CALIFORNIA WATER FIX
RELIABLE. CLEAN. WATER.

DWR-50

# DSM2 MODELING REBUTTAL
# WATER QUALITY AND WATER LEVELS

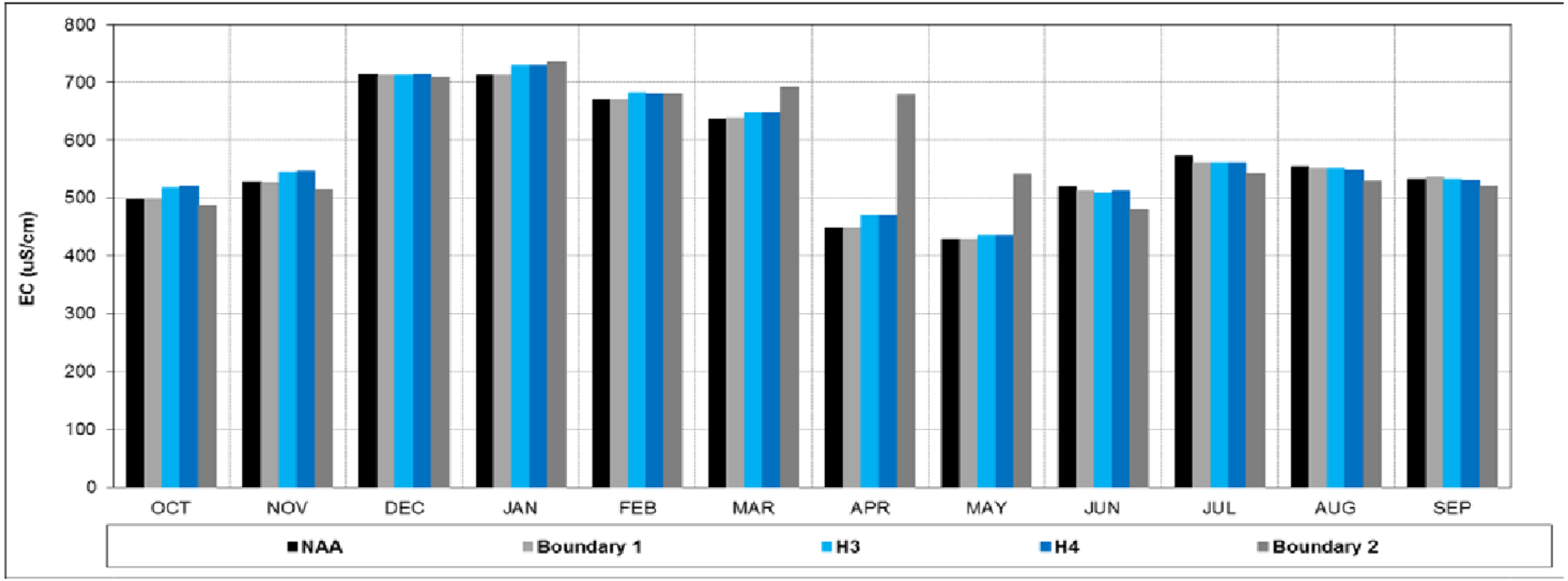
# OUTLINE

- **Effect of Head of Old River Gate on Water Quality in South Delta**
- **Effects of Fall X2 (Water Quality and Water Levels)**
- **Reverse Flows at Freeport**
- **Effects of WaterFix on Water Levels During Low Flows**
- **Effects of WaterFix on North Delta Water Quality**
- **Antioch Water Quality/Finger Printing Analysis**

# SOUTH DELTA SALINITY

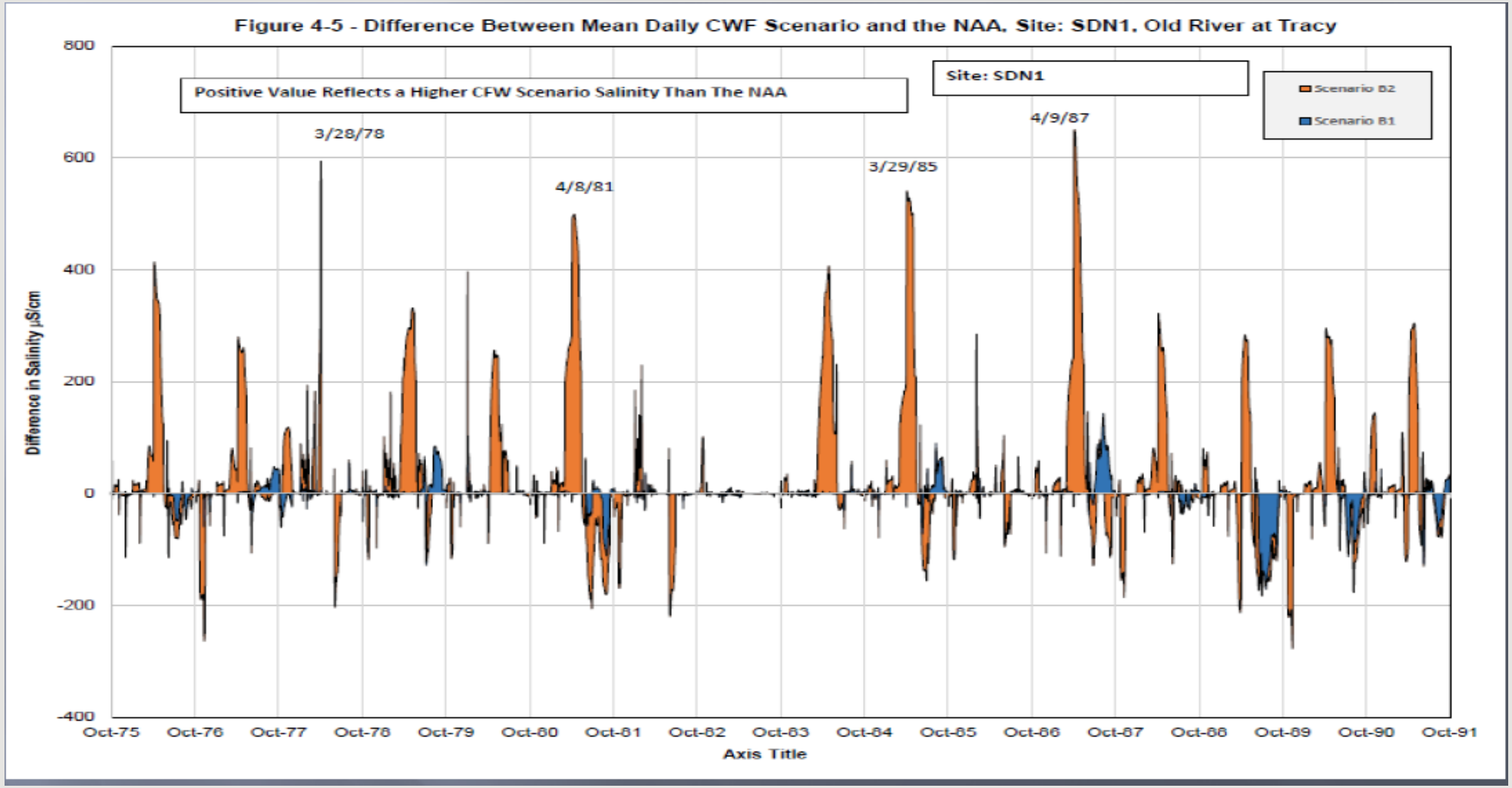
(DWR 513- FIGURE EC5)

Figure EC5: Monthly Average EC at Old River at Tracy Road




**Model results are used for comparative purposes and not for predictive purposes*

# SDWA-77 PAGE 20

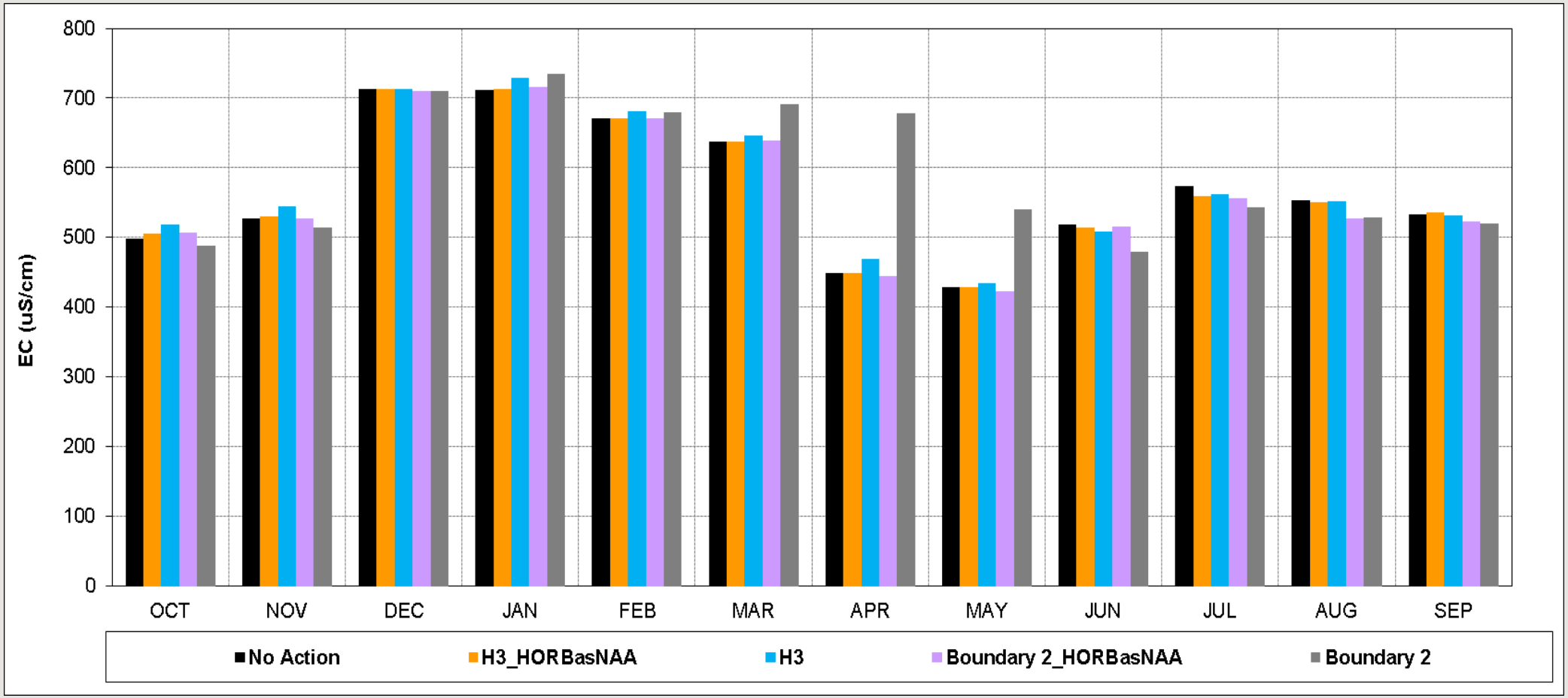


# EFFECTS OF HOR GATE OPERATIONS

- **Increase in EC at Old River Tracy Road during the months of March through May for Boundary 2 scenario mainly due to a difference in the Head of Old River Gate operation.**

- **Two new DSM2 studies performed for Boundary 2 and H3 by changing the Head of Old River Gate operation, making it consistent with NAA.**

