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November 11, 2012

State Water Resources Control Board
1001 I St.
Sacramento, CA 95814

LATE COMMENT

Via email: commentletters@waterboards.ca.gov

Subject: Bay-Delta Workshop 3 – Analytical Tools for Evaluating the Water Supply, Hydrodynamic, and Hydropower Effects of the Bay-Delta Plan
FSI 064136

Dear Ms. Townsend and Members of the Board,

On behalf of the City of Antioch, Flow Science is pleased to submit comments for consideration by the State Water Resources Control Board (State Board) during its Comprehensive (Phase 2) Review and Update to the Bay-Delta Plan.

Background. The City of Antioch (Antioch), located along the San Joaquin River in the western portion of the Sacramento and San Joaquin River Delta (Delta), is one of the oldest towns in California. Since the 1860s, Antioch has obtained all or part of its freshwater supply directly from the San Joaquin River. The City, because of its position in the western Delta, is also concerned with the ecological health of the Delta and its long-term viability as a recreational destination. Antioch previously provided written comments and testimony for Bay-Delta Workshop 1, and incorporates that information by reference.

Recommendations to the Board. The information provided below is intended primarily to address the State Board's first question, regarding the types of analyses that should be completed to estimate the water supply, hydrodynamic, and hydropower effects of potential changes to the Bay-Delta Plan. The City's comments focus on water supply and hydrodynamic issues, particularly effects to drinking water intakes (such as the City's) that are located within the Delta, and the tools available to address those effects. These comments are organized into three major categories: (1) validation of the operations model; (2) evaluation of water sources and relation to water quality; and (3) modifications necessary to evaluate habitat restoration and sea level rise. Recommendations are provided in italics at the end of each comment.

1. **Modeling should be extended to include recent years to allow validation of the operations model.** Most Delta modeling studies evaluate a period of record that ends approximately ten years ago. For example, the studies that are currently being conducted to evaluate the potential impacts of the Bay-Delta Conservation Plan (BDCP) evaluate an 82-year hydrologic period extending from 1922-2003. These

studies use modeling tools such as CALSIM II to "re-operate" the system—i.e., historical hydrology is used as the basis for simulations of current operations and operations rules.

However, significant changes have occurred in the way in which California's water resources system is operated since 2003. For example, Judge Oliver Wanger delivered a number of decisions beginning in 2007 that reduced the amount of water that could be exported from the Delta, and that imposed specific requirements for flows within the Delta (e.g., Old and Middle River ("OMR") flows). Although these operational changes are simulated by CALSIM II, the models are not being used to simulate hydrologic conditions in 2007 or later. Thus, model results for the period of 2007-present cannot be compared with observed conditions in the Delta for the same time period, and it has not been established that the models adequately simulate these new conditions.

The City recommends that the State Board examine model results for the period of 2007-present to establish that the available models accurately simulate conditions under current operational rules.

