Petition to De-List the Lower San Joaquin River

For

Impairment by Salt and Boron

EXHIBIT I

Flow Science Executive Summary

Submitted By:

SAN JOAQUIN RIVER GROUP AUTHORITY

Presentation by Flow Science Inc.
Susan Paulsen, Ph.D., P.E., and Alex Anderson, E.I.T.

Evaluation of Revised Salinity Standard at Vernalis

Introduction
Flow Science Incorporated (Flow Science) has been retained by the San Joaquin River Group Authority to evaluate the potential effects of modifying the current salinity standards for the San Joaquin River (SJR) at Vernalis. Presently, the SJR salinity standard at Vernalis, which bears the name "Case 1" for this study, is 0.7 mS/cm (414 mg/L)[1] in April-August, and 1.0 mS/cm (589 mg/L) the remainder of the year. The proposed new standard, called "Case 9" herein, is a salinity of 1.0 mS/cm (589 mg/L) year-round at Vernalis.

Overview
Flow Science utilized the Fischer Delta Model (FDM)[2] to simulate hydrodynamics and salinity within the Delta for this project. The FDM consists of two linked models, a hydrodynamic model (DELFLO) and a water quality model (DELSAL). The hydrodynamic model utilizes the fixed grid method of characteristics to simulate the hydrodynamics of the Delta. The water quality model, DELSAL, uses the Lagrangian method, in which the motions of parcels of water are followed through the Delta. The Lagrangian method- which avoids numerical dispersion- uses no grid points, but the computational effort required is equivalent to the use of approximately 2,500 grid points in a finite element numerical model.

The model extends from the downstream boundary in Carquinez Strait, upstream to Sacramento on the Sacramento River, and to Vernalis on the San Joaquin River. It also includes all tidally-influenced sloughs and accounts for inflows from all major tributaries, state and federal project exports, riparian diversions, channel depletions, and agricultural returns. The FDM has been successfully applied to the transport of total dissolved solids (TDS) and other neutrally buoyant tracers in the Sacramento-San Joaquin Delta for over twenty years. The model has undergone continuous improvement over the years.

Two water years were selected for modeling in this study, 1964 and 1988. Water year 1964 was a dry year in both the Sacramento and San Joaquin River basins, while 1988 was a critically dry year in both basins[3]. These years were selected by Dan Steiner as

1 Conversions between electrical conductivity (EC) and total dissolved salts (TDS) based upon historical data from the memorandum "Salinity Unit Conversion Equations", California Department of Water Resources, 1986. Data from the station in the memo nearest the site of interest was used.

2 The model is operated by Flow Science Incorporated for Hugo B. Fischer, Inc.

3 A dry water year is defined as having a water year index below 6.5 million acre-feet (Sacramento Valley) or below 2.5 million acre-feet (San Joaquin Valley). A critically dry water year is defined as having a water year index below 5.4 million acre-feet (Sacramento Valley) or below 2.1 million acre-feet (San Joaquin Valley) according to California Department of Water Resources criteria. 1964 was a dry year in both basins, while 1988 was a critically dry water year in both basins. See DWR's Chronological Sacramento and San Joaquin Valley Water year Hydrologic Classification Indices, available at cdec.water.ca.gov/cgi-progs/iodir/WSIHIST.

representative of a range of hydrologic conditions in which the proposed SJR salinity changes are likely to have the largest effect.

Eight different scenarios were modeled for this study. The eight scenarios stem from two basic configurations: a baseline case, called "Case 1", and the new SJR salinity standard case, called "Case 9". These two cases are then modified in various ways to reflect possible or anticipated changes in the Delta. These changes include 1) implementation of the South Delta Improvement Plan (SDIP)[4], 2) a modified operation schedule for the Head of Old River Barrier (HORB), and 3) a combination of alternatives 1 and 2. Each of these eight scenarios was modeled for both water years 1964 and 1988. The table below shows all the scenario names and the differences between them.

Table 1: Summary of Modeled Scenarios

	Modified HORB Schedule[a]	SDIP Operations[b]
Case 1 (Baseline)		
Case 9 (New Salinity Standard)		
Case 1-HORB	X	
Case 9-HORB	X	
Case 1-SDIP		X
Case 9-SDIP		X
Case 1-SDIP-HORB	X	X
Case 9-SDIP-HORB	X	X

a. Standard HORB schedule is as follows: In place Apr. 16-May 15 and Oct. 1-Nov. 30. Modified HORB schedule is: In place Apr. 16-May 15 and Oct. 1- Oct. 31.
b. SDIP operations include changes in export rates from the Banks and Tracy Pumping Plants and changes in flow rates to the Sacramento and Mokelumne Rivers.

Input data for the model were obtained from several sources. Dan Steiner provided river and export flow rates, as well as San Joaquin River electrical conductivity (electrical conductivity was converted to TDS for model use, see footnote 1). Salinity for other rivers was assumed by Flow Science based on previous experience[5]. Gates and barriers were modeled according to current barrier operations based on information obtained from DWR[6]. The table below summarizes the barrier operation schedules for the HORB, the Old River Barrier at Tracy (ORB), the Middle River Barrier (MRB), and the Grant Line Canal Barrier (GLCB). The table shows the dates that the barriers were in place.

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4 SDIP CALSIM simulations performed by DWR are preliminary and may change at a later date.
5 Flow Science assumed salinity as follows: Sacramento River and Yolo Bypass: 100 mg/L; Calaveras River and Mokelumne River: 72 mg/L.
6 Emails from Andy Chu, Senior Water Resources Engineer, California Department of Water Resources, 1/13/05; Mark Holderman, Chief-Temporary Barriers Project, California Department of Water Resources, 1/27/05.