# CHANGES IN EC AT OLD RIVER AT TRACY ROAD IS MAINLY DUE TO A DIFFERENCE IN THE HEAD OF OLD RIVER GATE OPERATION



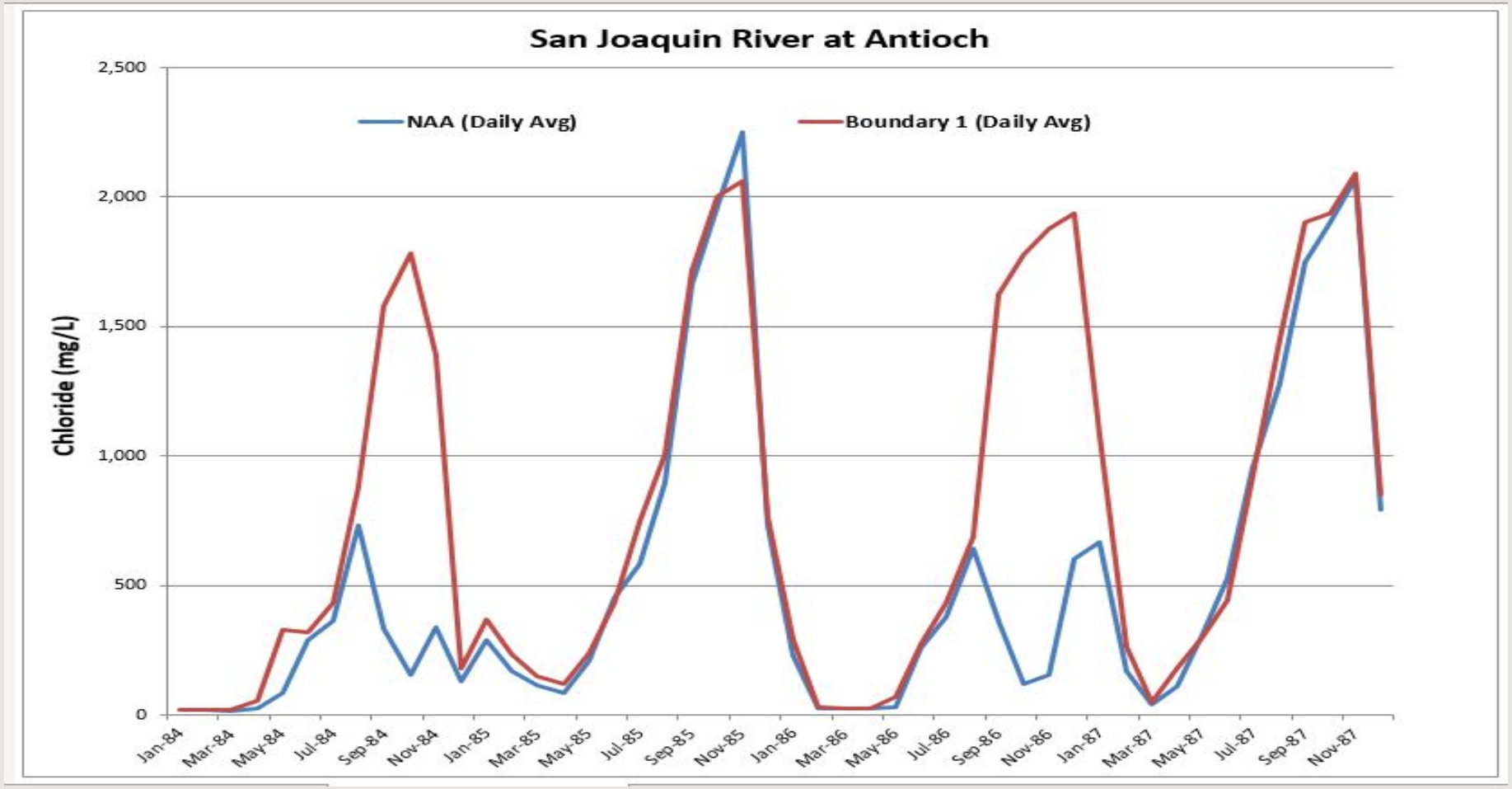
# OUTLINE

- Effect of Head of Old River Gate on Water Quality in South Delta
- Effects of Fall X2 (Water Quality and Water Levels)
- Reverse Flows at Freeport
- Effects of WaterFix on Water Levels During Low Flows
- Effects of WaterFix on North Delta Water Quality
- Antioch Water Quality/Finger Printing Analysis

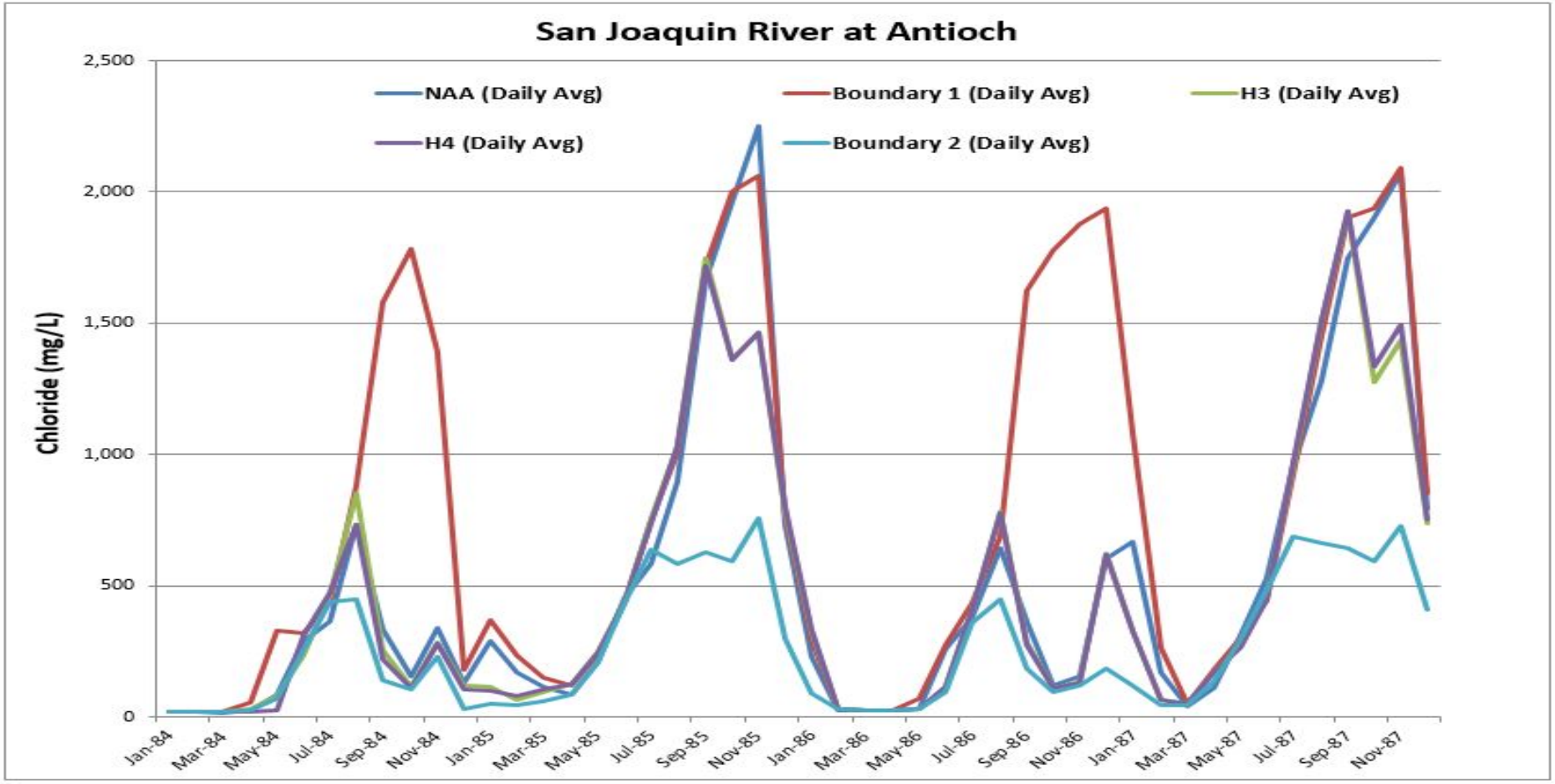
# EFFECTS OF FALL X2
# (WATER QUALITY AND WATER LEVELS)

- **USFWS BiOp Fall X2 - Requires higher outflow in Fall months of wet and above normal water years**
- **All operational scenarios considered for this petition include Fall X2 except for Boundary 1**
- **Fall X2 can have significant effects on water quality and water levels**

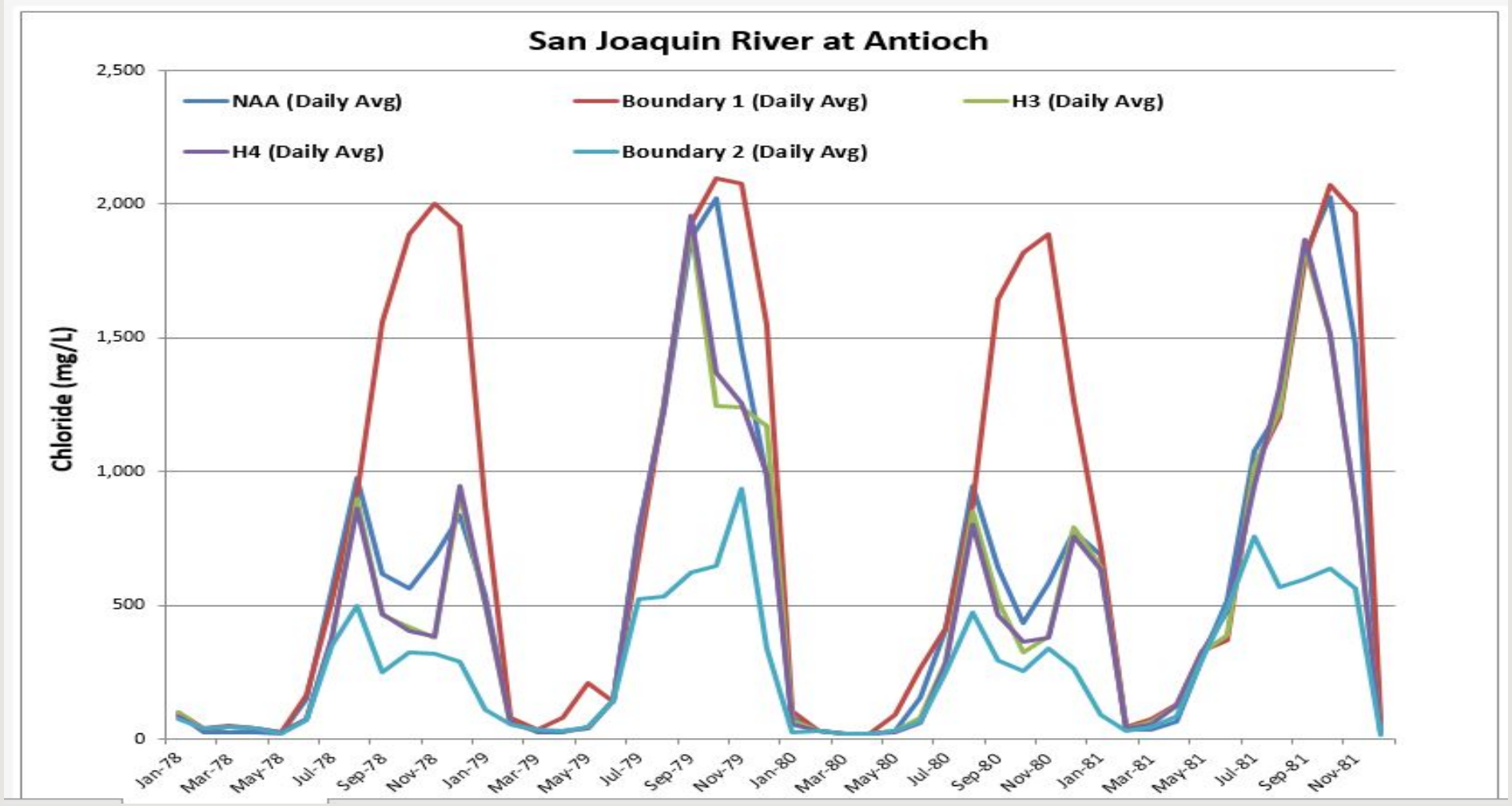
# EXAMPLE
# WATER QUALITY ANTIOCH (1984-1987)



# EXAMPLE
# WATER QUALITY ANTIOCH (1984-1987)



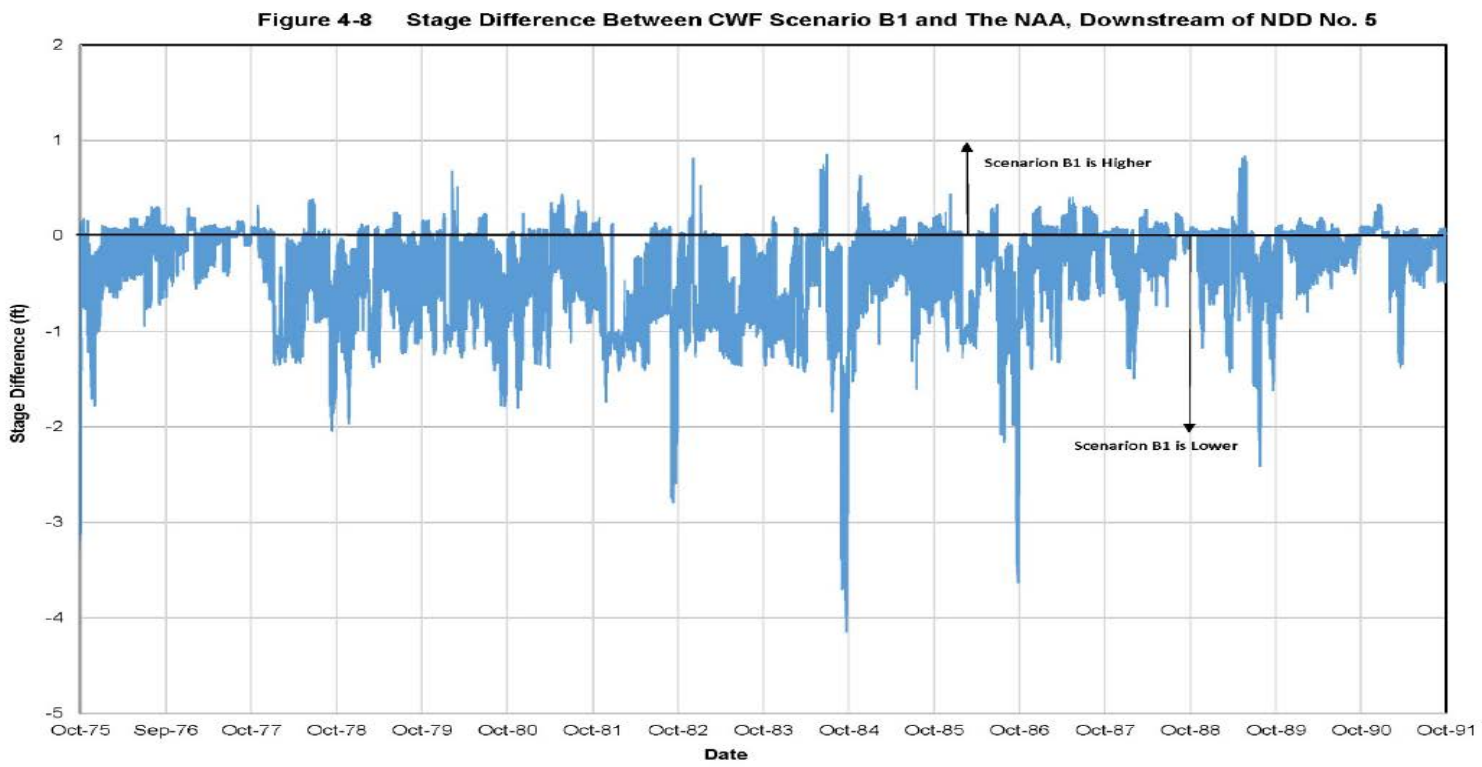
# EXAMPLE
# WATER QUALITY ANTIOCH (1978-1981)



