




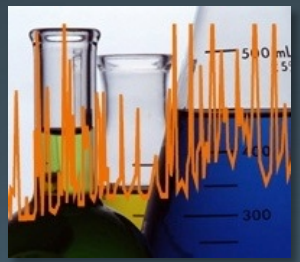

Exponent®

City of Antioch Testimony to SWRCB

Susan Paulsen, Ph.D., P.E.

Qualifications

Summary of Opinions

- 1: Water was historically fresh at Antioch
- 2: DWR's evaluation of the proposed WaterFix Project is inadequate
- 3: WaterFix will result in substantial changes in Delta hydrodynamics and in the composition of water in the Delta
- 4: WaterFix will result in increased salinity at Antioch's intake and will increase the number of days that Antioch must purchase water from other sources
- 5: Compliance with water quality standards is likely to be more challenging in the future, and water quality degradation will occur
- 6: The information provided in the Petition is insufficient for assessing the expected impacts of the WaterFix Project, but it appears that significant water quality degradation can be expected to occur

Background

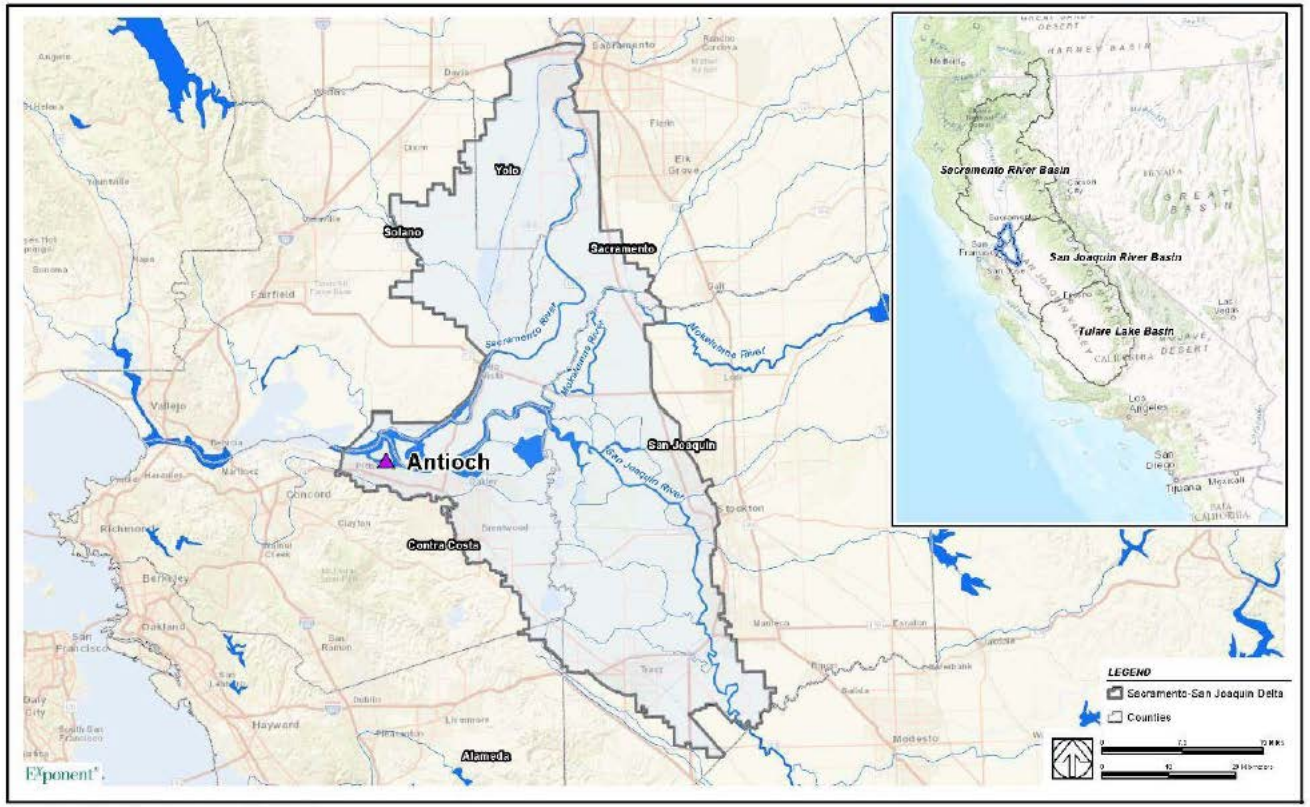

Figure 1 Location of the City of Antioch in the San Francisco Bay area, California.

Table 1. Water quality objectives (WQOs) for municipal and industrial beneficial uses as specified in D-1641.

