. For comparison, a DOC simulation assuming no Middle River levee breach and Jones Tract flooding in 2004 was also run and is presented in these figures.

The DOC simulated at Tracy Pumping Plant, and, to a lesser extent Clifton Court Forebay, benefited from closing the breach in the Middle River levee. DSM2 hydrodynamic simulations indicate an equivalent average exchange of approximately 3,500 cfs between the flooded Jones Tract and Middle River while the breach remained, potentially introducing much more DOC into Middle River compared to the early pump-out period during the 700 cfs Jones Tract pump-out scenario.

Dissolved Organic Carbon Used in DSM2 Simulation of June 1 - July 18, 2004
(values in mg/L)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River	3.01	3.01	2.85	2.33	1.92	1.81	1.81	1.81	1.81	1.81	2.32	2.91
San Joaquin River	4.70	4.75	4.69	3.84	3.42	3.38	3.38	3.38	3.38	3.38	3.51	3.60
Mokelumne/Cosumnes	2.00	2.13	2.00	1.74	1.74	1.66	1.66	1.66	1.66	1.66	1.87	1.87

Table 2. DOC values used at Delta boundaries for DSM2 Simulation of June 1, 2004 – July 18, 2004 period.

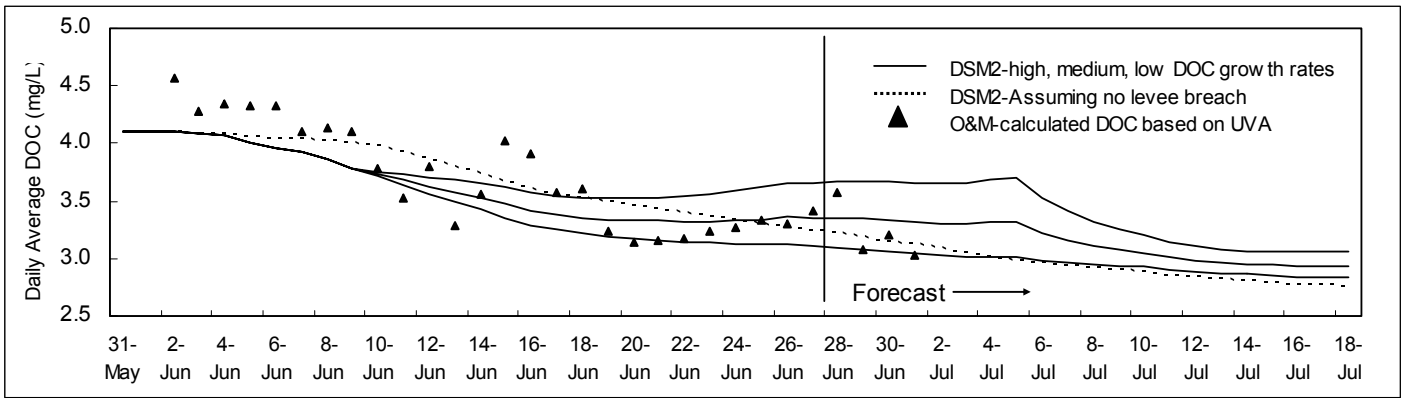

Figure 5. DSM2-generated DOC at Clifton Court Forebay, June 1 – July 18, 2004.