# EFFECTS OF WATERFIX ON WATER LEVELS

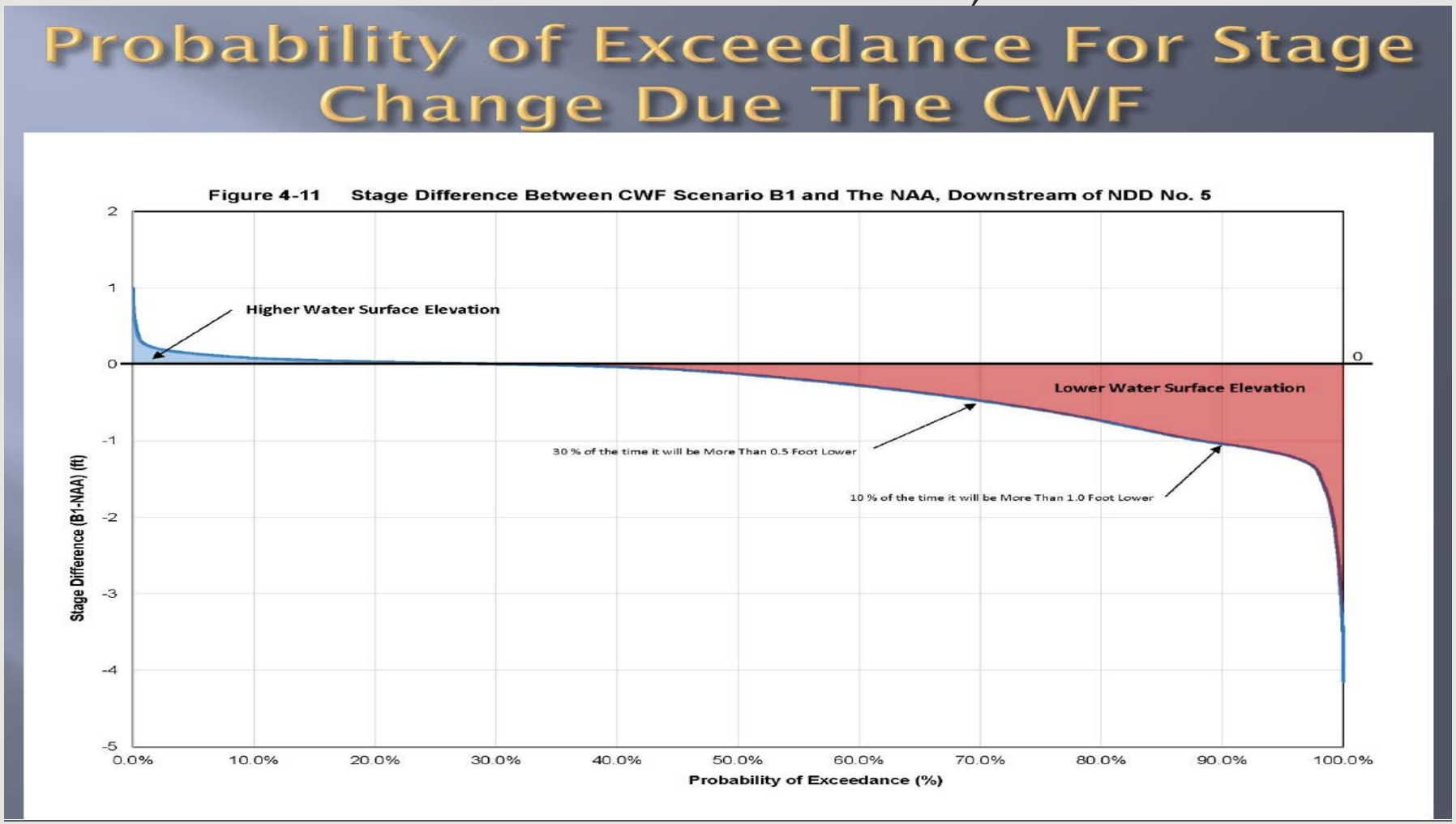
## DR. BURKE SDWA 77, PAGE 24

## Stage Difference DS of NDD



# EFFECTS OF WATERFIX ON WATER LEVELS

## DR. BURKE EXHIBIT SDWA-77, PAGE 26



# EFFECTS OF WATERFIX ON WATER LEVELS
# IMPORTANCE OF FALL X2

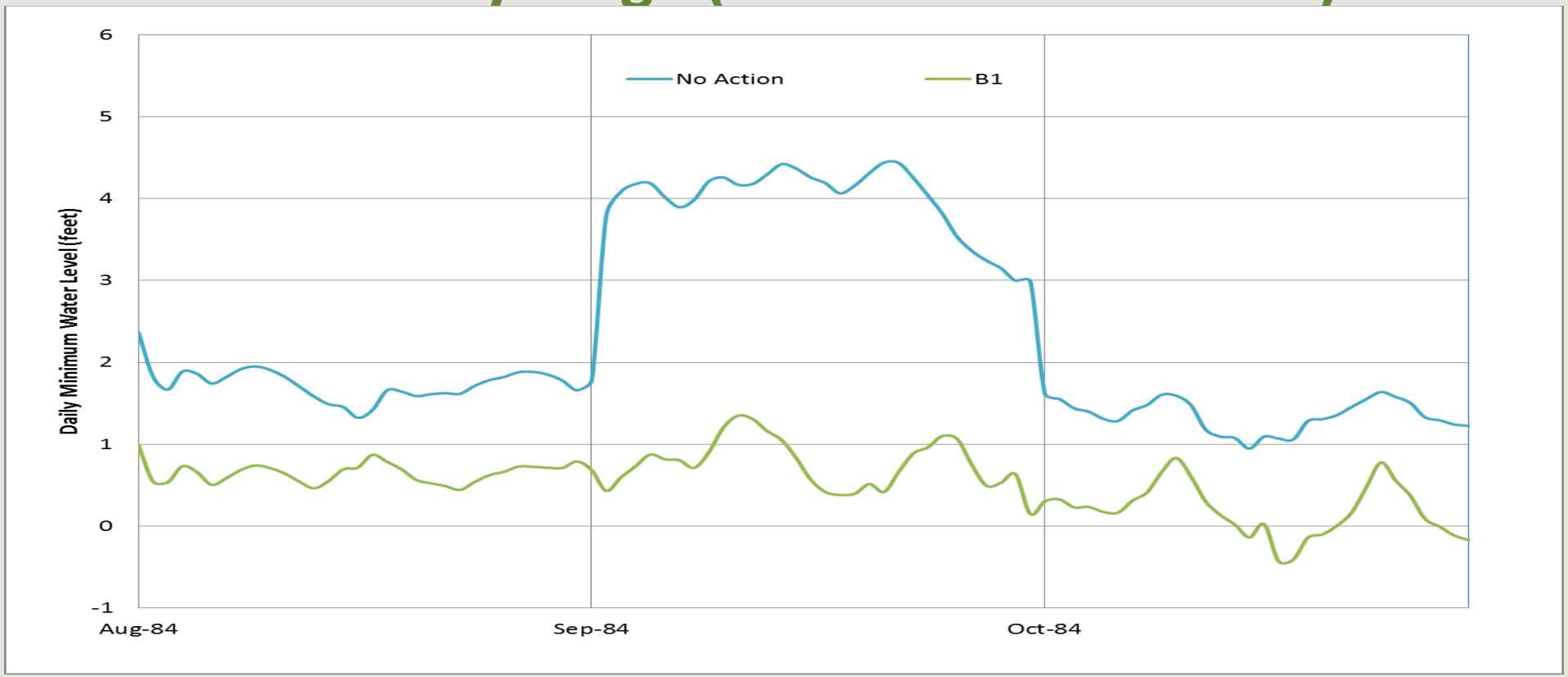
- **Based on the analysis by Dr. Burke, the three highest reductions in water levels occur during September of 1984, 1986, 1982 (All wet years)**

| | Freeport Flow (cfs) | | Maximum Reduction in Water Level (ft) |
|---|---|---|---|
| | B1 | NAA | |
| Sep-84 | 8867 | 29541 | 4.0 |
| Sep-86 | 11089 | 23949 | 3.6 |
| Sep-82 | 13521 | 24959 | 2.8 |

- **The large difference in flow at Freeport is directly related to Fall X2 not implemented under Boundary 1**

# EFFECTS OF WATERFIX ON WATER LEVELS
# IMPORTANCE OF FALL X2

- **Minimum Daily Stage (downstream of NDD)**



# OUTLINE

- Effect of Head of Old River Gate on Water Quality in South Delta
- Effects of Fall X2 (Water Quality and Water Levels)
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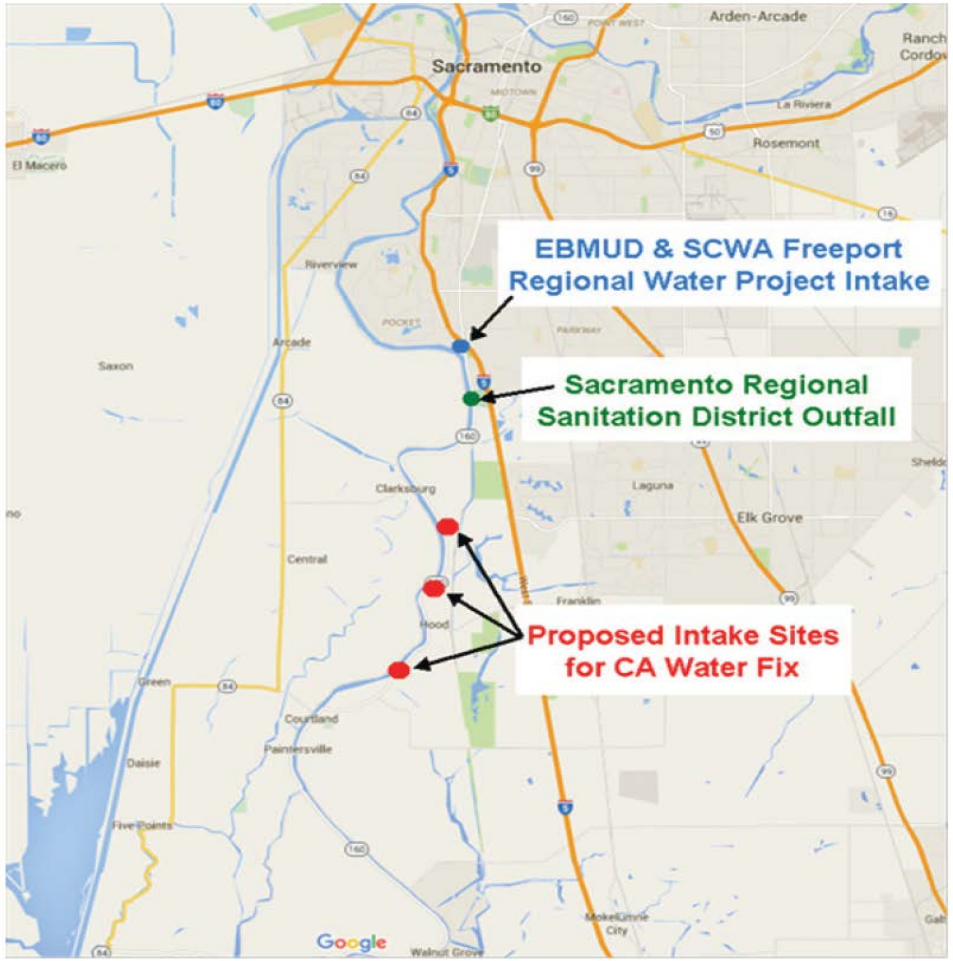
- Effects of WaterFix on North Delta Water Quality
- Antioch Water Quality/Finger Printing Analysis