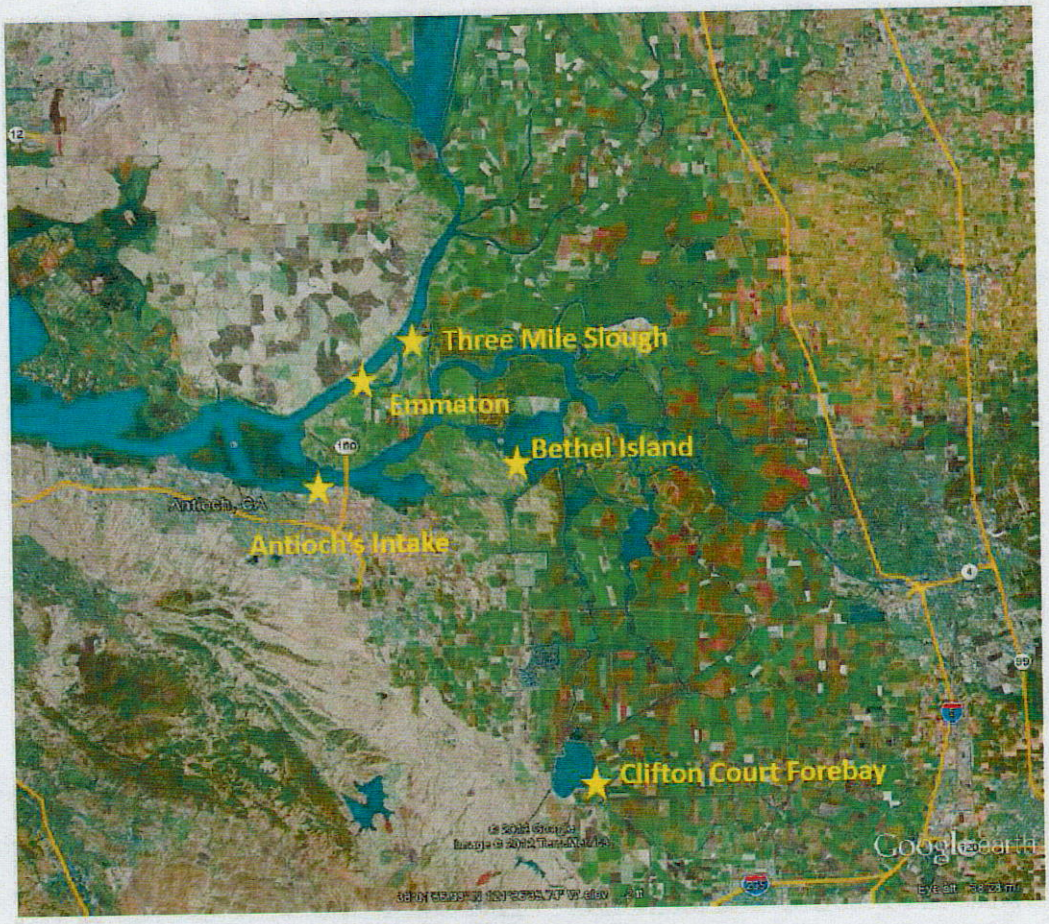
2. **The source of water in the Delta is an important determinant of water quality and should be considered when establishing water quality standards.** Much of the water in the western Delta (including the City's water supply) comes from the Sacramento River. Historically, significant amounts of Sacramento River water flowed into the San Joaquin River east of Antioch at Three Mile and Georgiana Sloughs. Sacramento River water also reaches Antioch where the river merges with the San Joaquin River just west of the City, and as a result of tidal mixing within the Delta. (See also Town of Antioch v. Williams Irrigation District et al. (1922) 188 Cal. 451, 455.)

   As will be demonstrated below, even though the City's intake is located on the San Joaquin River, very little San Joaquin River water is present at this location. Further, the source of water within the Delta is a strong determinant of the quality of water, and should be considered when evaluating potential future changes to the Delta or to water quality objectives for the Delta.

   My graduate work[1] investigated the sources of water in the Delta, and is illustrative in demonstrating the importance of water sources. Daily composite samples were collected at five locations within the Delta in the 1996-1997 time period, and the geochemistry of these samples were used to identify the source of water at the export pumps in the South Delta. Specifically, concentrations of sodium, calcium, magnesium, and strontium were used to develop "fingerprints" for Sacramento River water, San Joaquin River water, and water from San Francisco Bay, and to calculate

[1] S. C. Paulsen, 1997. A study of the mixing of natural flows using ICP-MS and the elemental composition of waters. Ph.D. Thesis, California Institute of Technology, May 22, 1997.

the fraction of water from each of those sources in water samples collected at Clifton Court Forebay and at Bethel Island, in the interior of the Delta (see **Map** below).



Map. Location of the City of Antioch's drinking water intake. Clifton Court Forebay, Bethel Island, Emmaton, and Three Mile Slough are also shown, and are referenced in these comments.