Table 2: Barrier Operations for Modeled Scenarios

	Standard, SDIP scenarios	**HORB, SDIP-HORB scenarios**
HORB[a]	Apr. 16-May 15; Notched Oct. 1-Nov. 30	Apr. 16-May 15; Notched Oct. 1-Oct. 31
ORB[b]	Apr. 16-Sep. 15; Notched Sep. 16-Nov. 30;	Apr. 16-Sep. 15; Notched Sep. 16-Nov. 30;
MRB[c]	Same as ORB	Same as ORB
GLCB[d]	Same as ORB	Same as ORB

a. HORB was simulated as spanning the full channel width at elevation 10 feet (all elevations reference NGVD29). The fall notch is 32 feet wide at elevation 0.0 feet.
b. ORB was simulated as spanning the full channel width at elevation 4 feet. The fall notch is 10 feet wide at elevation 0.5 feet.
c. MRB was simulated as spanning the full channel width at elevation 3 feet. The fall notch is 10 feet wide at elevation 0.3 feet.
d. GLCB was simulated as spanning the full channel width at elevation 3.5 feet. The fall notch is 10 feet wide at elevation 0.5 feet.

Before presenting the results, it is necessary to understand the assumptions that are built into the results. Flow Science made the following assumptions for modeling purposes:

- No culverts were placed in the three agricultural barriers (ORB, MRB, and GLCB), though "notches" were cut according to DWR specifications in the fall, as shown in Table 2.

- Clifton Court Forebay gates were assumed to be open all of WY64 because CCFB did not exist in WY64. Historical CCFB gate operations were used for WY88.

- The Delta Cross Channel Barrier (DXC) was simulated as open from the first of each month until the month's "open days" quota is spent, where the number of open days were specified by the CALSIM modeling. This is in accordance with DWR's modeling practices[7].

- All CCWD diversions are assumed to be through Rock Slough Pumping Plant #1 (i.e. no Old River diversions).

- Monthly data from CALSIM were transformed to daily data by assigning each day its corresponding month's average value (i.e. flow/salinity were not "smoothed" between months).

- Note that diversions, exports, and river flow rates employed are not actual WY64 and WY88 historical flows, but those specified in CALSIM runs provided by Dan Steiner.

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7 Telephone conversation with Andy Chu, Senior Water Resources Engineer, California Department of Water Resources, 1/18/05.

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Results

The proposed changes to the SJR salinity standard at Vernalis will have a small impact on salinity in the Delta under the conditions modeled. As shown in Figure 1, the salinity in Clifton Court Forebay will change by less than 10 mg/L (0.02 mS/cm) for nine months of water year 1964, and the largest salinity change for Clifton Court is 28 mg/L (0.06 mS/cm), occurring in the month of August. The increase of 28 mg/L (0.06 mS/cm) in August represents an increase in salinity of approximately 7%, from 380 mg/L (0.67 mS/cm) to 408 mg/L (0.73 mS/cm), as shown in Figure 2. Other areas of the Delta mirror this trend. In Rock Slough, for example, the greatest increase in salinity is 38 mg/L (0.07 mS/cm), once again observed in the month of August. This salinity increase, from 499 mg/L (0.91 mS/cm) to 537 mg/L (0.98 mS/cm), represents an increase of 8% (see Figures 5 and 6).

Flow Science also monitored major export locations to determine where SJR water leaves the Delta. Results are shown in Figures 12 and 13. For Cases 1 and 9 in water year 1964, approximately 34% of the water that flowed down the SJR past Vernalis exited the Delta through the Tracy Pumping Plant, while another approximately 44% of the SJR water exits the Delta through the State Delta Pumping Plant. Approximately 1 percent of SJR left the Delta through Rock Slough Pumping Plant #1. The remaining SJR water, approximately 21%, represents in-Delta consumptive use, evaporation, net Delta outflow, and water which remains in the Delta beyond the study period. In water year 1988 Cases 1 and 9, SJR water fate was as follows (percentages are approximate): 39% Tracy Pumping Plant, 23% State Delta Pumping Plant, 1% Rock Slough Pumping Plant #1, and 37% remainder.

In addition to examining salinity values and sources of water, Flow Science has examined how the three agricultural barriers (Middle River Barrier, Grant Line Canal Barrier, and Old River Barrier at Tracy) as well as the Head of Old River Barrier influence flow patterns in the Delta. Figures 14 and 15 show the "flow split" at this location, i.e., the percentage of SJR water that flows down Old River and the percentage of SJR water flowing toward the ship channel, along with barrier operations. Figure 6 represents a model scenario with standard HORB operations, while Figure 7 shows the flow split when the HORB is in place only 4/16-5/15 and 10/1-10/31. The figures clearly show that the flow split is strongly dependent on the barrier operations. While all barriers are in place, nearly all of the SJR water flows north. When the barriers are removed, approximately 50% of the SJR water flows down Old River into the southwest Delta region. Figure 14 shows that even when the HORB is open, if the agricultural barriers remain in place and are configured as simulated here, very little water will flow down Old River.

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Figure 1: Average change in salinity in Clifton Court due to change in SJR salinity at Vernalis, WY64