# REVERSE FLOW AT FREEPORT AND SIGNIFICANT REVERSE FLOW EVENTS

**EBMUD claims WaterFix increases frequency and duration, and impacts the timing of Significant Reverse Flow Events (SRFE) at Freeport Project Intake and require added shutdowns.**

# REVERSE FLOW AT FREEPORT

**Figure 2.** **Map Showing Approximate Locations of Freeport Regional Water Project Intake Facility in Relation to Sacramento Regional County Sanitation District and Proposed Intakes for CAWF.**



# REVERSE FLOW AT FREEPORT

## EBMUD Modeling Approach

- **CalSim II (Based on flow at Freeport)**

- **DSM2 (Based on velocity output)**

# REVERSE FLOW AT FREEPORT - CALSIM II

- **Used threshold of 8,000 cfs as a potential for SRFE**
- **Compared CalSim II flows**
- **Reported number of months flow at Freeport for WaterFix scenario was less than 8,000 cfs, and flow at Freeport for WaterFix scenario was lower than NAA by at least 20 cfs**

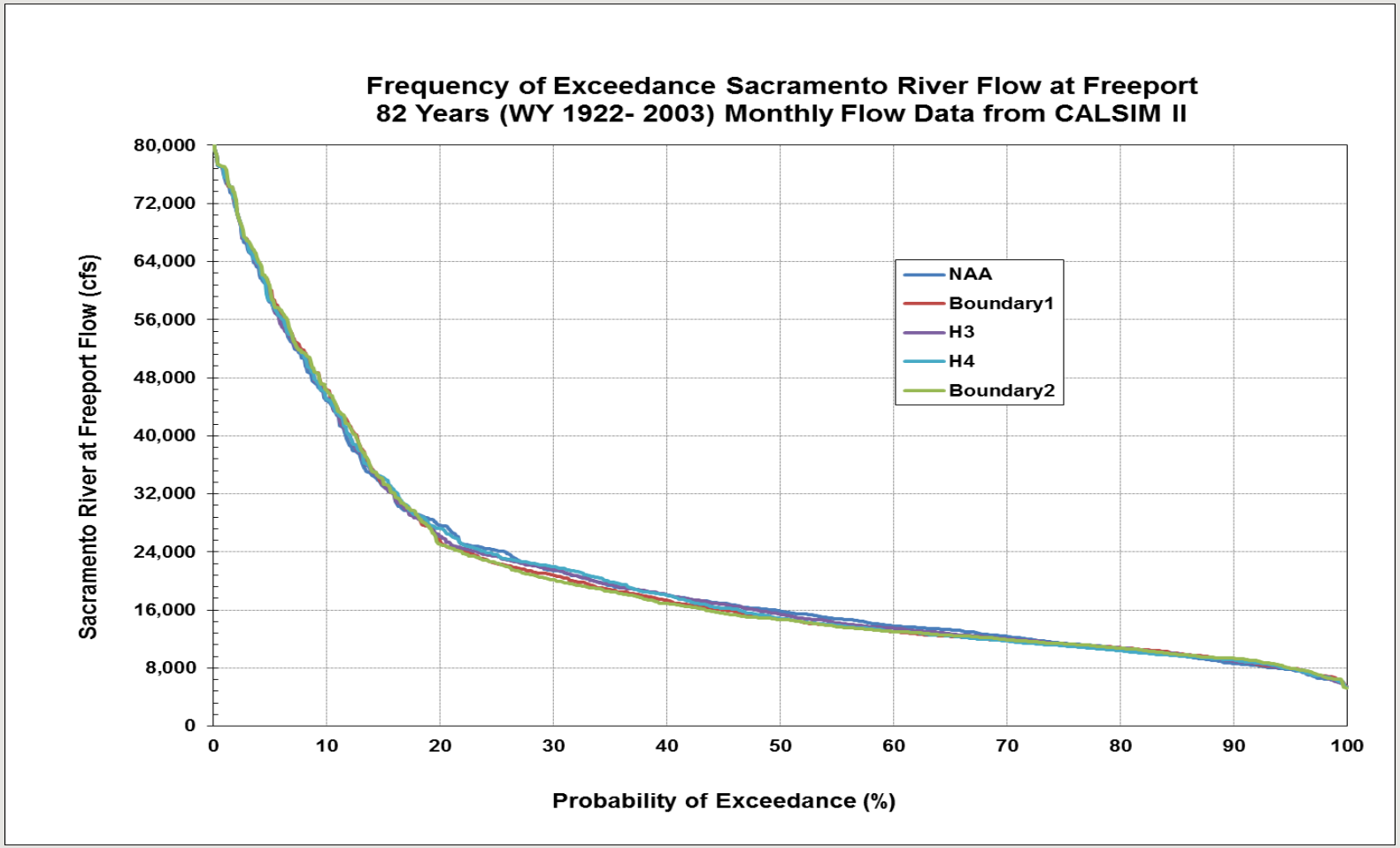
# WHAT IS THE PROBABILITY OF SRFE WHEN FLOW AT FREEPORT IS LESS THAN 8,000 CFS?

- **4 SRFE events April 2014 – December 2015 (According to EBMUD testimony)**
- **Flow at Freeport was lower than 8,000 cfs for 371 days in this period (Source: CDEC)**
- **1.1% probabilty (4/371) of SRFE when daily average flow at Freeport is below 8,000 cfs**

# REVERSE FLOW AT FREEPORT

**Dr. Bray did not consider the number of months where the flow at Freeport for any of the WaterFix operational scenarios were below 8,000 cfs but were higher than NAA by 20 cfs**

# ALL WATERFIX OPERATIONAL SCENARIOS SHOW A SIMILAR PROBABILITY DISTRIBUTION FOR FLOW AT FREEPORT



# ALL WATERFIX OPERATIONAL SCENARIOS HAVE A SIMILAR PROBABILITY FOR LOW FLOW (< 8,000 CFS) AT FREEPORT

| CWF Alternatives | Probability of Sacramento River Flow at Freeport below 8000 cfs (CALSIM II |
|---|---|
| NAA | 6.20% |
| Boundary 1 | 5.30% |
| H3 | 5.60% |
| H4 | 5.60% |
| Boundary 2 | 5.30% |

# REVERSE FLOW AT FREEPORT
# SRFE ANALYSIS - DSM2

- **Uses 15 minute velocity output**
- **Computes the number of SRFEs based on advective distance of greater than 0.9 mile under reverse flows**

# REVERSE FLOW AT FREEPORT
# SRFE ANALYSIS - DSM2

**Dr. Bray shows two different analysis:**

**a) No adjustments to DSM2 velocity output**

**b) Adds a “velocity bias adjustment”**

# SRFE ANALYSIS (DSM2)
# NO ADJUSTMENT TO VELOCITY OUTPUT

**According to Dr. Bray, there is actually an overall reduction of SRFEs under all WaterFix scenarios**



**Table 2. Significant Reverse Flow Events for California WaterFix Water Rights Hearing Modeling Studies. Period of analysis is indicated in parenthesis.**

| | No Action Alternative | Project Scenario H3 | H4 | Boundary 1 | Boundary 2 |
|---|---|---|---|---|---|
| 1976–1977 Drought (Oct. 1975 – Oct. 1977) | 31 | 30 | 33 | 27 | 28 |
| 1987–1992[α] Drought (Oct. 1987 – Sep. 1990) | 71 | 51 | 45 | 50 | 56 |
| WYs 1976–1991 Total (Oct. 1975 – Sep. 1991) | 113 | 89 | 86 | 82 | 96 |

α - Note that WY 1992 is not included in Petitioners DSM2 modeling simulation, therefore, this final year of the drought cannot be included in the analysis.

# SRFE ANALYSIS (DSM2)
# ADD BIAS CORRECTION TO VELOCITY OUTPUT

**Dr. Bray applied -0.230 (ft/sec) offset to correct the model's reverse flow under-prediction bias**

# DSM2 VELOCITY BIAS CORRECTION

- **The method seems to falsely identify reverse flow events that were truly not reverse flows (4 events were falsely identified as reverse flows in an 8-day period) (Feb 11,14,15,16)**

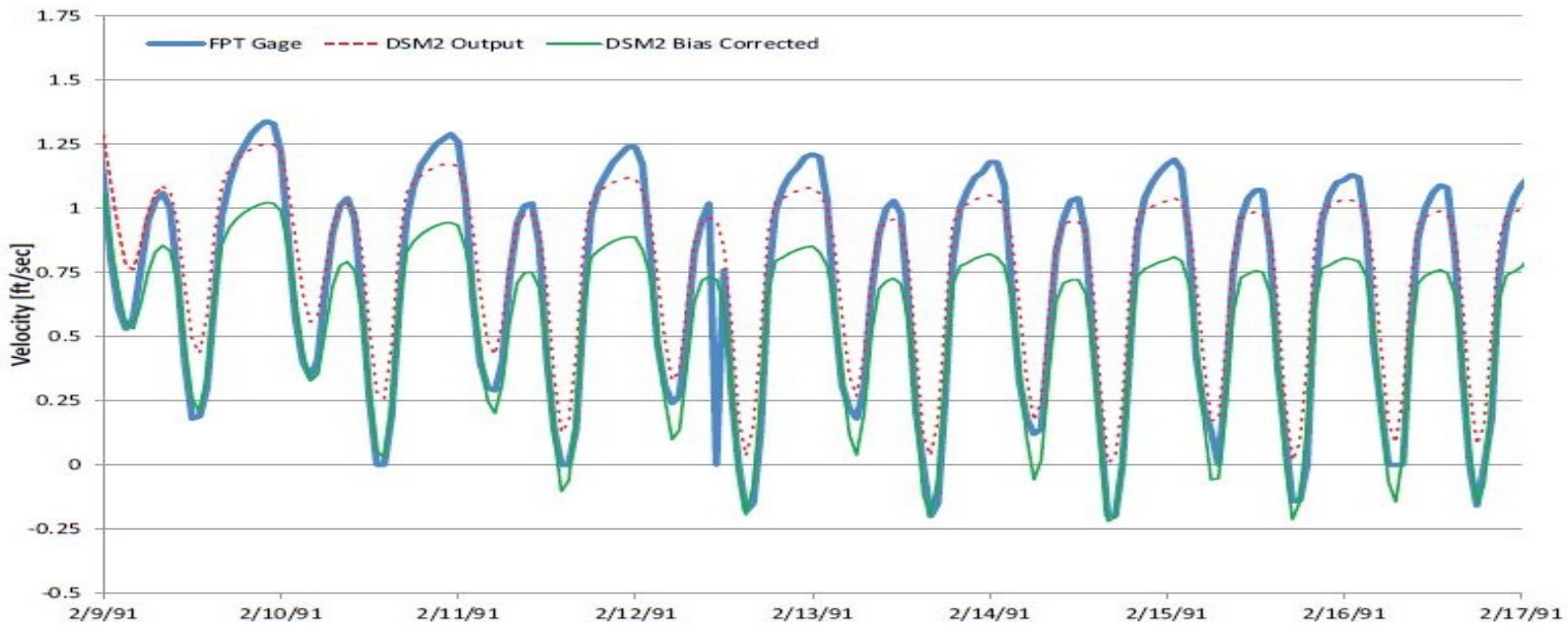



Figure 7. Freeport Gage Velocity with DSM2 Historical Simulated Velocity at Freeport Project Intake and DSM2 Velocity with -0.230 ft/sec Bias Correction Offset, Feb. 9 – 27, 1991.

34

EBMUD-152

PAGE 9 of 24

# DSM2 VELOCITY BIAS CORRECTION

**The approach predicts a much higher frequency of SRFEs**

# DSM2 VELOCITY BIAS CORRECTION

- **There is an overall reduction in SRFEs (WaterFix vs NAA)**
- **Increased frequency of SRFEs 1976-77 Drought**
- **Reduction in frequency of SRFEs 1987-1991 Drought**

45 EBMUD-152

**Table 3. Significant Reverse Flow Events for California WaterFix Water Rights Hearing Modeling Studies from Bias Corrected DSM2 Output. Period of analysis is indicated in parenthesis.**

| | No Action Alternative | Project Scenario H3 | H4 | Boundary 1 | Boundary 2 |
|---|---|---|---|---|---|
| 1976–1977 Drought (Oct. 1975 – Oct. 1977) | 165 | 183 | 183 | 160 | 176 |
| 1987–1992[α] Drought (Sep. 1987 – Sep. 1991) | 377 | 374 | 332 | 326 | 328 |
| WYs 1976–1991 Total (Oct. 1975 – Sep. 1991) | 596 | 572 | 541 | 500 | 504 |

α - Note that WY 1992 is not included in Petitioners DSM2 modeling simulation, therefore, this final year of the drought cannot be included in the analysis.