As shown in **Figure 1**, the chemical fingerprints were used to compute the source of water at Clifton Court Forebay and at Bethel Island. The blue bars indicate that most water at the State Water Project intakes originated from the Sacramento River; pink bars indicate the fraction that originated in the San Joaquin River, and the green bars (very small, near the top of the figures) indicate the fraction from the Bay at Martinez. (Note that it was assumed, mathematically, that all the water at these locations originated from the three sources; sources of water interior to the Delta were not considered, but were relatively minor.)

Figure 1a: Source fractions determined at Clifton Court Forebay using source "fingerprints"

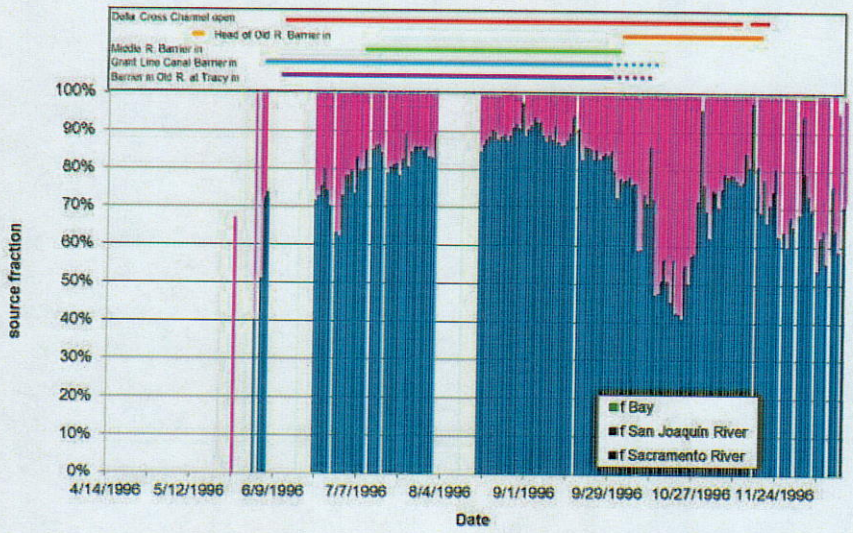


Figure 1b: Source fractions determined at Bethel Island using chemical "fingerprints"

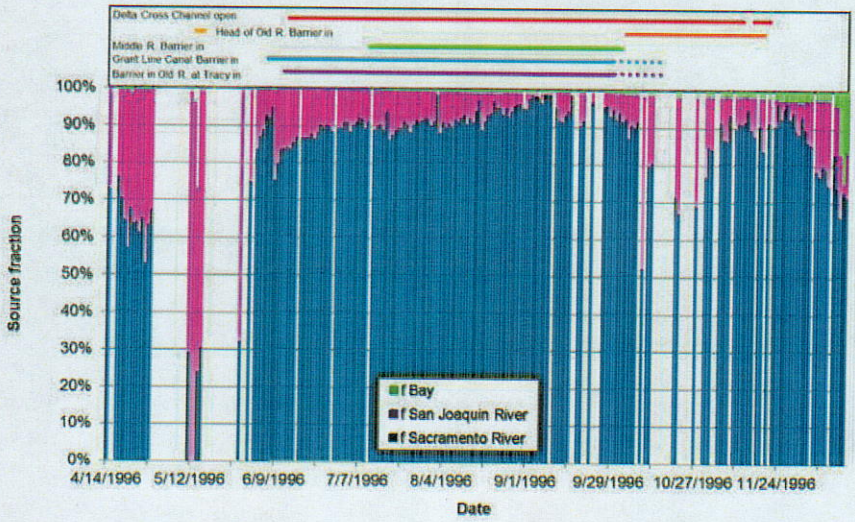


Figure 1. Fraction of water present at Clifton Court Forebay (panel 1a) and Bethel Island (panel 1b) that originated from the Sacramento River, the San Joaquin River, and San Francisco Bay at Martinez. Concentrations of sodium, magnesium, calcium, and strontium were measured in daily composite samples collected at these locations; "source fractions" were calculated to add to 100%.