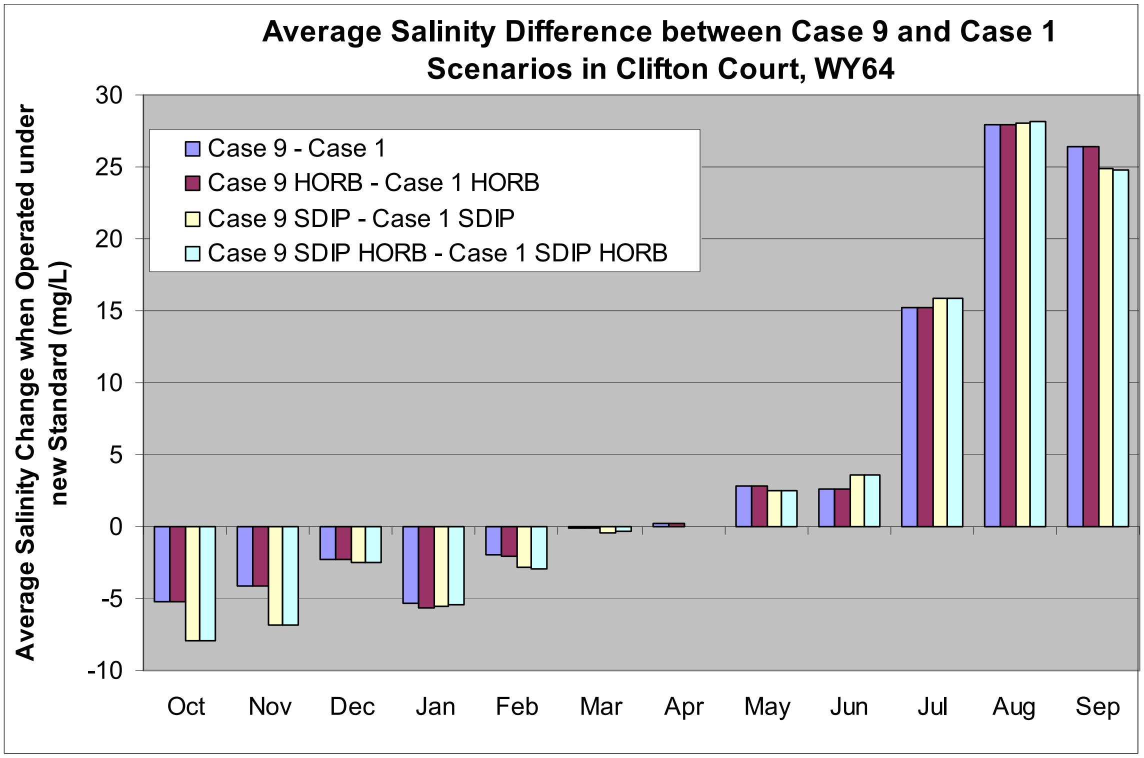

Figure 2: Average percent change in salinity in Clifton Court due to change in SJR salinity at Vernalis, WY64

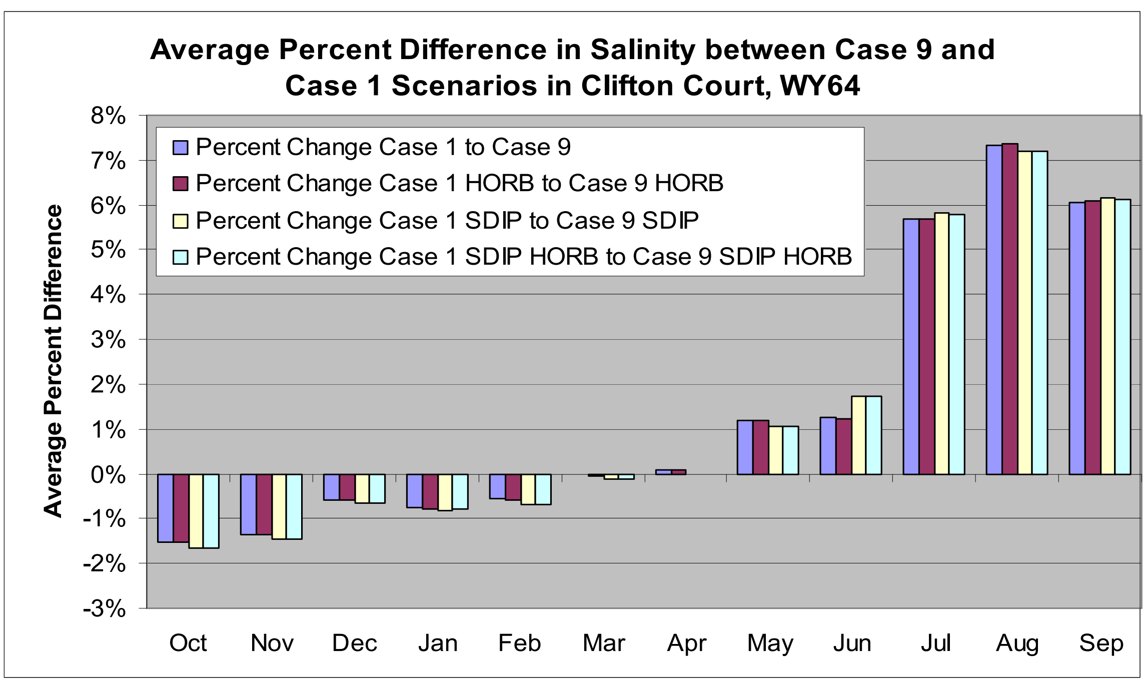

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Figure 3: Average change in salinity in Clifton Court due to change in SJR salinity at Vernalis, WY88

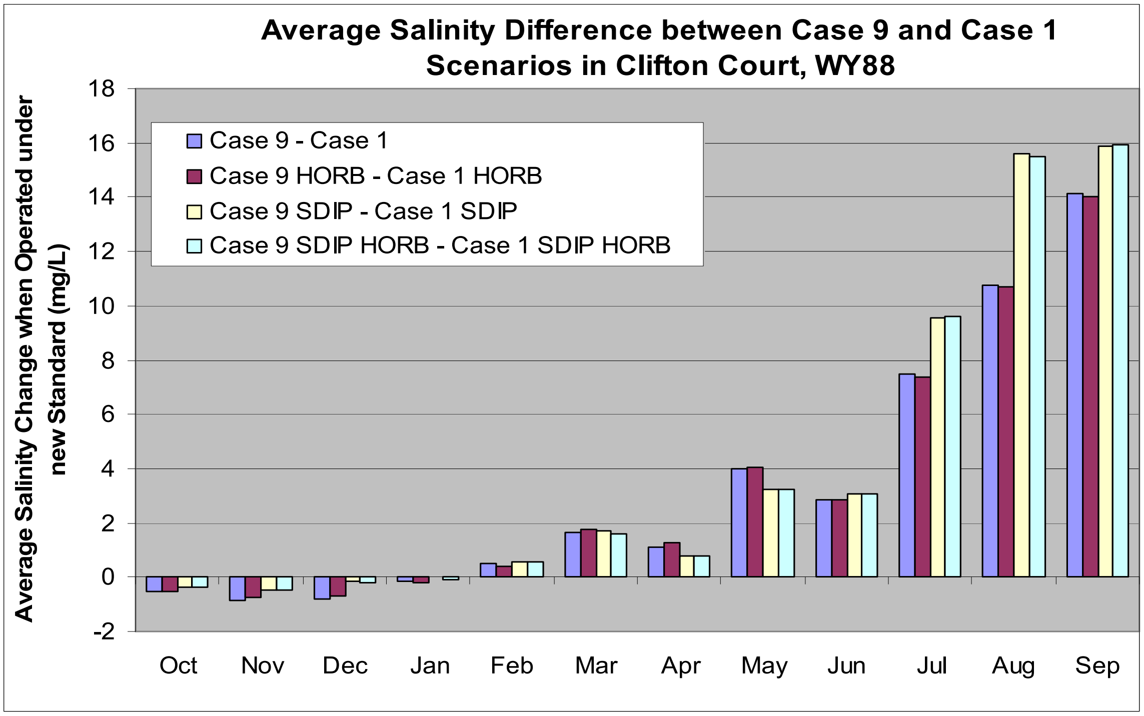

Figure 4: Average percent change in salinity in Clifton Court due to change in SJR salinity at Vernalis, WY88