Compliance Location	Parameter	Description	Water Year Type	Time Period	Value
Contra Costa Canal at Pumping Plant #1 **or** San Joaquin River at Antioch Water Works Intake	Chloride (Cl-)	Maximum mean daily 150 mg/L Cl- for at least the number of days shown during the Calendar Year [in the "Value" column]. Must be provided in intervals of not less than two weeks duration.	W	--	240 days
			AN	--	190 days
			BN	--	175 days
			D	--	165 days
			C	--	155 days
Contra Costa Canal at Pumping Plant #1, **and** West Canal at Mouth of Clifton Court Forebay, **and** Delta-Mendota Canal at Tracy Pumping Plant, **and** Baker Slough at North Bay Aqueduct Intake, **and** Cache Slough at City of Vallejo Intake	Chloride (Cl-)	Maximum mean daily (mg/L)	All	Oct-Sep	250 mg/L Cl-

$$\left[\frac{E}{I}\right]_{D-1641} = \frac{Banks + Jones + NDD\ Exports}{Sacramento + San\ Joaquin + Cosumnes + Calaveras + Mokelumne + Yolo\ inflows} \qquad \text{Eqn. 1}$$

$$\left[\frac{E}{I}\right]_{CWF,modified} = \frac{Banks + Jones\ Exports}{(Sacramento - NDD\ Exports) + San\ Joaquin + Cosumnes + Calaveras + Mokelumne + Yolo\ inflows} \qquad \text{Eqn. 2}$$

Opinion 1: Water was historically fresh at Antioch.

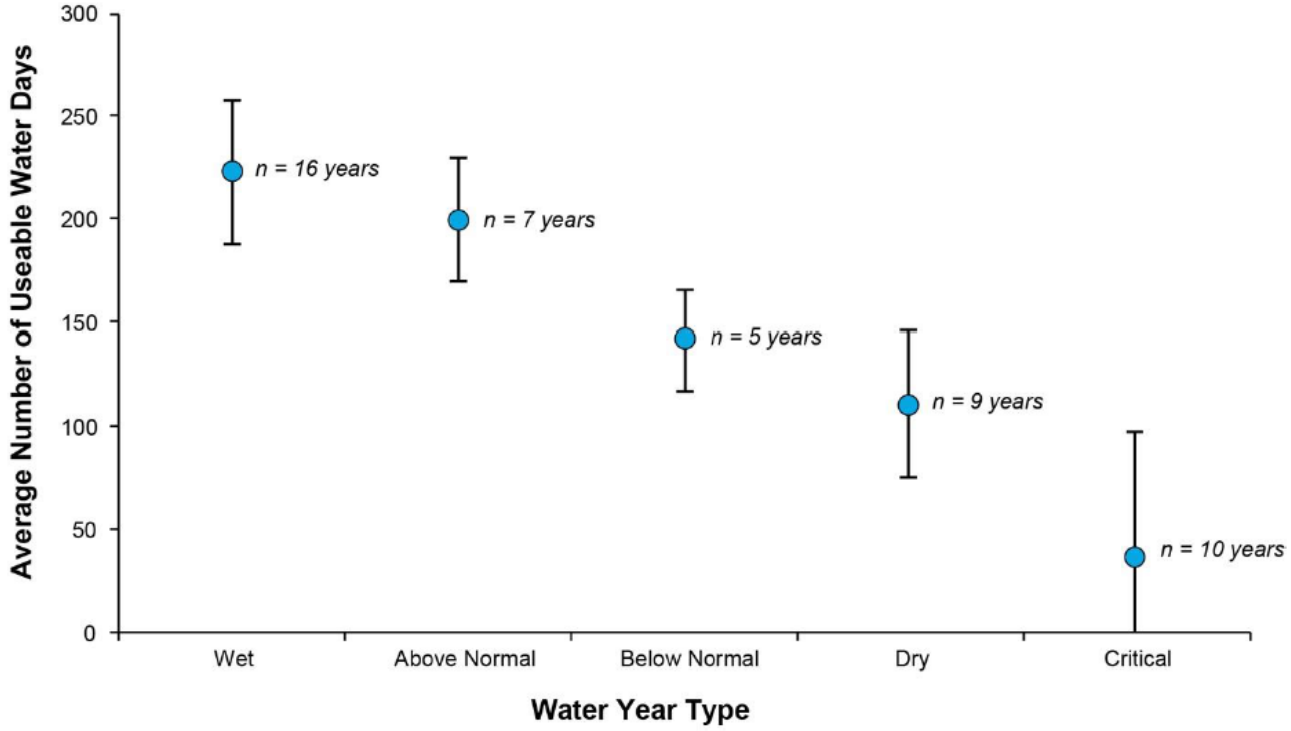

Figure 2 Average number of useable water days at Antioch (measured 2 hours after higher high tide [HHT]) between 1969 and 2015 according to water year type.

Opinion 2: DWR's evaluation of the proposed WaterFix Project is inadequate.