As shown in **Figure 2**, sodium, a surrogate for salinity, was one of the elements measured at Clifton Court Forebay, the entrance to the State Water Project. **Figure 2** includes open circles, which show the sodium concentration measured in water collected from Clifton Court Forebay on a daily basis. The shaded bars indicate the

source of the sodium in those samples based on source fingerprinting – i.e., the fraction of water in each day's sample that was calculated using the source fingerprints to have originated in the two rivers and the Bay. Even though the San Joaquin River was a relatively small fraction of the water (generally 10-30%), the San Joaquin River was the source of just over 50%, on average, of the salinity at this location. As expected, the presence of even small amounts of water from the Bay contributed to a large fraction of the salinity at this location toward the end of the study period. At Bethel Island (in the interior of the Delta), most salinity originated from the Bay.

Figure 2a: Sources and concentration of sodium at Clifton Court Forebay

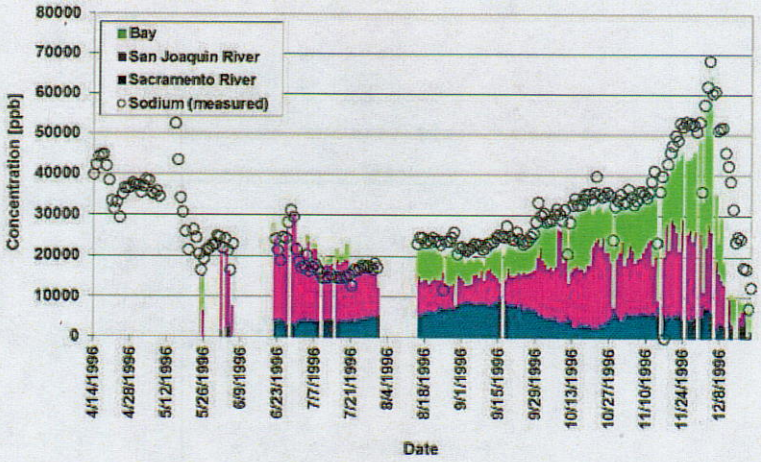


Figure 2b: Source and concentration of sodium (salinity) at Bethel Island

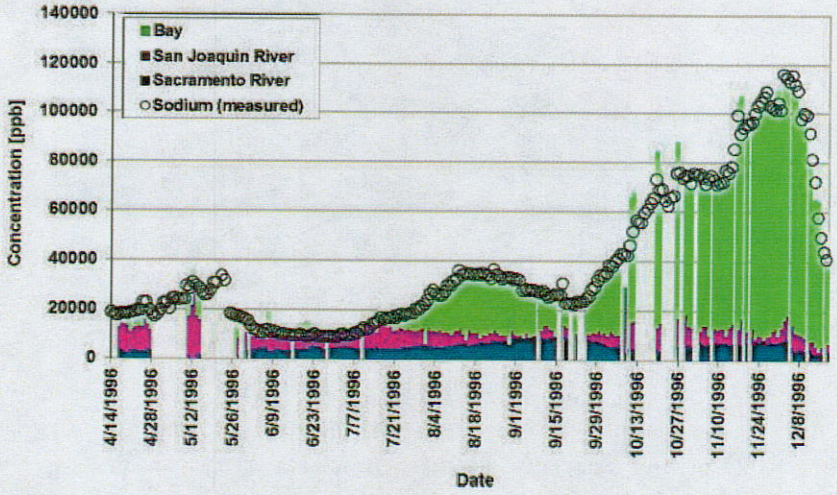


Figure 2. Concentrations and sources of sodium (a surrogate for salinity) at Clifton Court Forebay (panel 1a) and Bethel Island (panel 1b) that originated from the Sacramento River, the San Joaquin River, and San Francisco Bay at Martinez. Open circles show concentrations of sodium measured at these locations; colored bars show the concentration of sodium from each of the three major sources of water to the Delta, calculated from source fingerprints shown in Figure 1.