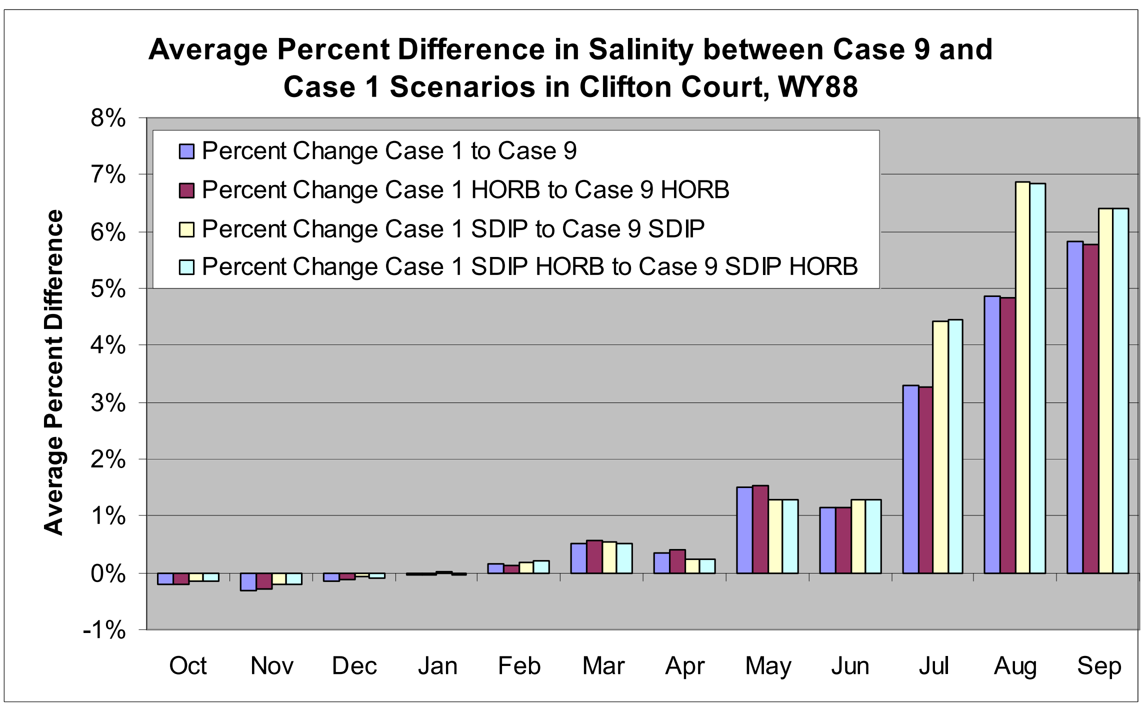

Figure 5: Average change in salinity in Rock Slough due to change in SJR salinity at Vernalis, WY64

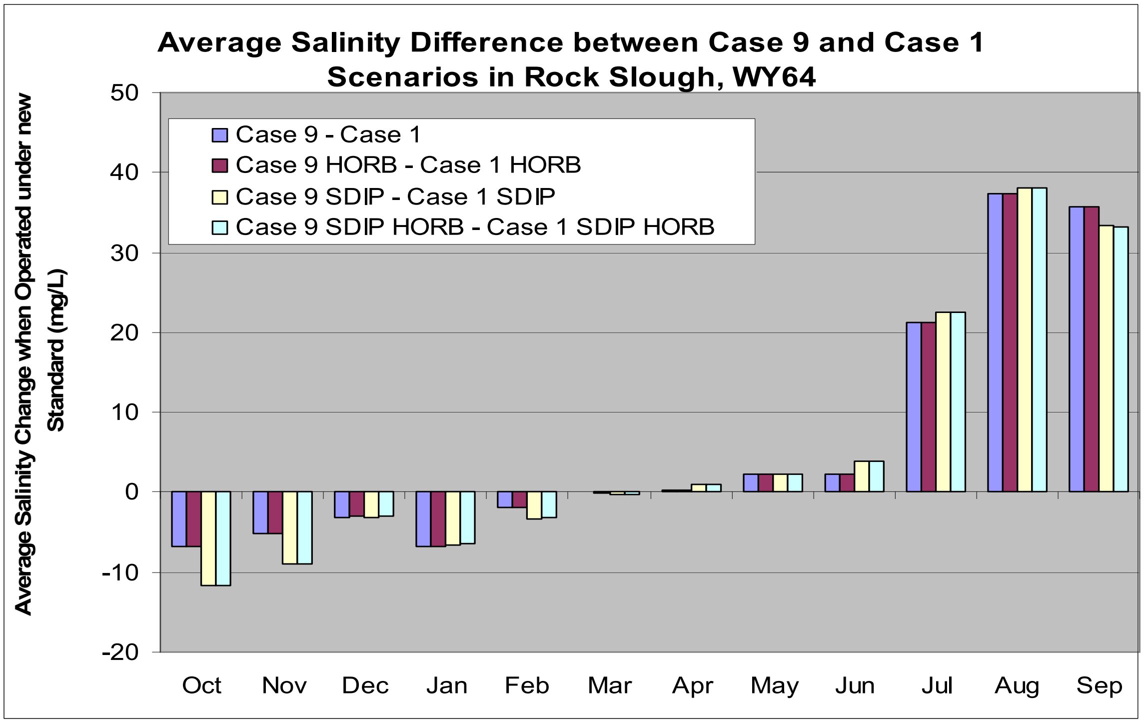

Figure 6: Average percent change in salinity in Rock Slough due to change in SJR salinity at Vernalis, WY64