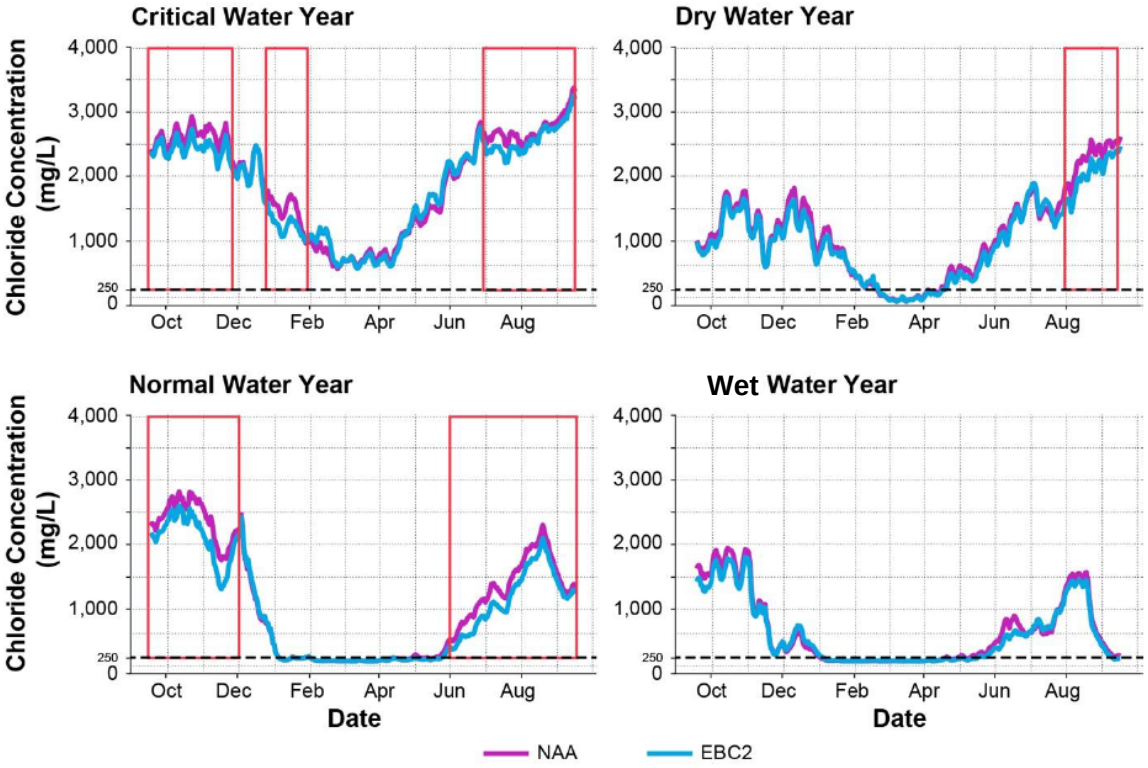

Figure 3 Concentration of chloride at Antioch's intake as modeled by DSM2 (simulated 2 hours after higher high tide [HHT]) averaged for a given water year type.