These results were used to validate source fractions predicted by Delta models. **Figure 3** shows source fractions predicted for this time period by the Fischer Delta Model (FDM); results obtained using the Department of Water Resources Delta Simulation Model II (DSM2) are not shown but are similar. In general, the model reproduces the source fractions that were calculated from direct water chemistry measurements quite well, giving us confidence that the models can simulate the source of water within the Delta with reasonable accuracy.

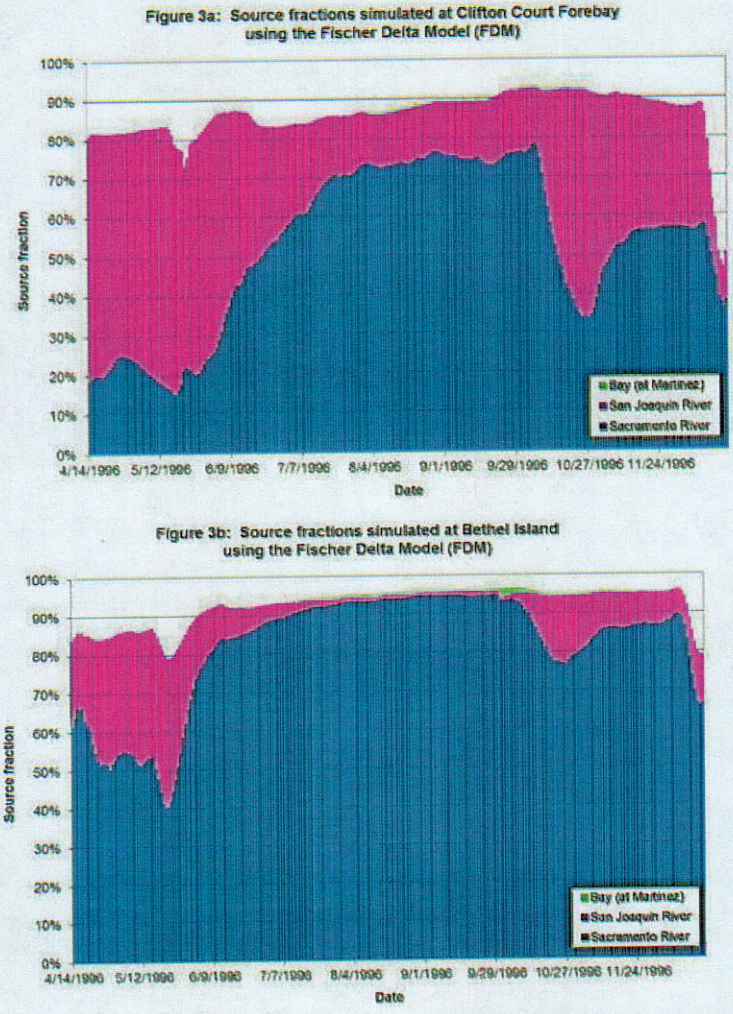


Figure 3. Source fractions predicted by the Fischer Delta Model (FDM) at Clifton Court Forebay (panel 1a) and Bethel Island (panel 1b) that originated from the Sacramento River, the San Joaquin River, and San Francisco Bay at Martinez. Results from the DSM2 model (not shown) are similar.

Model studies have confirmed that, over a much longer period, very little San Joaquin River water reaches San Francisco Bay, particularly during dry conditions. (See, for example, Flow Science 2008, *Effect of Increased Flow in the San Joaquin River on*

Stage, Velocity, and Water Fate, Water years 1964 and 1988.) Most San Joaquin River water is diverted within the Delta (in-Delta consumptive use) or exported from the Delta.

Future changes to the Delta may include the construction and operation of water intakes in the North Delta (as proposed by the BDCP), which would export Sacramento River water from the Delta. Some fraction of the river's flow, which formerly flowed from the Sacramento River into the Central, South, and Western Delta, would be diverted before it reached these areas of the Delta. In addition, exports from the South Delta, which historically have been composed primarily of water from both the Sacramento and San Joaquin Rivers, would decrease or even be eliminated during certain time periods.