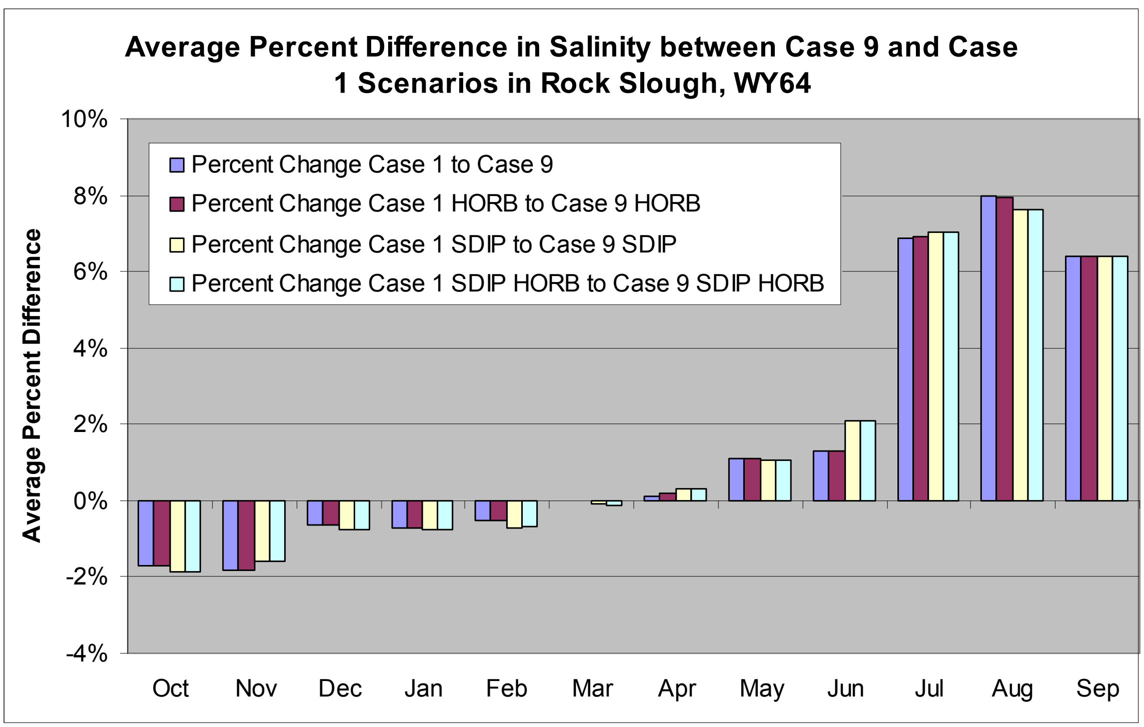

Figure 7: Average change in salinity in Rock Slough due to change in SJR salinity at Vernalis, WY88

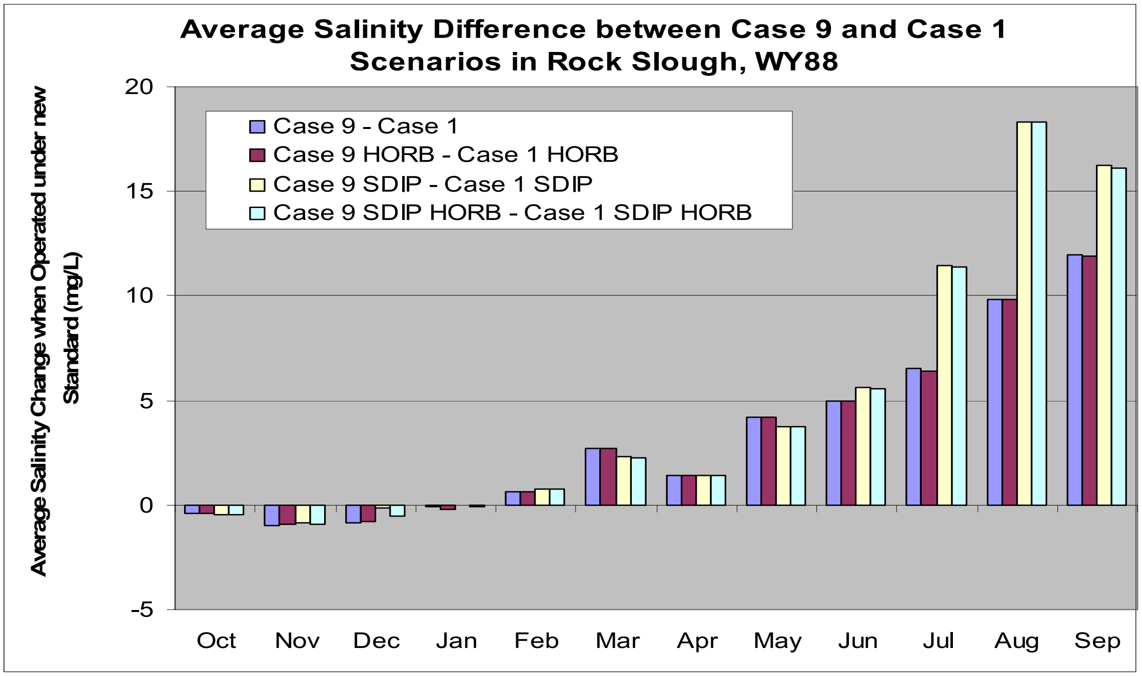

Figure 8: Average percent change in salinity in Rock Slough due to change in SJR salinity at Vernalis, WY88