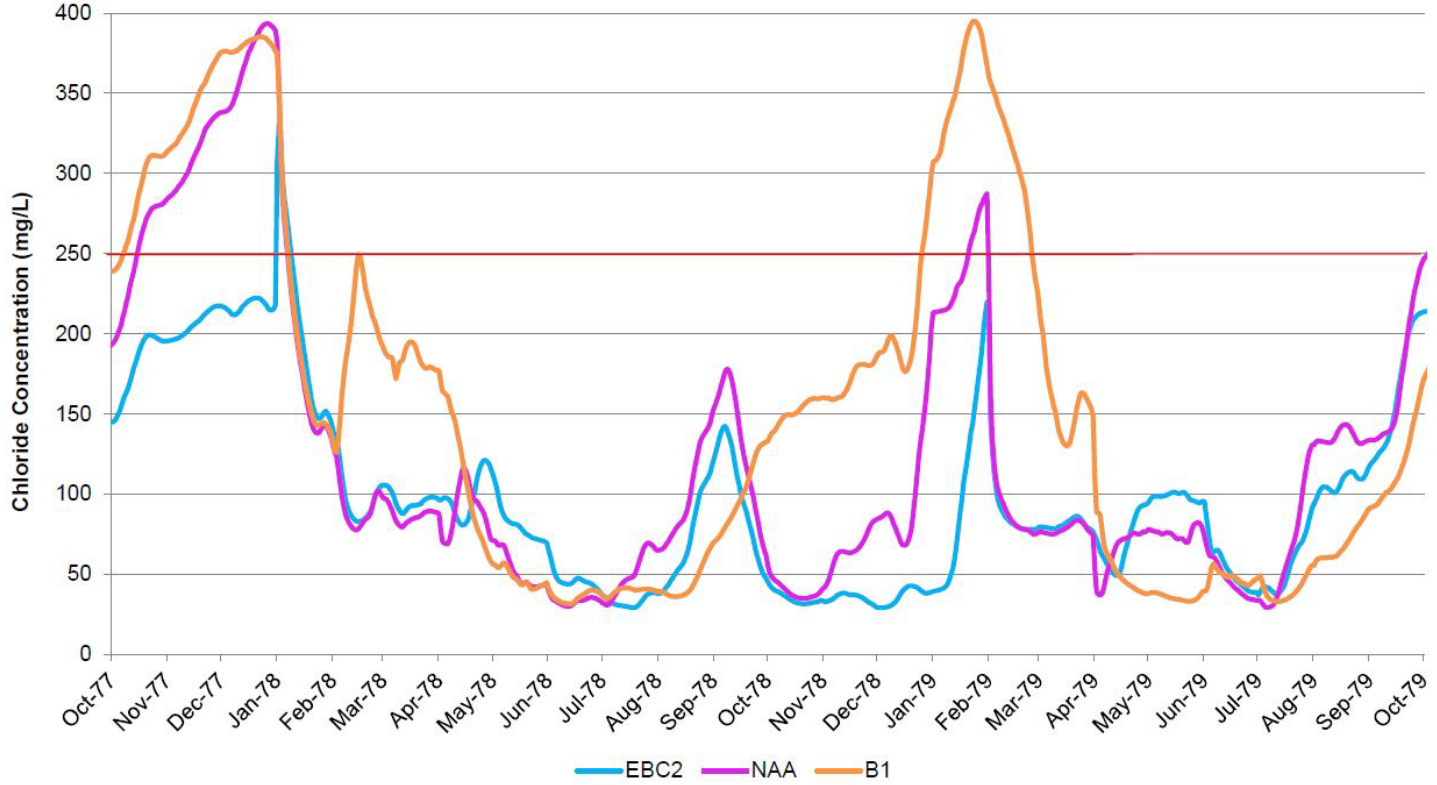

Figure 4 Daily average chloride concentrations at PP#1 for WY 1978–WY 1979, from DWR's model results. The red line indicates the 250 mg/L chloride threshold of D-1641.

Opinion 3: WaterFix will result in substantial changes in Delta hydrodynamics and in the composition of water in the Delta.

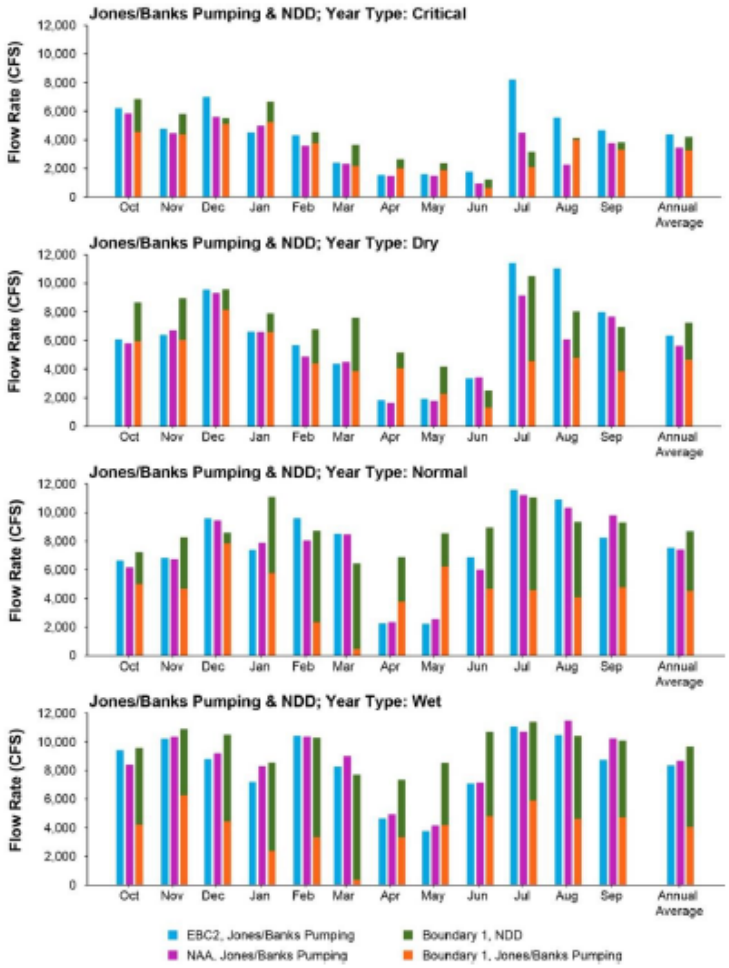

Figure 5 Quantity of water that would be exported from the Delta under the model scenarios EBC2 (existing condition), NAA (no action alternative), and B1 (high export scenario) as modeled by DSM2. Exports in the B1 scenario are divided to show the location from which water was exported from the Delta in the model simulations: either from the South Delta or from the NDD. Results are averaged by water year type—i.e., export quantities were calculated for each month in the simulation period, and averaged by month for each year type (wet, normal, dry, and critical).