# PROBABILITY OF OCCURRENCE OF SRFES

- **Actual observation (4 events)**
  **(April-2014 to Dec-2015  Extreme low flow period)**
  **2.3 events per year (Source EBMUD)**

- **Dr. Bray's DSM2 Bias Corrected Analysis**
  **596 SRFEs for NAA in 16 years (mix of high and low flow periods)  37.25 events per year**

# REVERSE FLOW AT FREEPORT
# SUMMARY OF SRFE ANALYSIS

- **EBMUD Dr. Bray's analysis is inconclusive**
- **I do not expect an increased frequency of SRFEs for any of the WaterFix operational scenarios**

# OUTLINE

- Effect of Head of Old River Gate on Water Quality in South Delta
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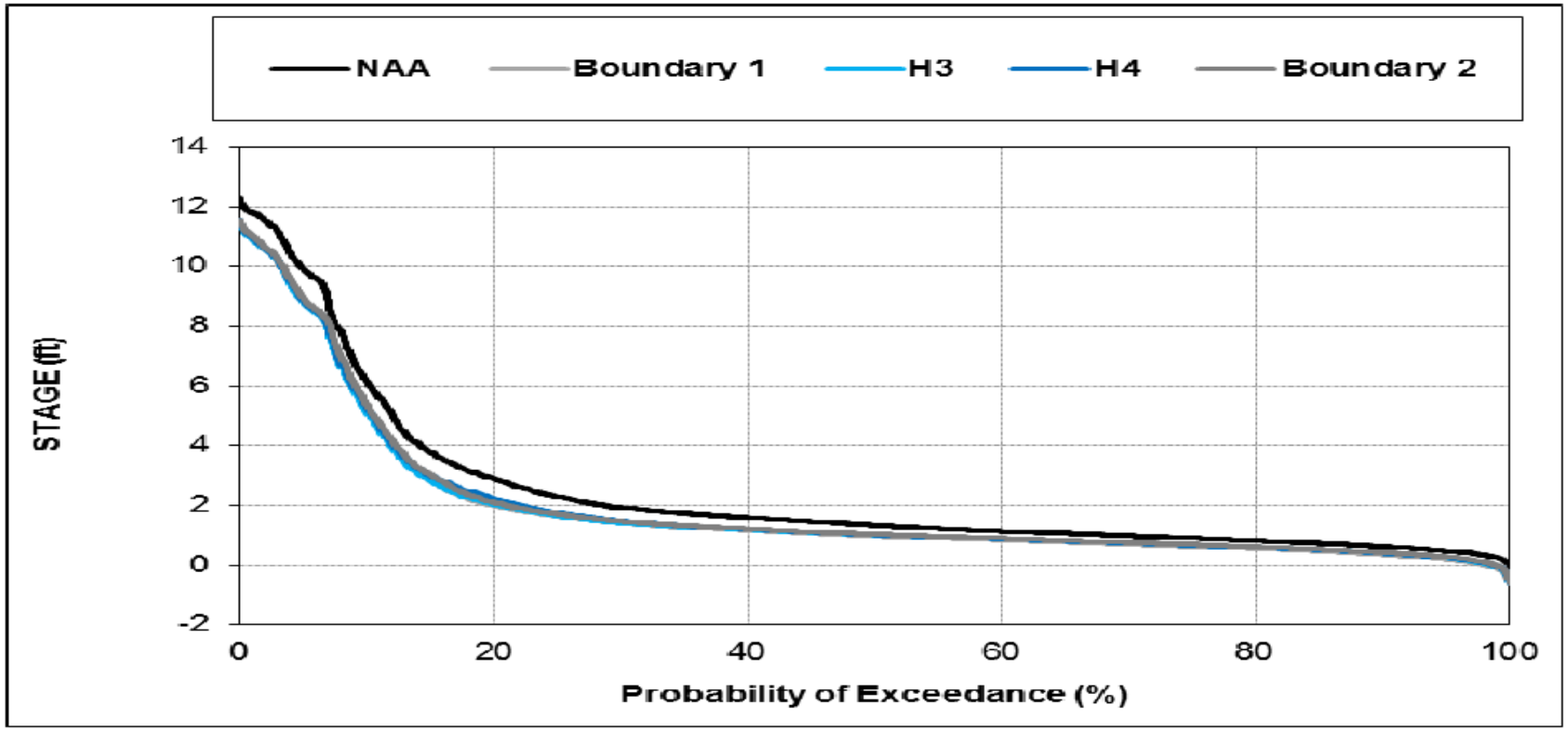
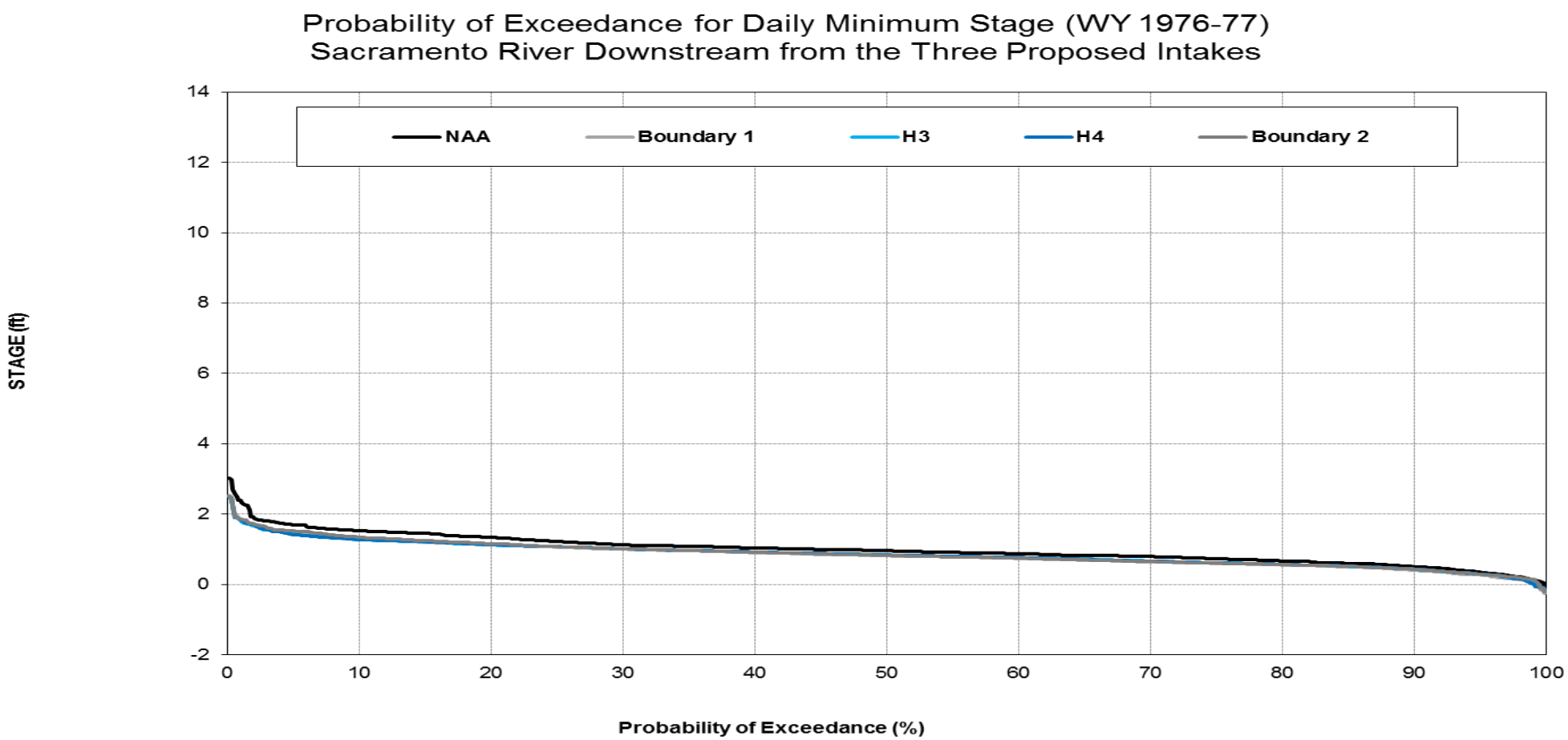
DWR 513, PAGE 11 (16 YEARS SIMULATION 1976-1991)

Figure W1: Probability of Exceedance for Daily Minimum Stage at Sacramento River Downstream From the Three Proposed Intakes.




**Model results are used for comparative purposes and not for predictive purposes*

# EFFECTS OF WATERFIX ON WATER LEVELS DURING LOW FLOWS (1976-77) (IMMEDIATELY DOWNSTREAM OF THE PROPOSED INTAKES) (MUCH LOWER EFFECTS ON WATER LEVELS)



# OUTLINE

- **Effect of Head of Old River Gate on Water Quality in South Delta**
- **Effects of Fall X2 (Water Quality and Water Levels)**
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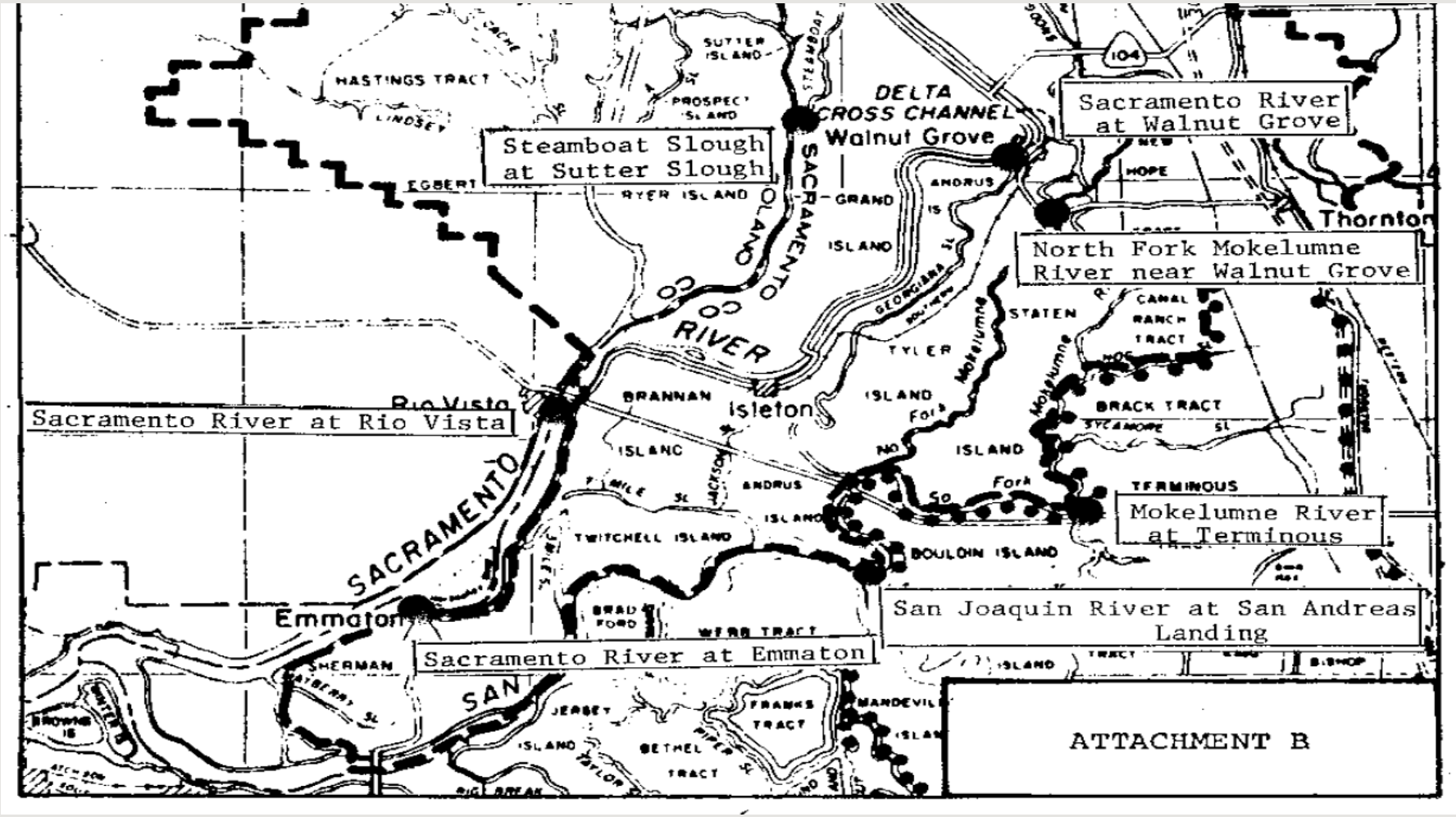
# NDWA CONTRACT STATION LOCATIONS