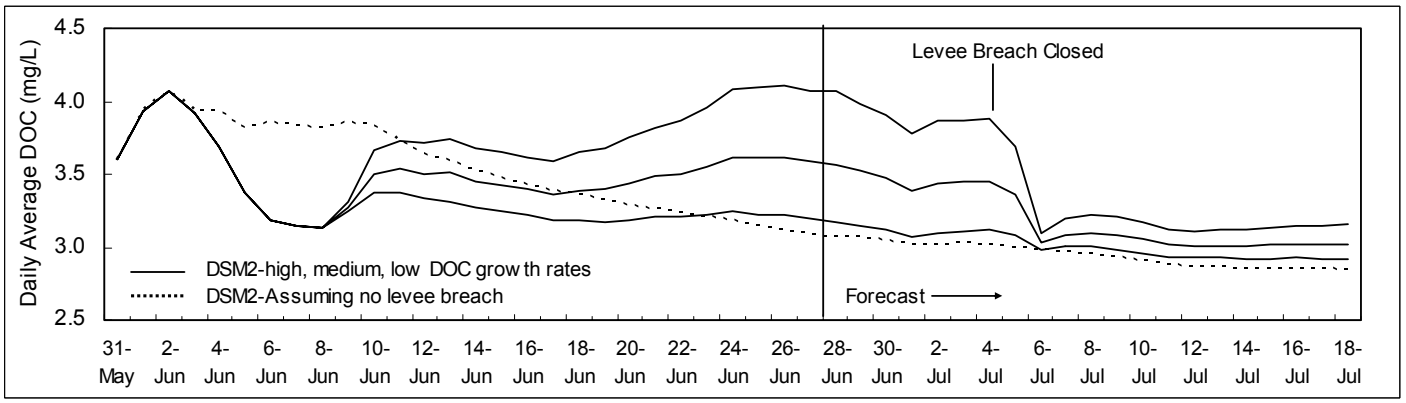

Figure 6. DSM2-generated DOC at Tracy Pumping Plant, June 1 – July 18, 2004.

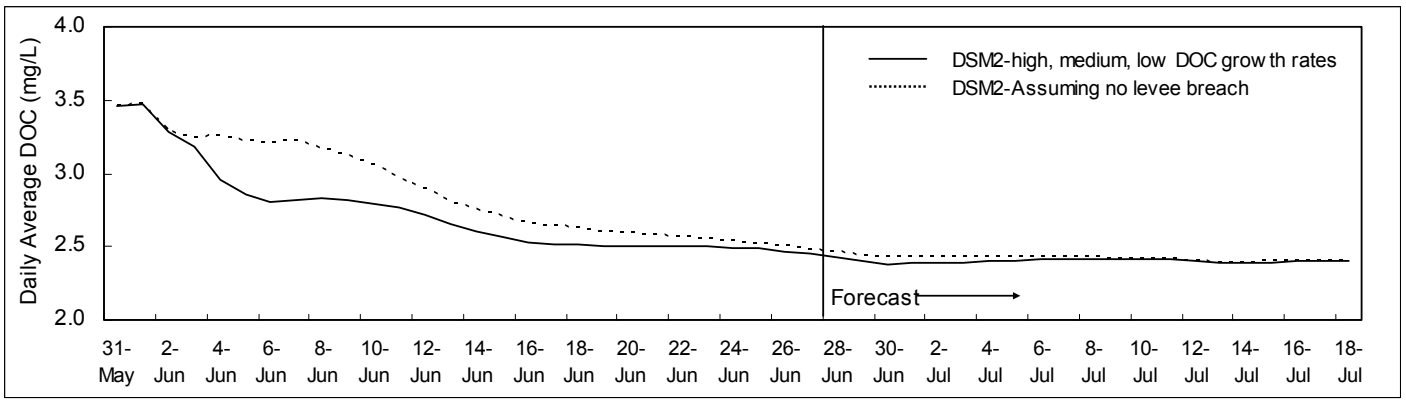

Figure 7. DSM2-generated DOC at Old River at Rock Slough, June 1 – July 18, 2004.