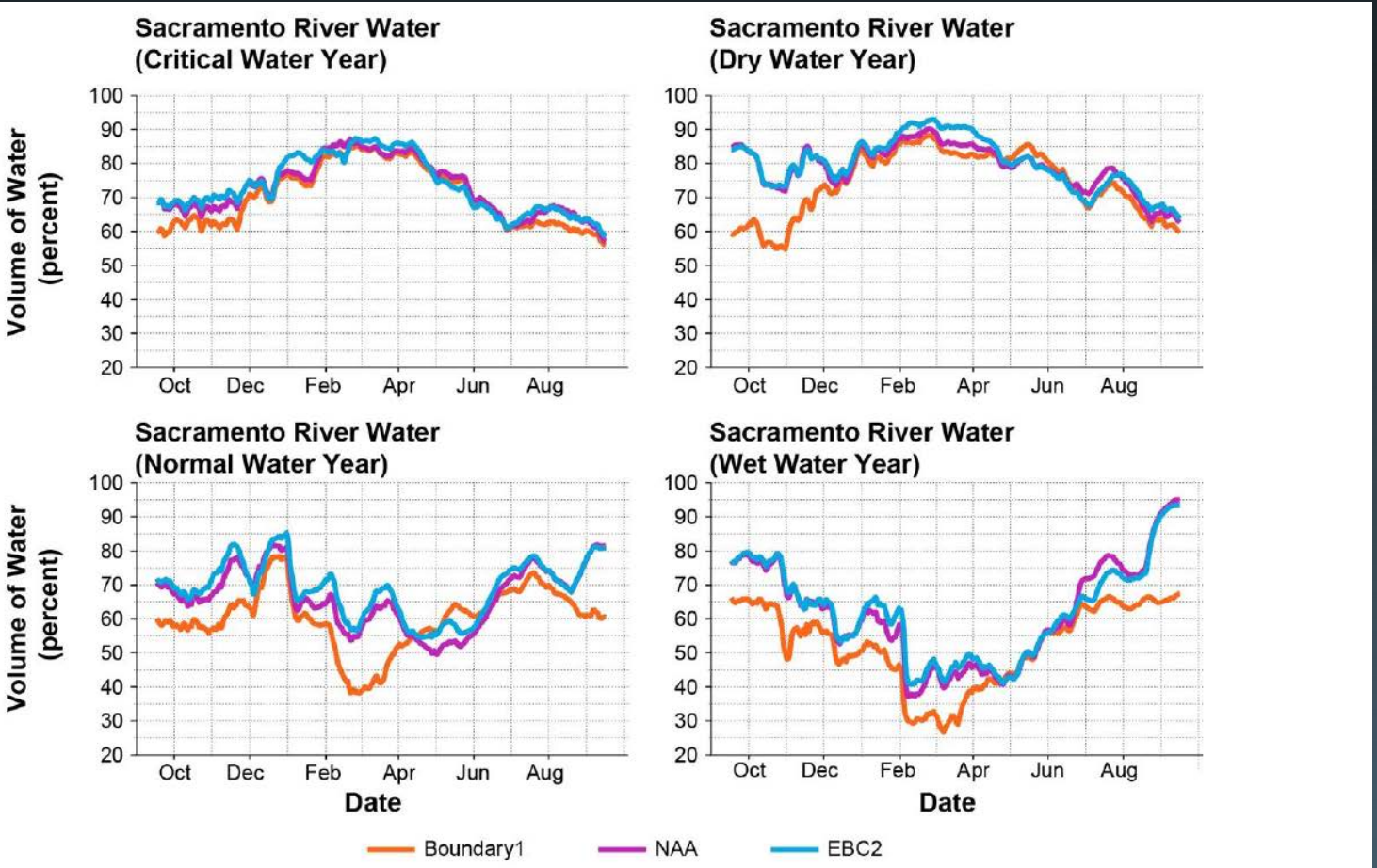

Figure 6 Source fractions of Sacramento River water at Antioch's intake location as modeled by DSM2 by water year type.