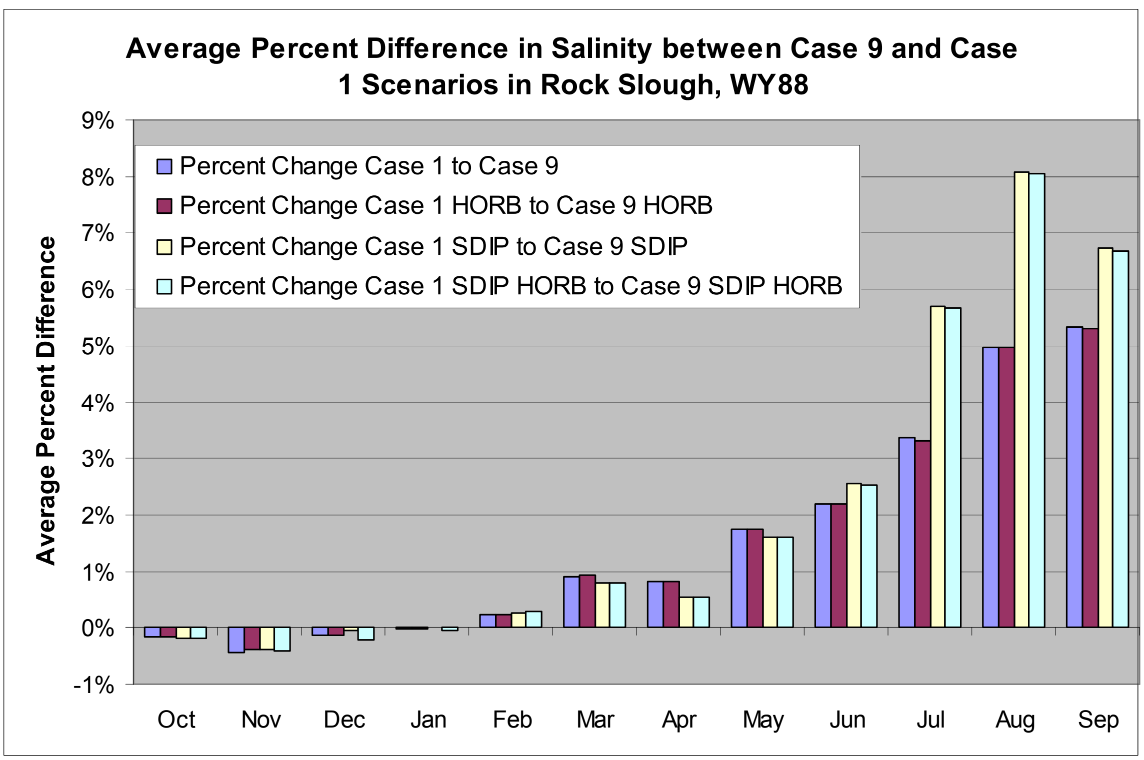

Figure 9: Salinity at Vernalis, Case 1 scenarios and Case 9 scenarios, WY64

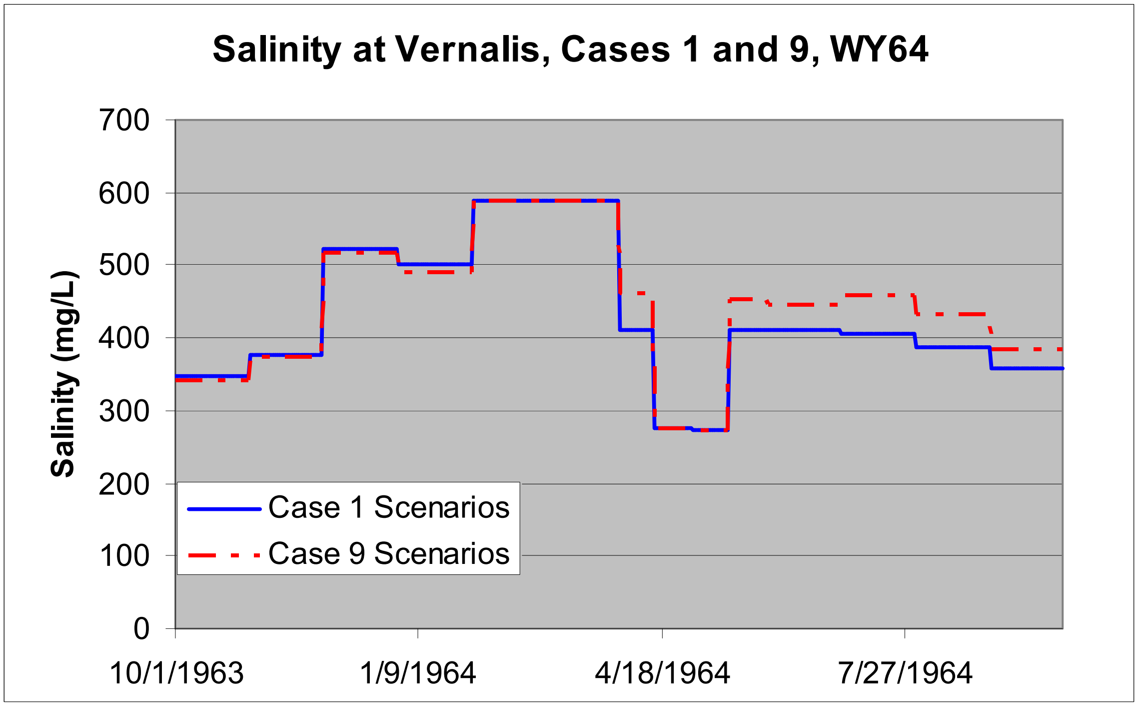

Figure 10: Salinity at Vernalis, Case 1 scenarios and Case 9 scenarios, WY88