# EFFECTS OF WATERFIX ON NDWA

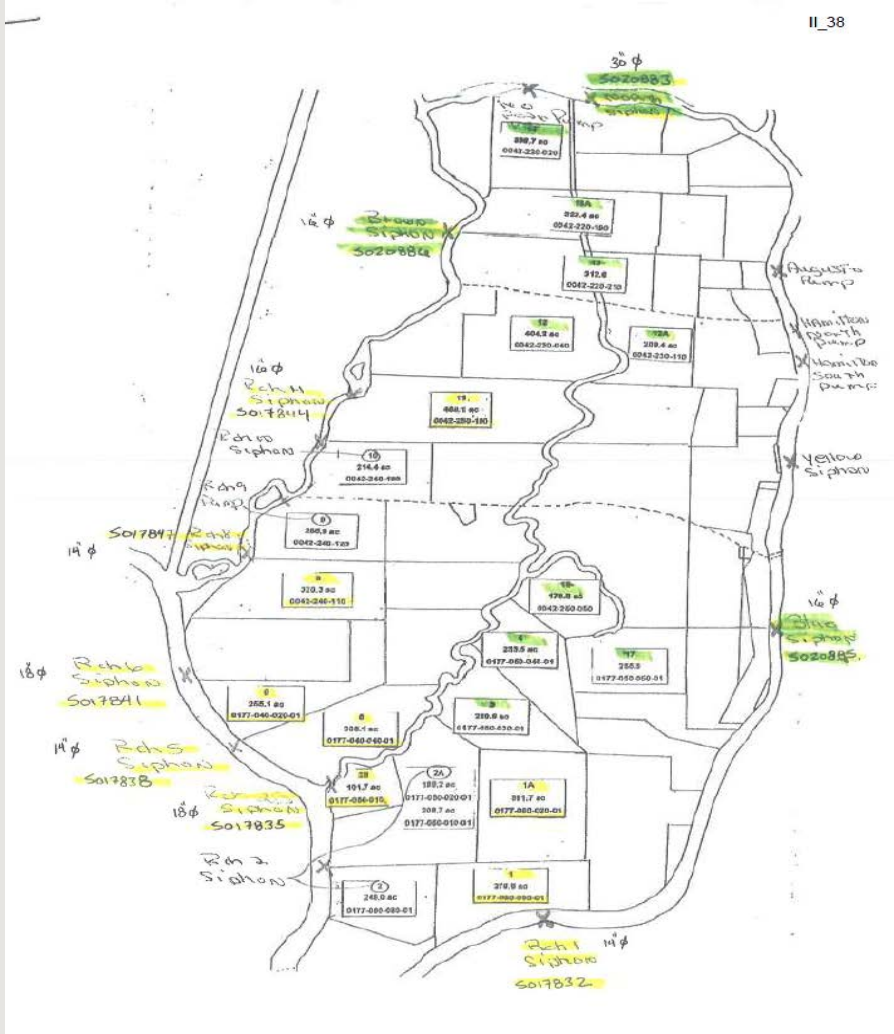
- **Terms of NDWA Contract is protective of NDWA water quality**
- **Water quality at 5 of the 7 stations listed have been historically (fairly) fresh even during extreme dry years (2014-2015) (See NDWA 14-19 and 21-26)**
- **MBK Analysis (NDWA 32) under WaterFix H3+ scenario using DSM2 16 years simulation shows exceedance above thresholds described in NDWA Contract relative to NAA:**

  **1- Three Mile Slough – 20 additional days (an average of 1.25 days per year)** **(See NDWA-32 Page 6, last paragraph)**

  **2- Rio Vista - 12 additional days (an average of 0.75 day/year)**
  **(See NDWA-32 Page 9, First paragraph)**

# ISLANDS, INC. PARCEL MAP

(II-38)



# EFFECTS OF WATERFIX ON ISLANDS, INC.

- **Mr. Ringelberg mainly focused on water quality at Rio Vista (II-25, Page 9).**
- **Rio Vista is about 2 miles to the southern tip of the Ryer Island (most downstream location).**
- **Water quality in and around Ryer Island has been fresh even during recent droughts.**
- **Water quality at Rio Vista is not representative of water quality in and around Ryer Island.**

# OUTLINE

- **Effect of Head of Old River Gate on Water Quality in South Delta**
- **Effects of Fall X2 (Water Quality and Water Levels)**
- **Reverse Flows at Freeport**
- **Effects of WaterFix on Water Levels During Low Flows**
- **Effects of WaterFix on North Delta Water Quality**
- **Antioch Water Quality/Finger Printing Analysis**

# DR. PAULSEN ANTIOCH 202

- **Main Focus of Dr. Paulsen's testimony is on Boundary 1 scenario**
- **Boundary 1 scenario does not contain USFWS Fall X2**
- **Fall X2 requires higher outflow during Fall of wet and above normal water years, resulting in water quality improvements**

# DSM2 FINGER-PRINTING ANALYSIS
# DR. PAULSEN ANTIOCH 202

## Antioch 202

The fingerprinting analysis shows that for nearly all water year types and months the fraction of Sacramento River water at the City's intake will be lower for operational scenario B1 than for scenarios EBC2 and NAA. Under operational scenario B1, an additional 1,200,000 acre-feet per year of exports will occur, on average; as shown in Figure 6, the fraction of Sacramento River water at the City's intake will decline in all year types. In some years, this "lost water" will be made up primarily by San Joaquin River water. For example, in March of a normal water year, the fraction of Sacramento River water decreases from 60% to 40% when scenario B1 is implemented (relative to EBC2 and NAA baselines), while the fraction of San Joaquin River water increases from 20% to 40% (Figure 7). The increase in the fraction of San Joaquin River water results in degraded water quality at the City's intake.

# RIVER WATER QUALITY

- **Sacramento River (Typically fresh year round)**

- **San Joaquin River (Typically fresh during high flows, can have high EC during low flows)**

# DSM2 FINGER-PRINTING ANALYSIS
# OBSERVATION: HIGHER SAN JOAQUIN RIVER CONTRIBUTION AT ANTIOCH IN WET AND NORMAL YEARS

**Antioch 202 Figure 7 Page 26**

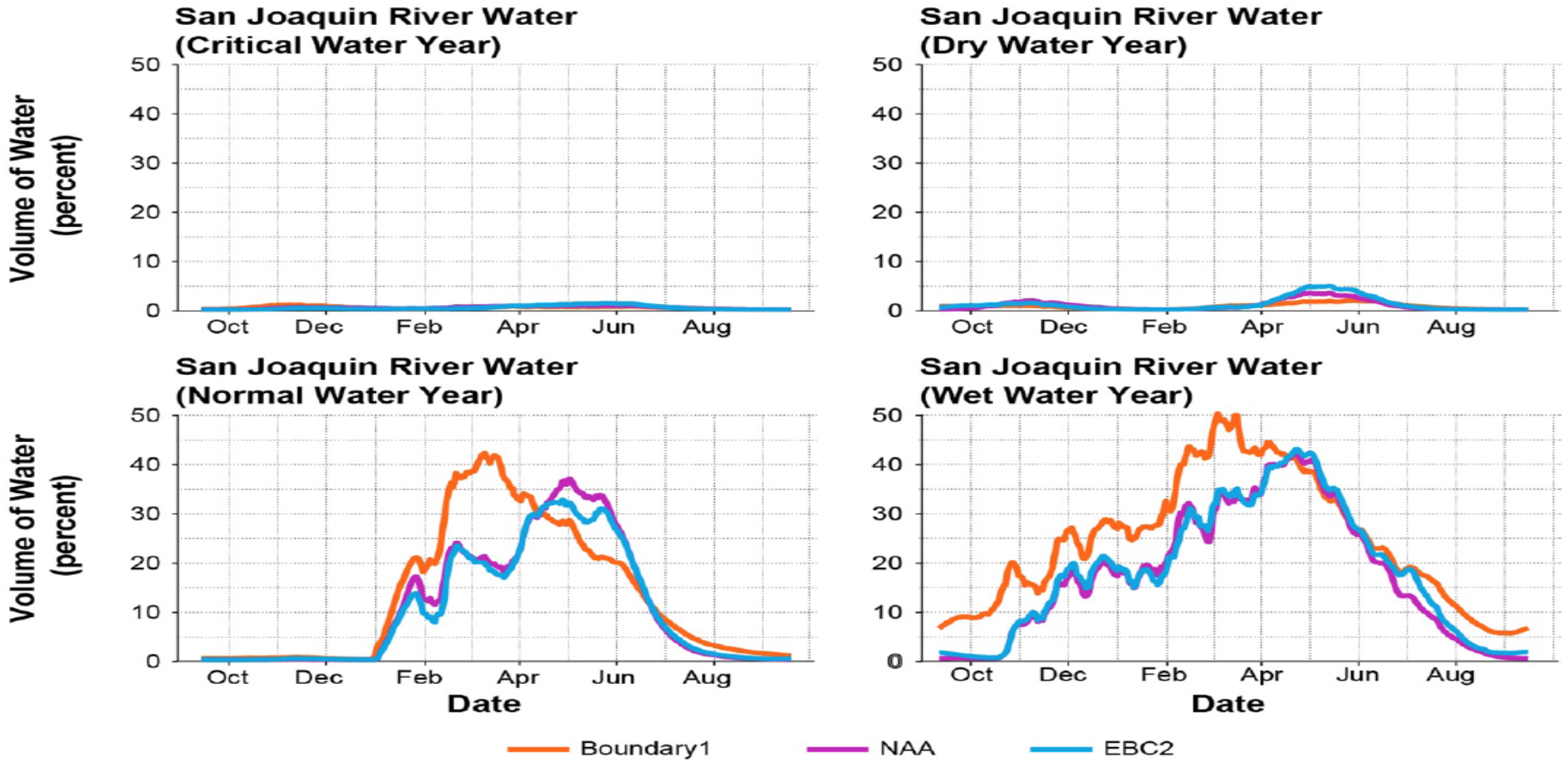
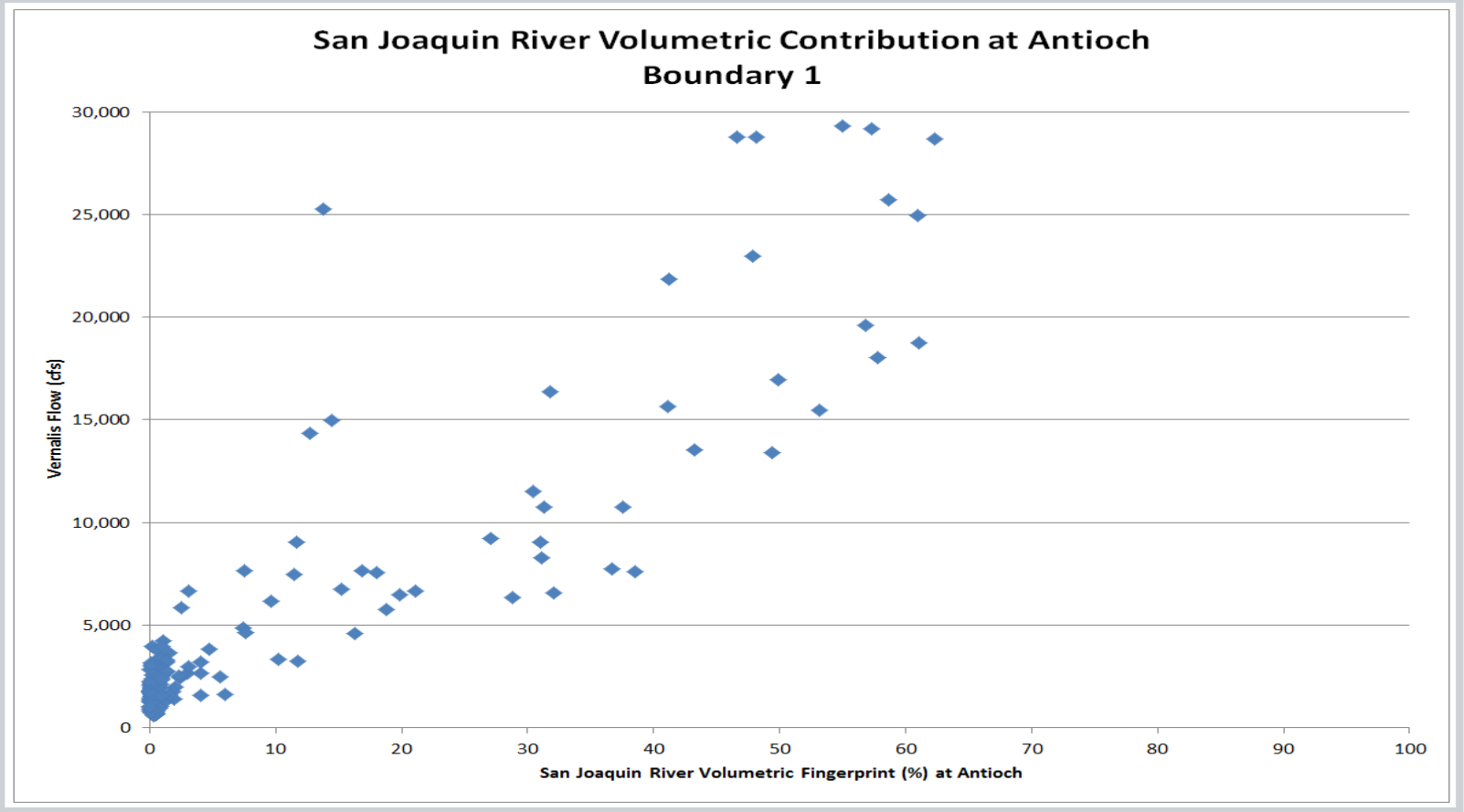