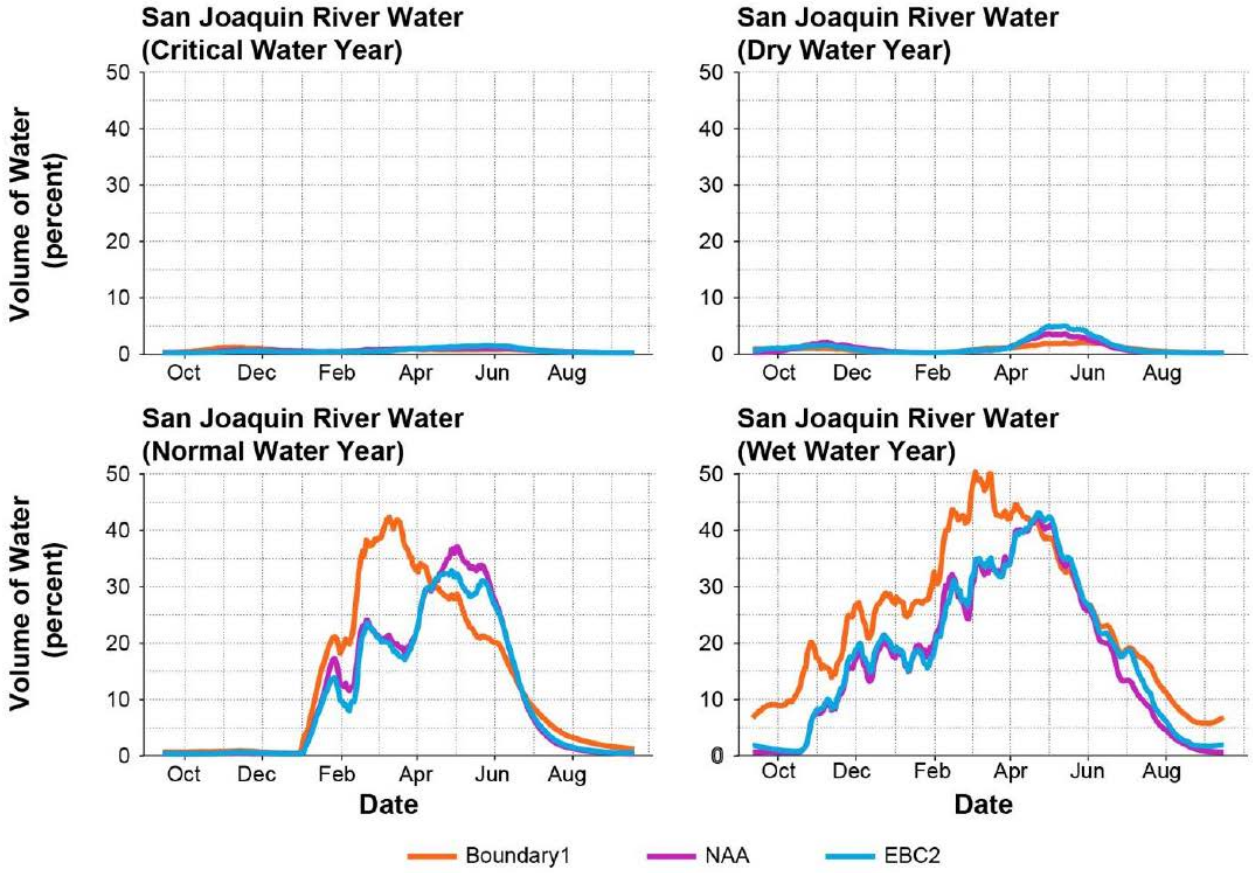

Figure 7 Source fractions of San Joaquin River water at Antioch's intake location as modeled by DSM2 by water year type.

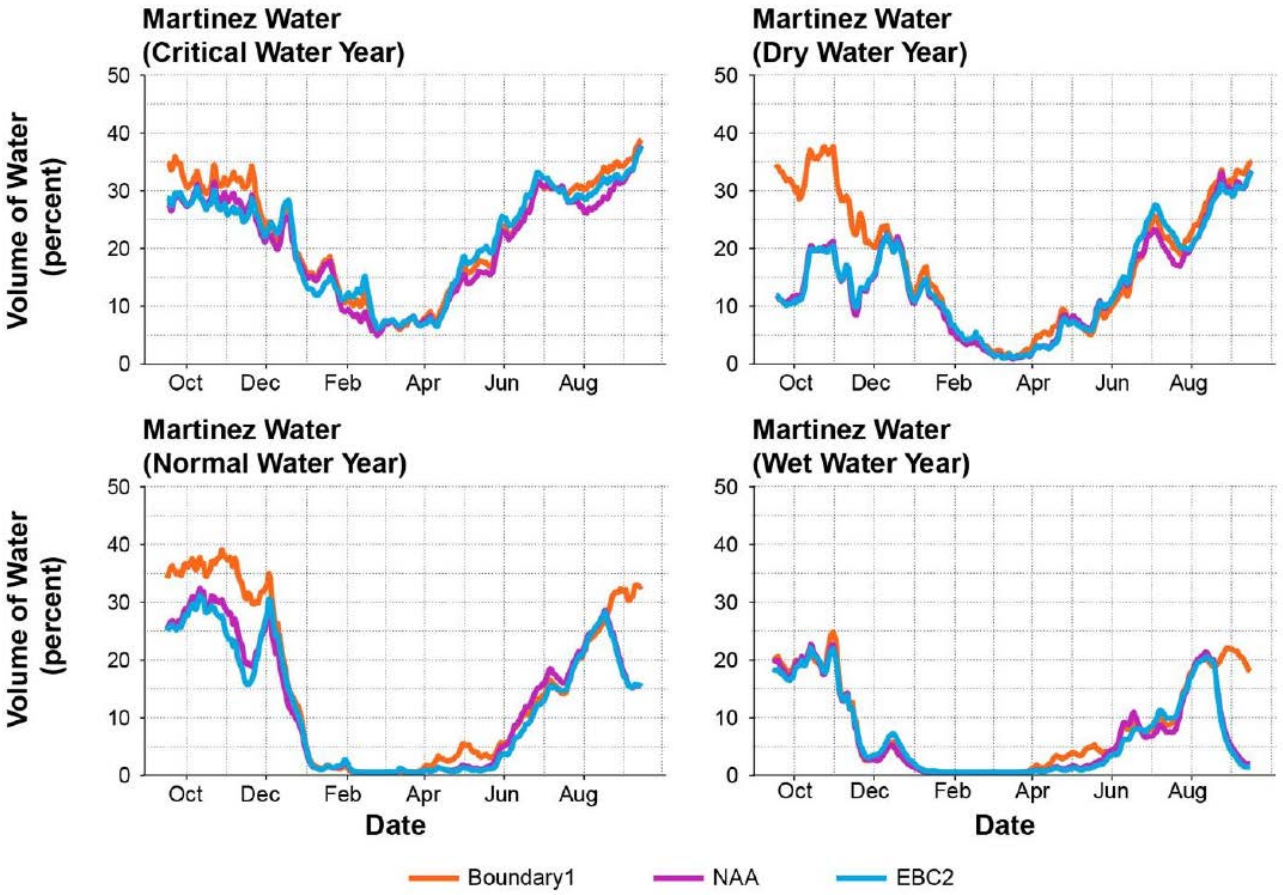

Figure 8 Source fractions of water from Martinez at Antioch's intake location as modeled by DSM2 by water year type.