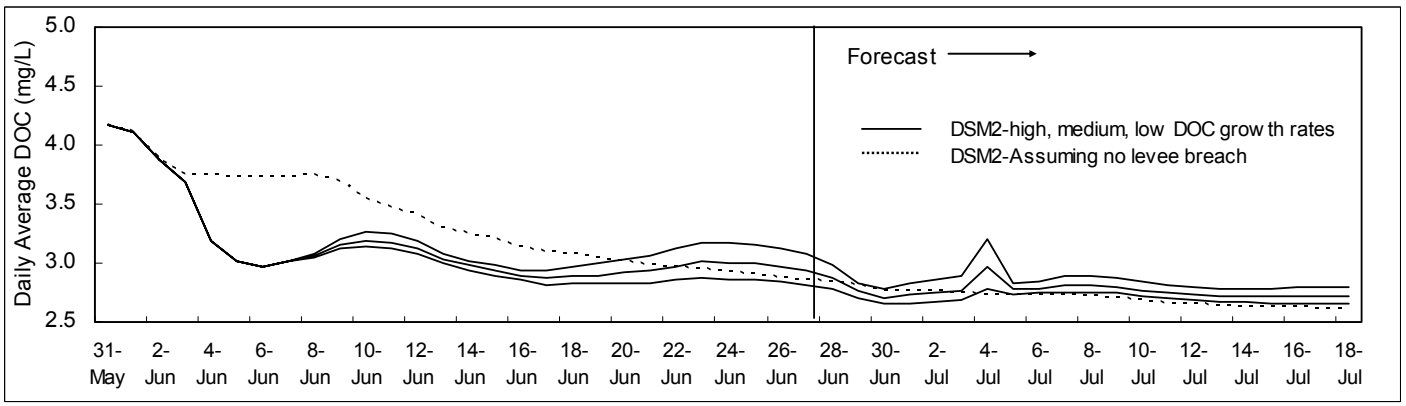

Figure 8. DSM2-generated DOC Los Vaqueros Intake, June 1 – July 18, 2004.

Long-Term DOC Forecast Assumptions and Methodology

Using O&M's May 2004 seasonal forecast of Delta operations, DSM2 was used to forecast DOC at Delta export locations through the end of 2004 assuming a pump out of flooded Jones Tract at 735 cfs and lasting from July 5, 2004 through October 5, 2004. DOC for Delta conditions under O&M's 50% and 99% exceedence probabilities for the May 2004 forecast was simulated. Three DOC growth rates in flooded Jones Tract were simulated: 0.05, 0.25, and 0.50 grams carbon per m^2 surface area per day. Delta hydrodynamics of the June 3, 2004 levee breach and filling of Jones Tract were simulated in order to establish the DOC distribution within the Delta and in the flooded island before the pumping out of Jones Tract in early July 2004 began. Boundary DOC was assumed the same between the 50% and 99% exceedence Delta conditions and likely contributed to DOC results at Delta exports under the two exceedences that were quite similar. For the purpose of this memo, then, only the DOC for the 99% exceedence Delta operations is presented. A separate simulation at each exceedence level that assumed no levee breach and flooding in 2004 was also conducted for reference.

Delta Hydrodynamics

O&M's May 2004 seasonal Delta operations forecast was used to provide monthly average Delta inflows and exports (Table 3). The forecast also provided the percent time the Delta Cross Channel would be opened, but the June forecast of 53% was altered to account for the opening of the Delta Cross Channel on June 3, 2004 due to the levee breach. This data in turn generated daily flows and Delta Cross Channel operation. The Adjusted Astronomical Tide was used at Martinez. The south Delta temporary barriers were assumed installed and operated in accordance with San Joaquin River inflows and assumptions consistent with general planning studies (Table 4). Similar to the short-term forecast described above, the June 3, 2004 Middle River levee breach and subsequent flooding of Jones Tract was simulated with very similar results as presented above. Small differences from the short-term forecasted Delta hydrodynamics were seen due to using O&M's seasonal forecasted Delta inflows and exports for June instead of the actual historical that the short-term forecast used from June 1, 2004 through June 27, 2004.

Delta DOC

After the Delta hydrodynamics were simulated for the forecasted June – December, 2004 period, DOC was modeled using the same monthly average DOC values at the boundaries as listed in Table 2 for the forecast period. As shown in Figures 9 – 12, the DOC growth in flooded Jones Tract has the potential to generate DOC values at several export locations of in excess of 6 mg/L by late summer under the assumed constant pump out rate of 735 cfs from July 5, 2004 through October 5, 2004 and a DOC growth rate within flooded Jones Tract of 0.50 grams carbon per m^2 surface area per day. Once the pumping out of Jones Tract ceases in October, though, DOC at the exports may quickly return to levels that would have been predicted without a levee breach in June, 2004.