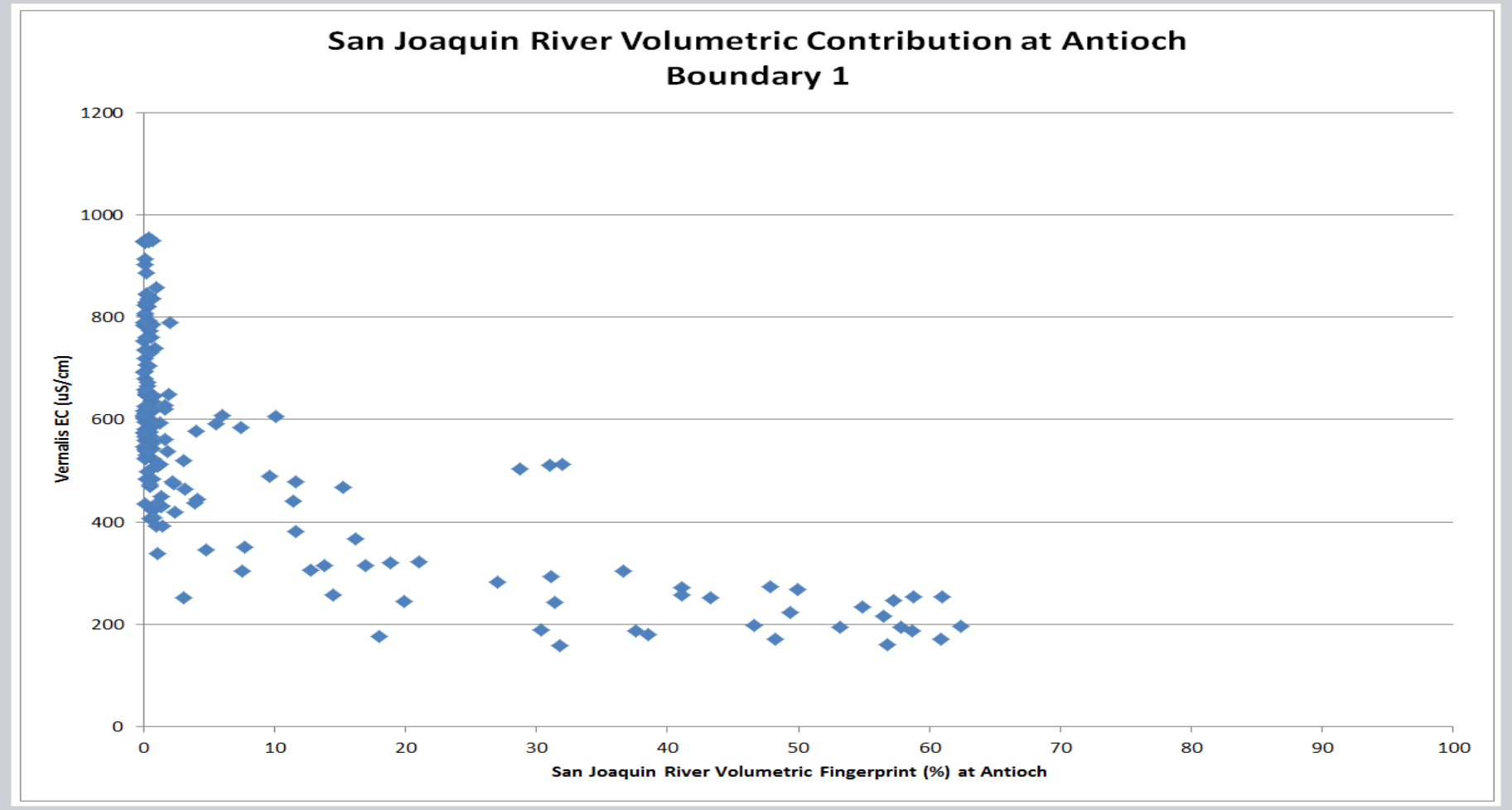

Figure 7 Source fractions of San Joaquin River water at Antioch's intake as modeled by DSM2, averaged by water year type.

# HIGH SAN JOAQUIN RIVER CONTRIBUTION AT ANTIOCH ONLY OCCURS DURING HIGH FLOWS

**Vernalis flow has to be greater than 7,000 cfs to have 40% volumetric contribution at Antioch**



# HIGH SAN JOAQUIN RIVER CONTRIBUTION AT ANTIOCH TYPICALLY OCCURS DURING TIMES WHEN SAN JOAQUIN RIVER HAS FRESH WATER (EC<300 FOR 40%+ CONTRIBUTION)



# DSM2 FINGER-PRINTING ANALYSIS
# OBSERVATION: HIGHER MARTINEZ CONTRIBUTION AT ANTIOCH MOSTLY DURING FALL MONTHS

**Antioch 202 Figure 8 Page 27**

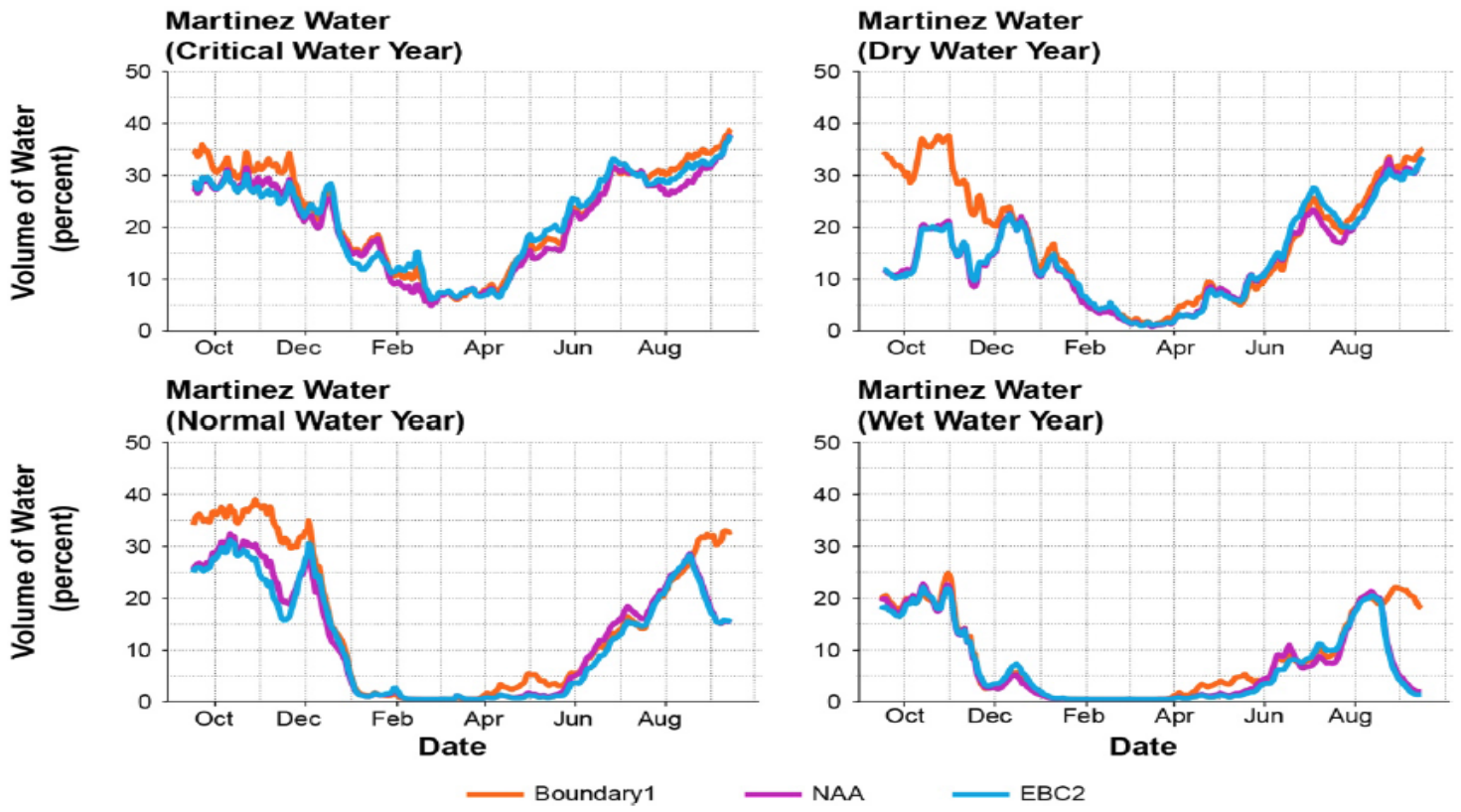
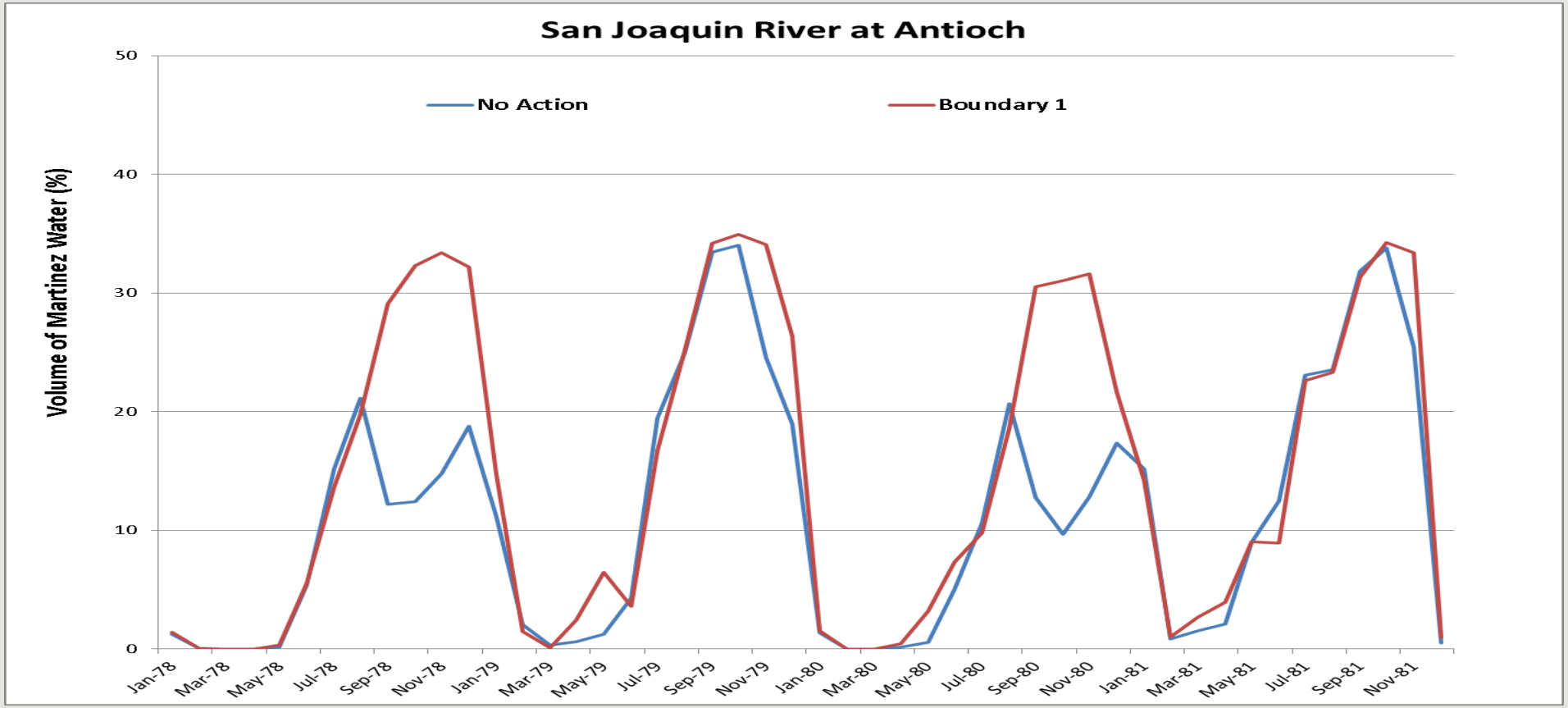



Figure 8 Source fractions of water from Martinez at Antioch's intake as modeled by DSM2, averaged by water year type.