Opinion 4: WaterFix will result in increased salinity at Antioch's intake and will increase the number of days that Antioch must purchase water from other sources.

Table 2 **Difference in monthly average chloride concentration (mg/L) at Antioch's intake at slack current after HHT for Scenario B1 relative to existing conditions (EBC2). Positive numbers indicate an increase in chloride concentrations for Scenario B1 relative to existing conditions (EBC2).**

	Difference in Chloride Concentration (mg/L) between B1 and EBC2 at Antioch			
	Wet WY	Normal WY	Dry WY	Critical WY
Jan	-2	149	408	380
Feb	4	9	97	132
Mar	1	9	46	37
Apr	27	52	114	113
May	187	214	123	34
Jun	205	257	8	-15
Jul	153	347	121	249
Aug	272	359	453	381
Sep	1395	1304	548	339
Oct	333	969	1895	608
Nov	223	1381	1596	638
Dec	12	901	819	410

Table 3 **Number of days per year when water is not useable at the City's intake (i.e., when that the chloride concentration at Antioch's intake is greater than 250 mg/L at slack current after HHT), calculated from DWR simulation results.**

Water Year	Water Year Type	Number of Days Chloride > 250 mg/L		
		EBC2[b]	NAA[a]	B1[a]
1976	critical	332	340	361
1977	critical	365	365	365
1978	normal	204	200	206
1979	normal	220	220	261
1980	normal	206	192	226
1981	dry	280	268	291
1982	wet	140	118	162
1983	wet	45	0	65
1984	wet	131	114	180
1985	dry	270	280	326
1986	wet	209	202	239
1987	dry	286	297	311
1988	critical	306	325	331
1989	dry	291	288	299
1990	critical	356	341	357
1991	critical	325	326	326

[a] WaterFix model runs (05/2016)
[b] EIR/EIS model runs (2013), existing condition model run most representative of current conditions

Table 4 **Average number of days per year in each year type when water is not useable at the City's intake (i.e., when that the chloride concentration at Antioch's intake is greater than 250 mg/L at slack current after HHT), calculated from DWR simulation results**

	Average Number of Days Chloride > 250 mg/L		
Water Year Type	**EBC2[b]**	**NAA[a]**	**B1[a]**
Wet	131	109	162
Normal	210	204	231
Dry	282	283	307
Critical	337	339	348

[a] WaterFix model runs (05/2016)
[b] EIR/EIS model runs (2013), existing condition model run most representative of current conditions

Table 5 Decrease in number of days of water usability at Antioch's intake, averaged by water year type, compared to existing conditions.

	Number of Lost Useable Days Relative to EBC2	
Water Year Type	**NAA[a]**	**B1[a]**
Wet	22	31
Normal	6	21
Dry	-1	25
Critical	-2	11

[a] WaterFix model runs (05/2016)

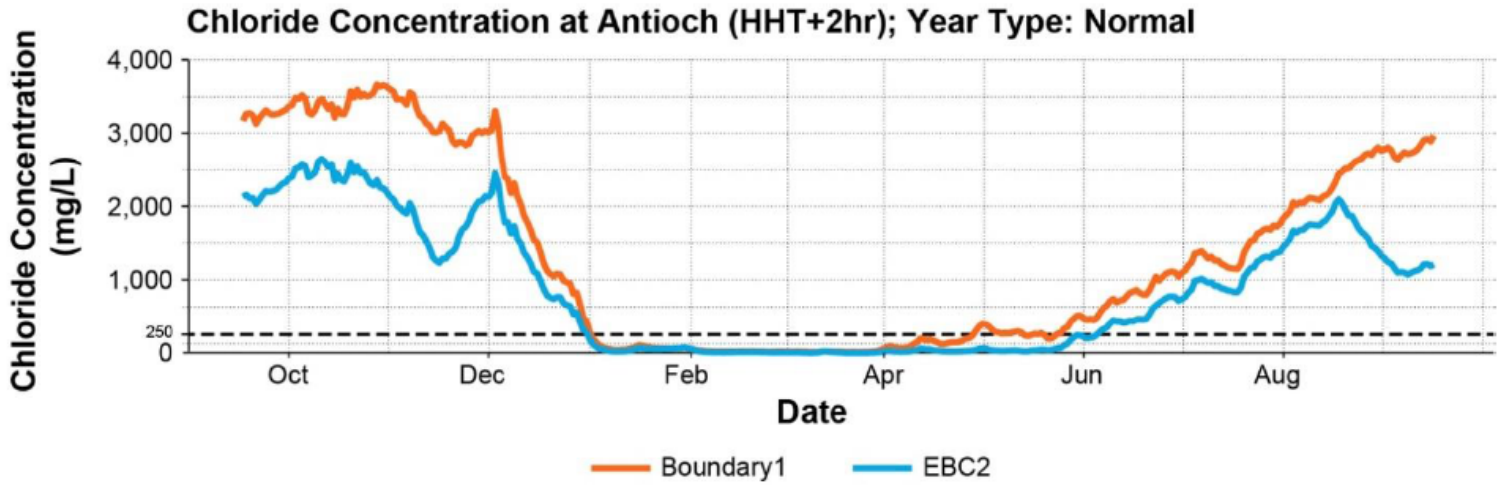

Figure 9 Daily chloride concentrations in water at Antioch's intake location as modeled by DSM2 (at slack current after HHT) and averaged for each day for normal water years.