	50 Percent Exceedence						99 Percent Exceedence					
	Sac R. Inflow	SJR Inflow	Banks PP	Tracy PP	Contra Costa Canal	Delta Cross Channel % Open	Sac R. Inflow	SJR Inflow	Banks PP	Tracy PP	Contra Costa Canal	Delta Cross Channel % Open
May	13,889	3,090	2,114	1,805	81	18%	24,889	2,756	2,134	1,949	134	18%
Jun	15,058	1,529	3,227	3,176	168	93%*	13,281	2,586	2,261	1,594	81	93%*
Jul	18,817	1,236	5,627	4,196	179	100%	13,797	588	2,823	1,496	168	100%
Aug	17,662	1,220	5,969	4,196	163	100%	17,304	699	4,651	2,944	179	100%
Sep	13,781	1,092	4,235	4,201	168	100%	15,792	667	4,879	2,862	163	100%
Oct	10,818	1,545	2,846	4,082	130	100%	13,596	723	4,790	3,092	168	100%
Nov	10,789	1,597	3,714	4,201	50	50%	11,336	651	3,269	3,155	130	50%
Dec	11,368	1,708	4,765	4,098	49	48%	9,966	840	2,101	2,252	50	48%

*O&M May forecast assumed that the Delta Cross Channel would be open for 53% of time. This value has been updated to reflect actual operation after the levee breach on June 3, 2004.

Table 3. Forecast Delta Operations from O&M's May 2004 Seasonal Delta Operations Forecast under 50 Percent and 99 Percent Exceedences.

	Barrier Location			
	Head of Old River	Middle River	Old River at Tracy	Grant Line Canal
December 1, 2003	Out	Out	Out	Out
April 15, 2004	In	In	In	Out, Boat Ramp In
May 15, 2004	Out			In
September 16, 2004	In with notch	In with notch	In with notch	In with notch
December 1, 2004	Out	Out	Out	Out

Table 4. Forecasted 2004 Installation and Operation of South Delta Temporary Barriers.

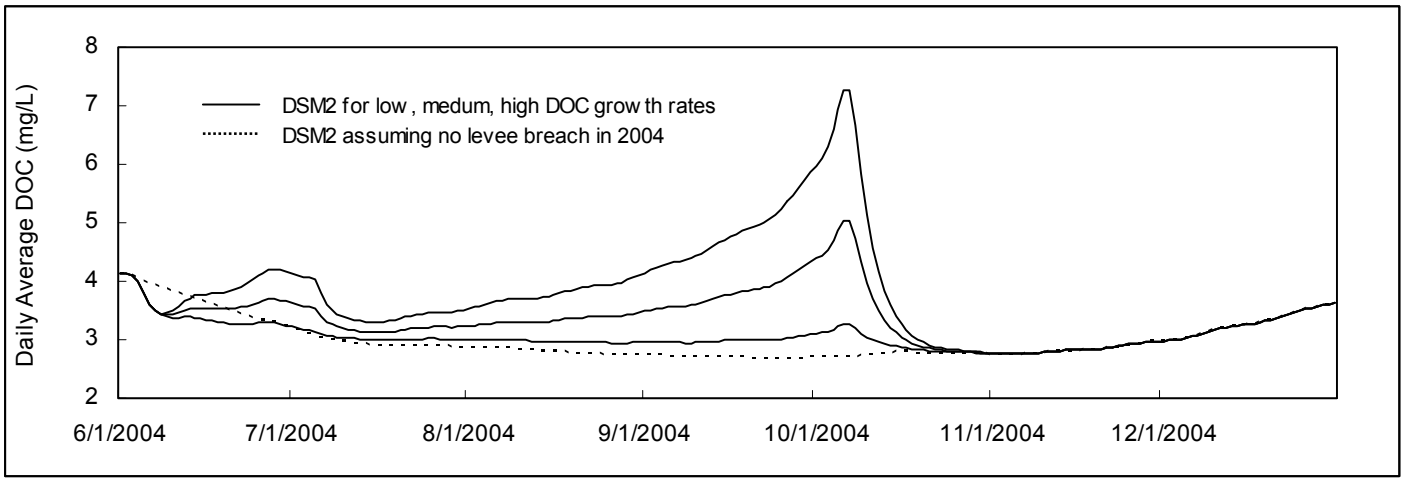

Figure 9. Seasonal forecast of DOC at Clifton Court Forebay, June through December of 2004.