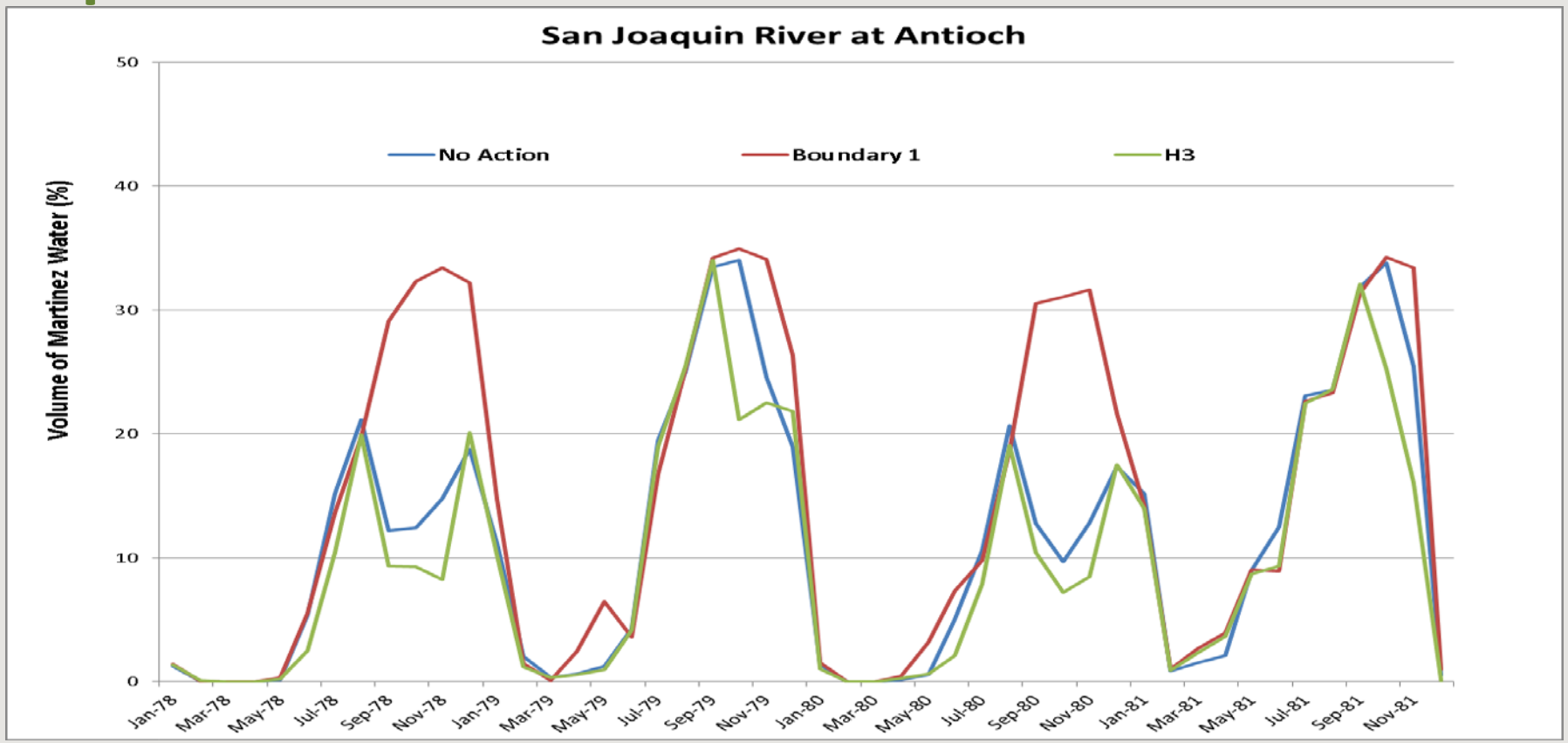
# MARTINEZ VOLUMETRIC CONTRIBUTION AT ANTIOCH BOUNDARY 1 VS NAA (1978-1981)

## Effects of Fall X2 in 1978 and 1980



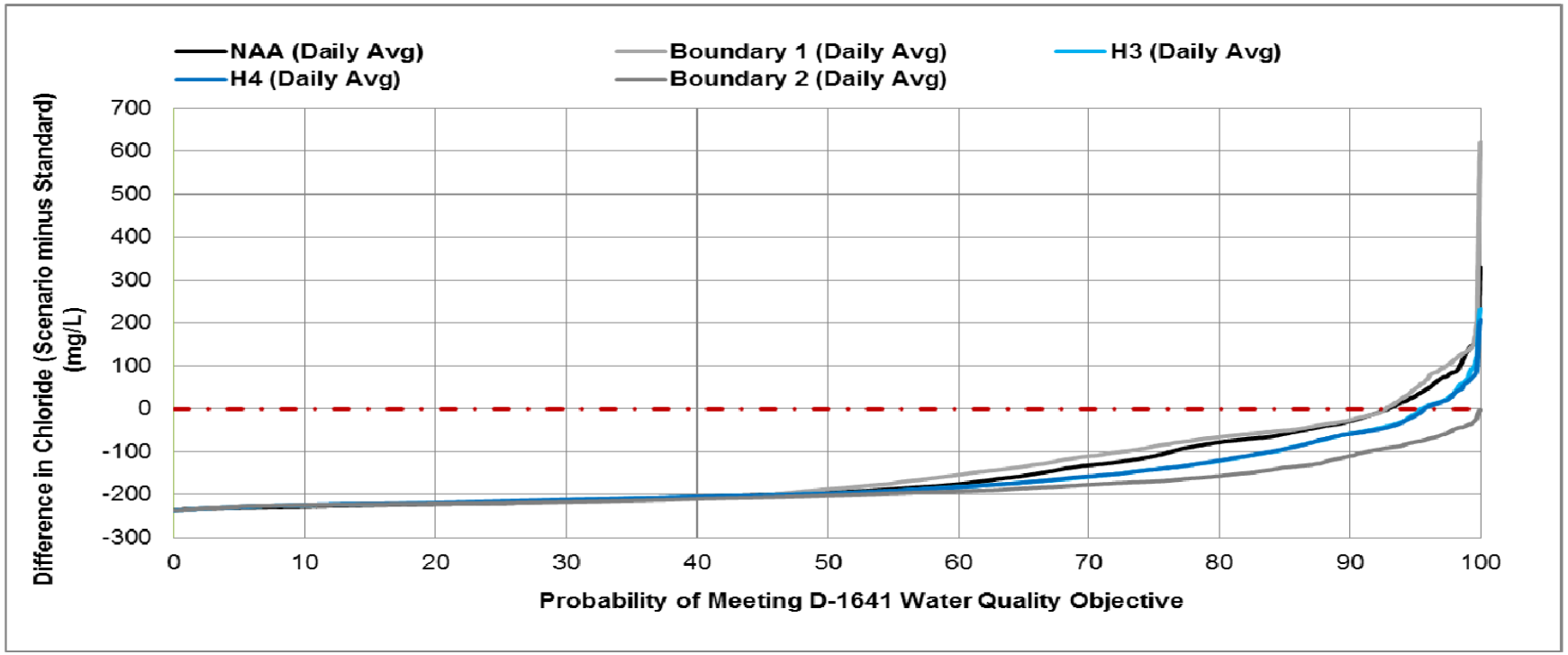
# MARTINEZ VOLUMETRIC CONTRIBUTION AT ANTIOCH BOUNDARY 1 AND H3 VS NAA(1978-1981)

**Overall H3 has similar or lower Martinez Contribution compared to NAA**



DWR 513 (PAGE 9)

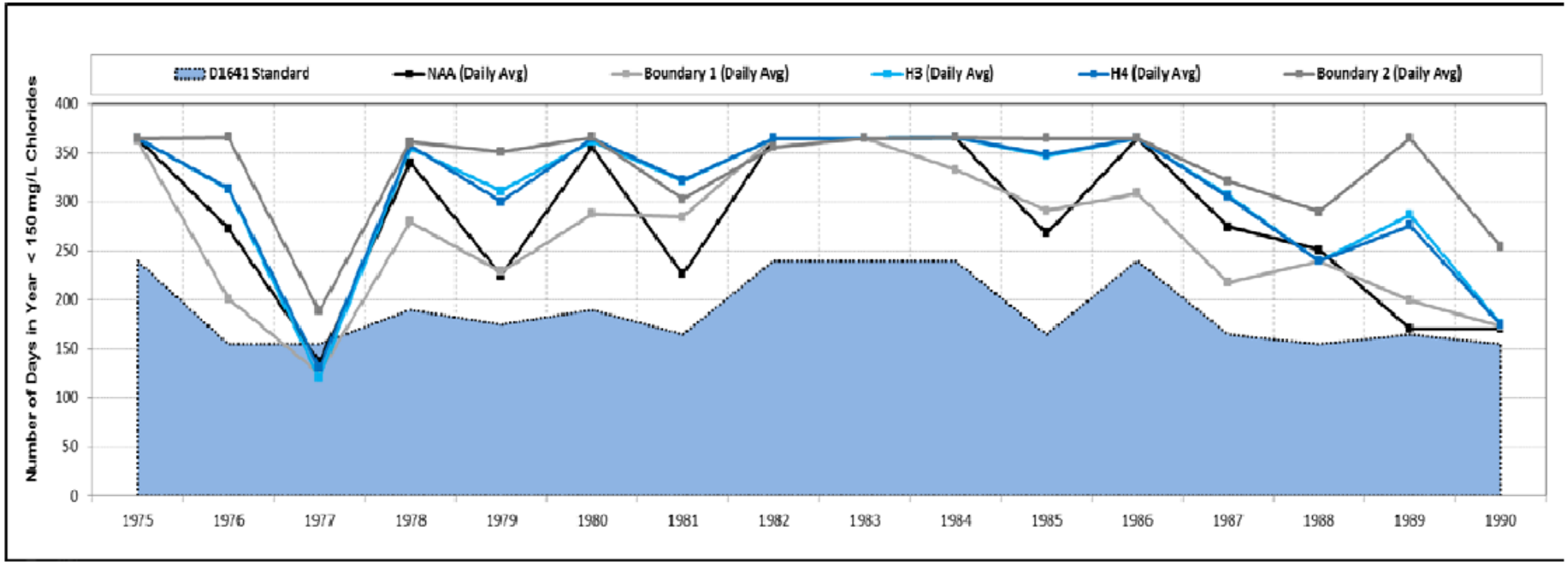
Figure C5: D-1641 250 mg/L Chloride Objective at Contra Costa Canal Pumping Plant 1 – Probability of Meeting D-1641




**Model results are used for comparative purposes and not for predictive purposes*

DWR 513 (PAGE 10)

Figure C6: D-1641 Number of Days in a Year Meeting the Mean Daily Concentration 150 mg/L Chloride Objective at Contra Costa Canal Pumping Plant 1




**Model results are used for comparative purposes and not for predictive purposes*

# ANTIOCH 202

**Table 12** **Number of days per year in the 16-year modeled record that the D-1641 WQO of 150 mg/L chloride for Municipal and Industrial Beneficial Uses is met at PP#1 based on DWR model results. Bold numbers in gray cells indicate that the threshold criteria were not met.**

| | | Number of Days 150 mg/L Chloride Threshold is Met at PP#1 | | |
|---|---|---|---|---|
| Water Year | Threshold Criteria (days) | EBC2 (days) | NAA (days) | B1 (days) |
| 1976 | 155 | 291 | 366 | 301 |
| 1977 | 155 | 156 | **145** | **112** |
| 1978 | 190 | 243 | 239 | **188** |
| 1979 | 175 | 338 | 311 | 178 |
| 1980 | 190 | **187** | 202 | 242 |
| 1981 | 165 | 289 | 281 | 255 |
| 1982 | 240 | 299 | 298 | 287 |
| 1983 | 240 | 298 | 337 | 365 |
| 1984 | 240 | 366 | 357 | 366 |
| 1985 | 165 | 310 | 361 | 298 |
| 1986 | 240 | **213** | **235** | 254 |
| 1987 | 165 | 300 | 365 | 257 |
| 1988 | 155 | 217 | 263 | 250 |
| 1989 | 165 | 186 | **159** | 209 |
| 1990 | 155 | 164 | 165 | 168 |
| 1991 | 155 | 159 | **132** | **138** |

# ANTIOCH WATER QUALITY CONCLUSION

- **With the exception of Boundary 1, all WaterFix operational scenarios show similar or better water quality at Antioch as measured in EC, Chloride, or Bromide.**
- **Boundary 1 shows a higher EC at Antioch mostly because it does not include the Fall X2 action.**
- **The large increases from San Joaquin River volumetric contribution under all WaterFix operational scenarios mainly occurs during high San Joaquin River flows. Not expected to cause substantial increase in EC at Antioch.**

# SUMMARY

- **The salinity increase in South Delta under Boundary 2 is mainly due to a more aggressive operation of the Head of Old River Gate**
- **Fall X2 has a significant effect on water quality and water levels**
- **Most of the increases in EC and reductions in water levels associated with Boundary 1 are due to lack of Fall X2 implementation in Boundary 1 Scenario**

# SUMMARY (CONT'D)

- **WaterFix is not expected to increase the frequency of occurrences of SRFEs at EBMUD's Freeport Facility**
- **Reductions in water levels under WaterFix are expected to be very small during extreme low flow periods**

# SUMMARY (CONT'D)

- **North Delta water quality upstream of Rio Vista (including areas around Ryer Island) should continue to remain fresh under WaterFix**
- **Water quality objectives described under the NDWA contract are expected to be met at almost the same frequency under WaterFix**
- **With the exception of Boundary 1, water quality at Antioch under WaterFix for the most part is expected to be similar or better than NAA**