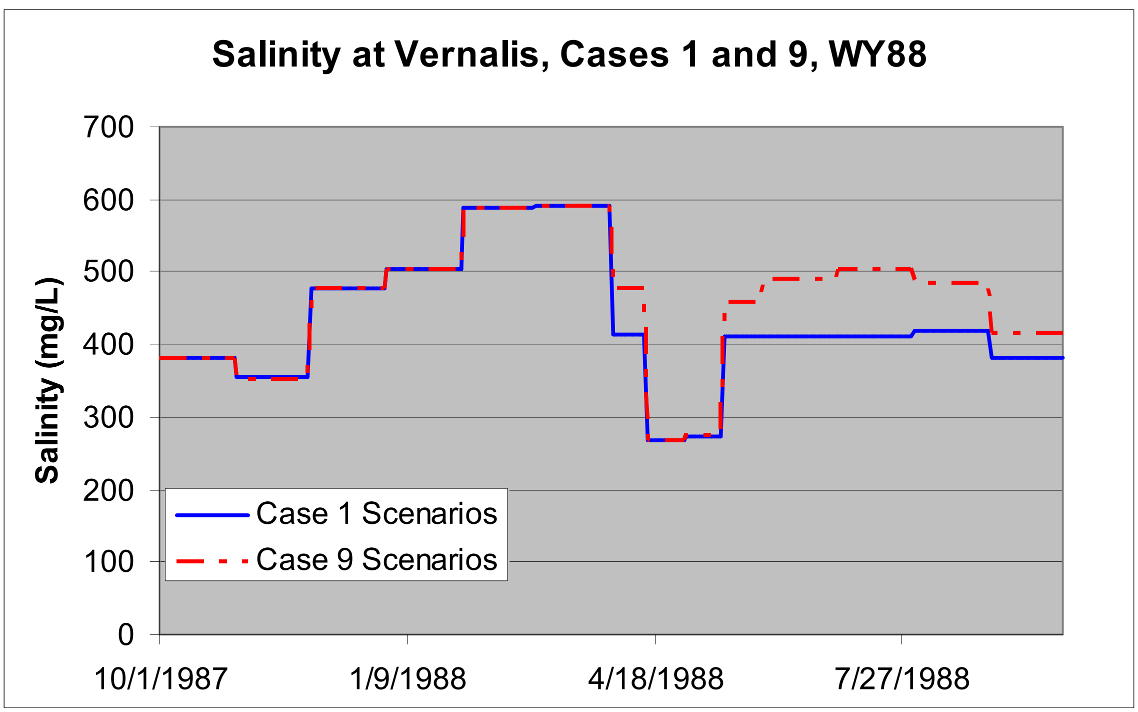

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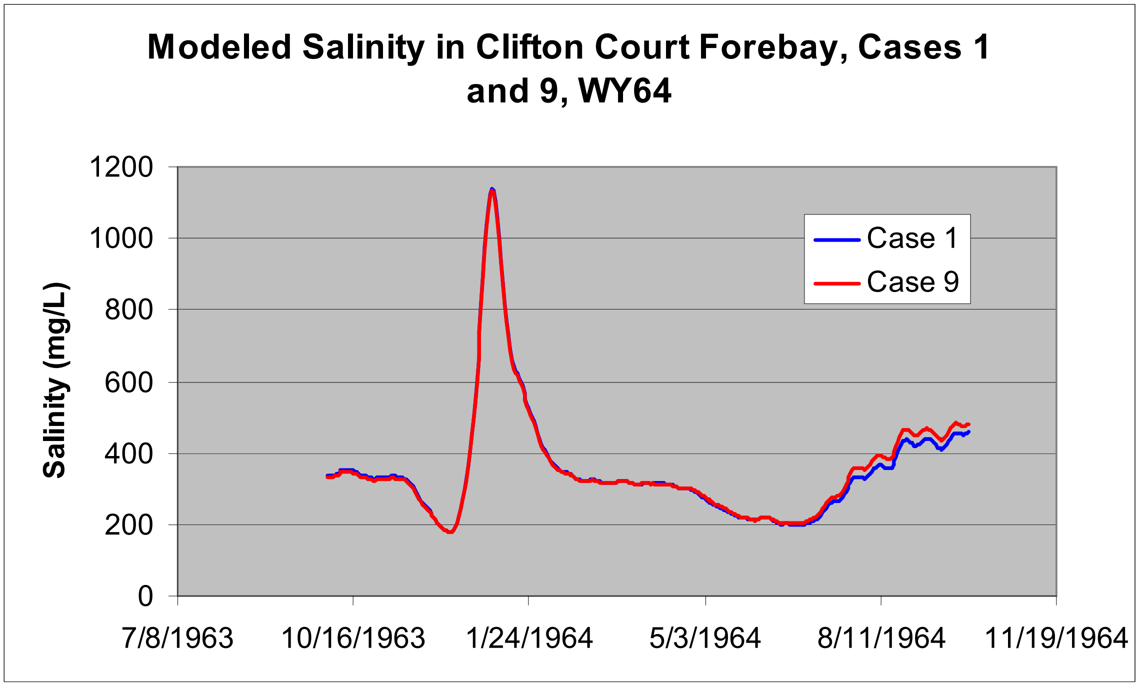
Figure 11: Salinity in Clifton Court Forebay, Case 1 and Case 9, WY64