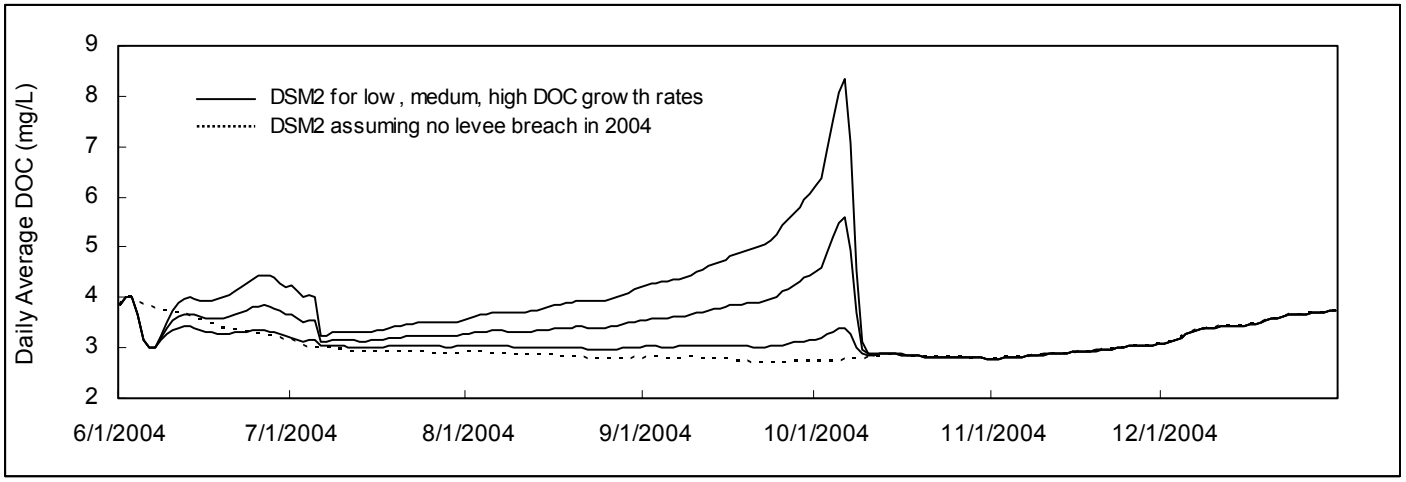

Figure 10. Seasonal forecast of DOC at Banks Pumping Plant, June through December of 2004.