Changes in the point at which water is diverted from the Delta would also, therefore, change the composition of water within the Delta, and the residence time of water within the Delta (i.e., the time period water is resident in the Delta before either being diverted/exported or flowing to the Bay).

Antioch's prior testimony presented preliminary model results from the BDCP process that indicated that the proposed project would increase salinity at the City's intake. Salinity increases were simulated to be particularly large during the late summer and fall months of above normal and wet years, and were largely independent of the salinity increases projected to occur as a function of sea level rise. That testimony is incorporated by reference and is not repeated here, except to say that the proposed project has serious and potentially irreversible implications for the City's water supply and for the municipal/domestic supply (MUN) beneficial use in the western Delta.

These comments, instead, focus on a second point: that other aspects of water quality are also important and should be evaluated. Not only does the San Joaquin River have higher salinity water than the Sacramento River, it also has higher concentrations of other water quality constituents, such as pesticides and selenium. Decreasing exports from the South Delta also is likely to increase the residence time of water in the Delta, potentially resulting in worsening water quality due to higher concentrations of in-Delta agricultural discharge water and potentially higher temperature, algae levels, and lower dissolved oxygen levels.

The City recommends that the source of water, water quality impacts, and impacts of changed residence time be modeled and evaluated by the State Board as part of its effort to establish objectives for the Bay-Delta.

3. **Creation of new habitat, combined with sea level rise, has the potential to alter hydrodynamics and salinity within the Delta.** As noted in prior testimony, habitat creation can result in unintended consequences—e.g., depending on the location and design of new habitat, salinity levels in the western Delta could be increased as a direct consequence of habitat creation.

   In addition, models typically retain current geometry when simulating new habitat. However, flooding new areas may affect hydrodynamics throughout the region and will certainly affect currents and sediment transport in the channels adjacent to the new habitat. Over time, there will likely be erosion in some areas and deposition in others, which in turn will affect velocity and turbidity. The geomorphic changes caused by the new habitat should be incorporated into the models, perhaps running multiple scenarios as the habitat evolves.

   Similarly, models typically retain the current geometry when simulating the higher water levels that will occur with sea level rise—i.e., the models typically assume that current channel walls and levees will extend vertically upward to the new water surface. This assumption, which implies that a sea wall will be built along the shoreline of the Bay and all Delta channels, is clearly incorrect. For instance, it is unlikely that levees would be built to prevent inundation of the salt ponds that are currently undergoing restoration in the north Bay. The model designers need input from policy makers to specify which areas in the future will be protected by sea walls and which will be open to inundation. Without this information, the models do not rigorously simulate the new shallow water areas that are likely to be important in determining hydrodynamics and tidal behavior in the Delta.

   The City recommends that model simulations rigorously evaluate the potential salinity and water quality impacts of new habitat that is expected during the life of the plan. Models should be adjusted, if necessary, to include shallow inundated areas that are not currently simulated but would be important at higher water levels.

In addition, and as detailed in prior testimony, Antioch believes that it is in the City's best interest, and in the interest of the Delta ecosystem, to maintain freshwater conditions in the western Delta. Thus, the City reiterates its requests that:

- Given historical conditions, salinity should not be allowed to rise (and outflows should not be allowed to decline) beyond existing levels as required by D-1641 and X2 operations criteria.
- Compliance points (such as the compliance point currently located at Emmaton) should not be moved landward (as is being proposed by the BDCP).
- The State Board should consider using the gauging station at Antioch as a point of interest for monitoring of both salinity and flow conditions in the western Delta.

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- The State Board should ensure that mitigation is provided for impacts to beneficial uses that occur as a result of the BDCP project.

Please contact me at (626) 304-1134 if you have any questions regarding this submittal. We thank you for your consideration of these comments and for the opportunity to participate in the process to revise the Bay-Delta Plan.

Sincerely,

Susan C. Paulsen

Susan C. Paulsen, Ph.D., P.E.
President and Senior Scientist