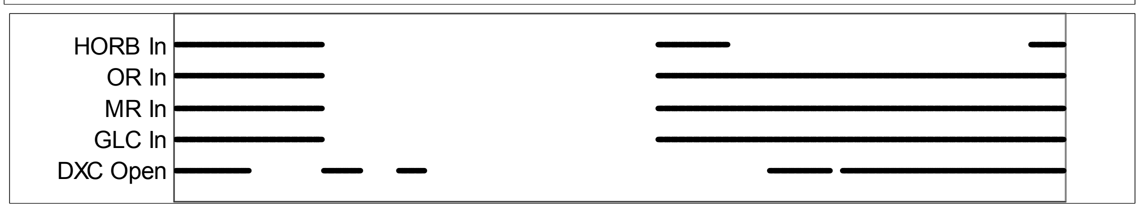


Figure 12: Fate of San Joaquin River water during water year 1964

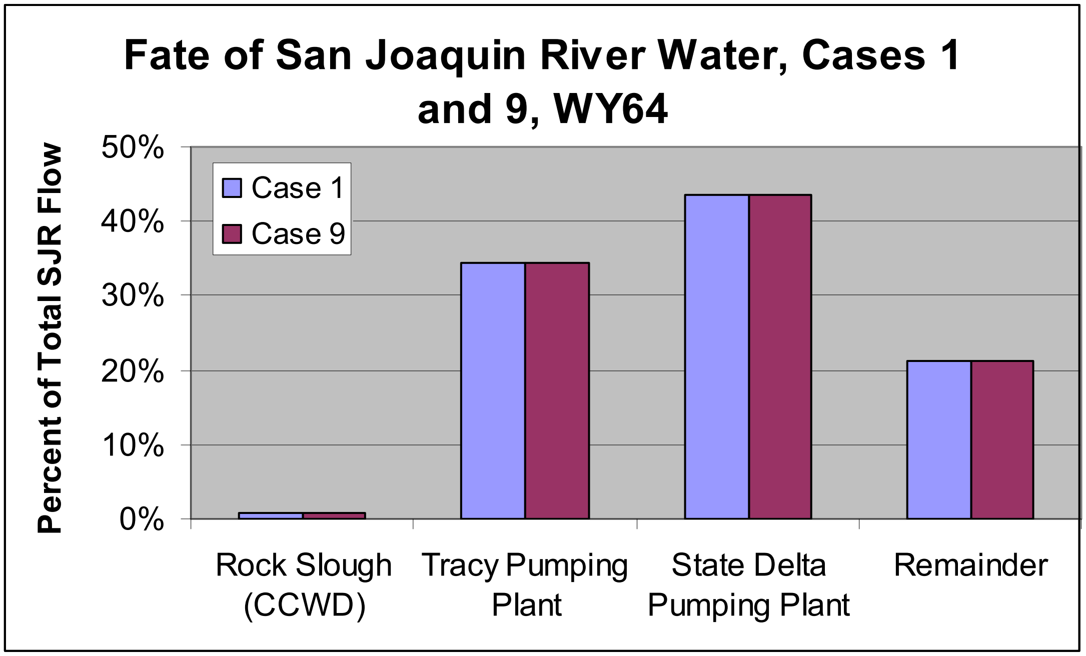


Figure 13: Fate of San Joaquin River water during water year 1988

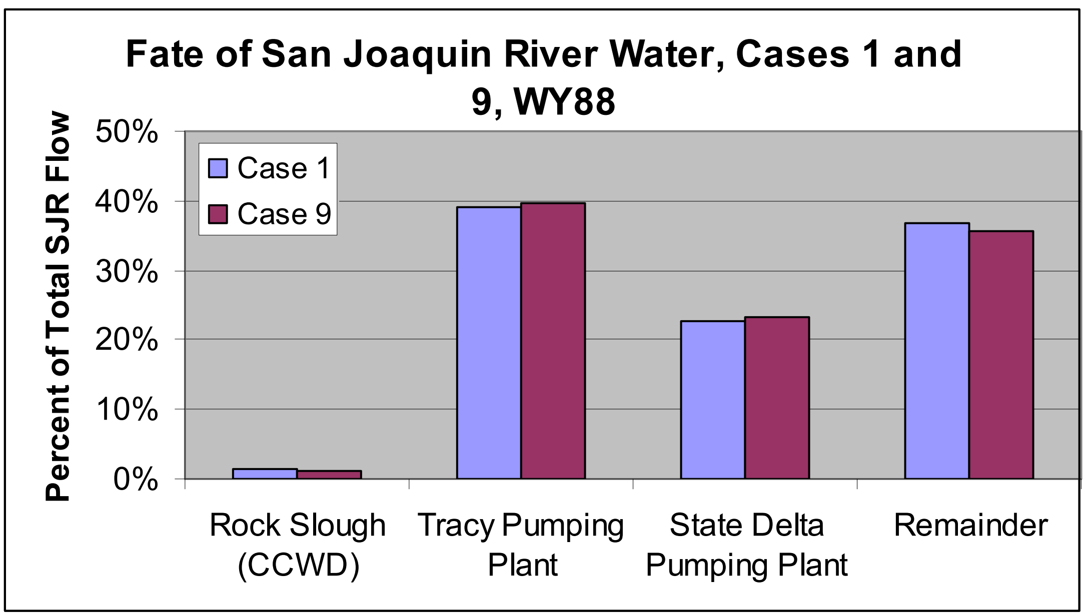


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Figure 14: Flow split at confluence of Old and San Joaquin Rivers with standard HORB schedule

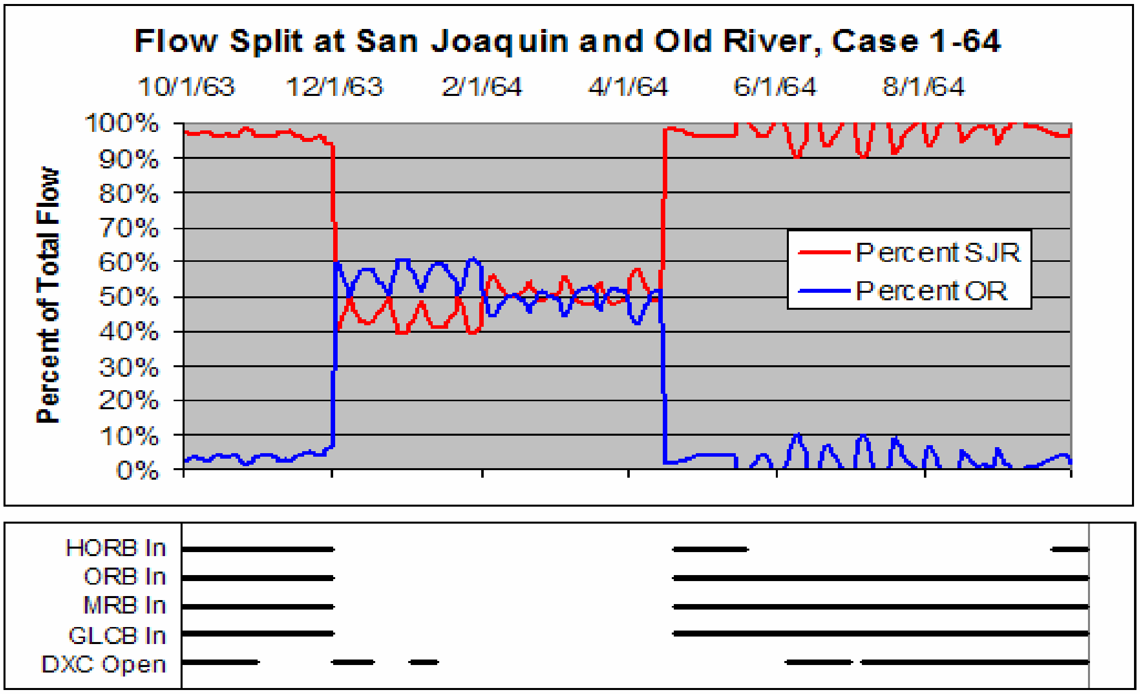

Figure 15: Flow split at confluence of Old and San Joaquin Rivers with modified HORB schedule