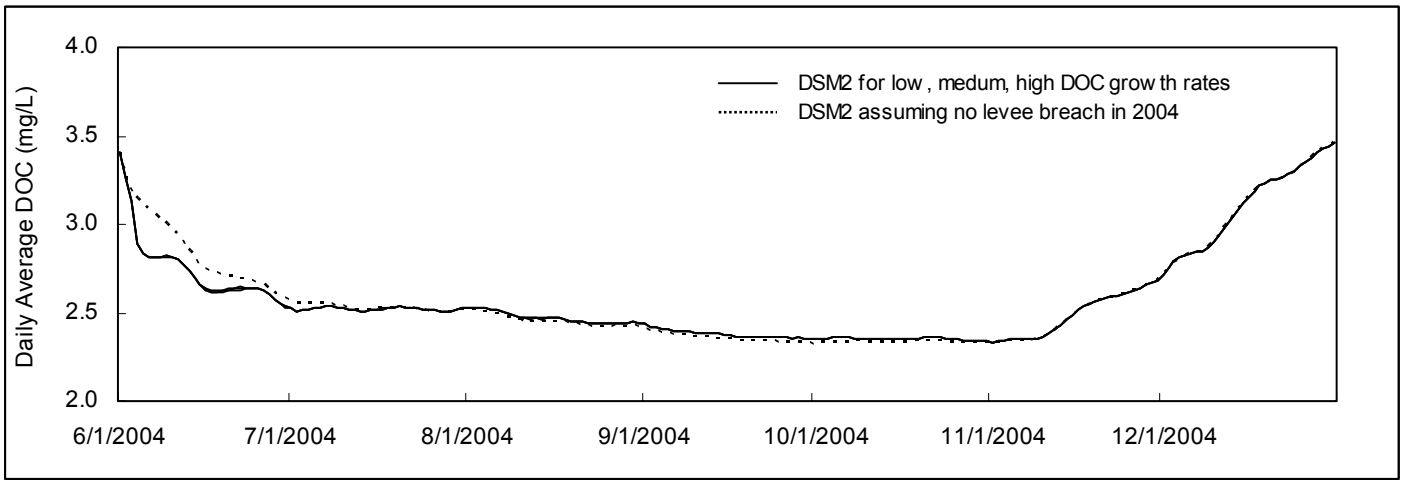

Figure 11. Seasonal forecast of DOC at Old River at Rock Slough, June through December of 2004.

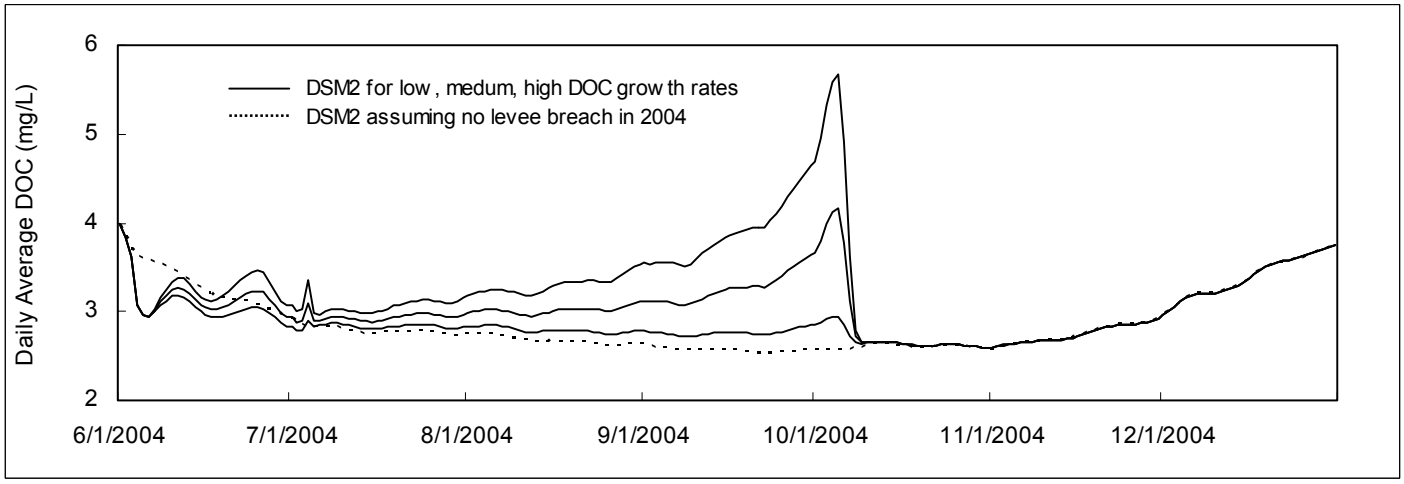

Figure 12. Seasonal forecast of DOC at Los Vaqueros Intake, June through December of 2004.

References

1. Ateljevich, E. (2001). "Chapter 10: Planning Tide at the Martinez Boundary." *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.

2. Suits, B. (2002). "Chapter 7: Generating Monthly Dissolved Organic Carbon and UVA at DSM2 Boundaries." *Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh*. 23rd Annual Progress Report to the State Water Resources Control Board. California Department of Water Resources, Office of State Water Project Planning. Sacramento, CA.

3. Pandey, G. (2001). "Chapter 3: Simulation of Historical DOC and UVA Conditions in the Delta." *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.

4. Jung, M. (2000). *Revision of Representative Delta Island Return Flow Quality for DSM2 and DICU Model Runs, Municipal Water Quality Investigation Program*. California Department of Water Resources, Division of Planning and Local Assistance. Sacramento, CA.

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