Table 6 **Average number of equivalent days per year Antioch's water treatment plant can use water at the intake (i.e., total amount of time, expressed in days, when water at the City's intake is simulated to have a chloride concentration of less than 250 mg/L) assuming real-time operations.**

	Average Number of Equivalent Water Days per Year		
Water Year Type	**EBC2[b]**	**NAA[a]**	**B1[a]**
Critical	63	66	44
Dry	145	134	102
Normal	188	171	163
Wet	270	265	240

[a] WaterFix model runs (05/2016)
[b] EIR/EIS model runs (2013), existing condition model run most representative of current conditions

Table 7 **Anticipated cost of water purchases by 2028 based on Antioch diversion and treatment operations under WaterFix Project scenarios EBC2, NAA, B1.**

Water Year Type (% recurrence)	Modeled Annual Cost of Water Purchases by 2028 (million dollars in 2028)		
	EBC2[b]	NAA[a]	B1[a]
Critical (16%)	$14.4	$14.3	$15.0
Dry (22%)	$11.2	$11.6	$12.9
Normal (33%)	$8.6	$9.3	$9.9
Wet (29%)	$4.7	$5.4	$6.3
Annual weighted average by WYT (2028 $, millions)	$9.0	$9.4	$10.3
Total purchases over 50-years (2028 $, millions)[c]	$435.6	$458.6	$501.4
Present value of total purchases over 50-years (2016 $, millions)	$305.5	$321.7	$351.7

[a] WaterFix model runs (05/2016)
[b] EIR/EIS model runs (2013), existing condition model run most representative of current conditions
[c] Assumes a 3% annual interest rate, 3% discount rate

Opinion 5: Compliance with water quality standards is likely to be more challenging in the future, and water quality degradation will occur.

Table 8 **Number of days in each water year that the D-1641 WQO of 250 mg/L chloride for Municipal and Industrial Beneficial Uses at Contra Costa Pumping Plant #1 is not met, based on DWR model results.**

Water Year	Water Year Type	Total Days	Number of Days 250 mg/L Chloride Threshold is Not Met at CCPP		
			EBC2[b]	NAA[a]	B1[a]
1976	Critical	366	37	0	0
1977	Critical	365	8	50	16
1978	Normal	365	10	87	105
1979	Normal	365	0	17	64
1980	Normal	366	87	57	44
1981	Dry	365	0	0	0
1982	Wet	365	3	12	10
1983	Wet	365	34	0	0
1984	Wet	366	0	0	0
1985	Dry	365	0	0	15
1986	Wet	365	23	26	6
1987	Dry	365	0	0	46
1988	Critical	366	1	4	14
1989	Dry	365	77	106	124
1990	Critical	365	40	60	25
1991	Critical	365	76	107	117

[a] WaterFix model runs (05/2016)
[b] EIR/EIS model run EBC2 (2013), the existing condition model run most representative of current conditions

Table 9 Average days per year by water year type that the D-1641 250 mg/L chloride WQO for Municipal and Industrial Beneficial Uses at PP#1 is not met, based on DWR model results.

	Average Number of Days 250 mg/L Chloride Threshold is Not Met at PP#1		
Water Year Type	EBC2[b]	NAA[a]	B1[a]
Critical	32	44	34
Dry	19	27	46
Normal	32	54	71
Wet	15	10	4
Average	25	33	37

[a] WaterFix model runs (05/2016)
[b] EIR/EIS model run EBC2 (2013), the existing condition model run most representative of current conditions

Table 10 **Number of years 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 Antioch Water Works Intake, averaged by water year type, and based on DWR model results.[44]**

Water Year Type	Total Years in Each Water Year Type	Number of Years 150 mg/L Chloride Threshold is Met at Antioch Water Works Intake		
		EBC2[b]	NAA[a]	B1[a]
Critical	5	0	0	0
Dry	4	0	0	0
Normal	3	0	0	0
Wet	4	3	1	1

[a] WaterFix model runs (05/2016)
[b] EIR/EIS model runs (2013), existing condition model run most representative of current conditions

Table 11 Number of years 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, averaged by water year type, and based on DWR model results.

Water Year Type	Total Years in Each Water Year Type	Number of Years 150 mg/L Chloride Threshold is Met at PP#1		
		EBC2[b]	NAA[a]	B1[a]
Critical	5	4	3	3
Dry	4	4	3	4
Normal	3	2	3	3
Wet	4	3	3	4

[a] WaterFix model runs (05/2016)
[b] EIR/EIS model run EBC2 (2013), the existing condition model run most representative of current conditions

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 Contra Costa Pumping Plant #1 based on DWR model results. Bold numbers in gray cells indicate the threshold criteria were not met.

		Number of Days 150 mg/L Chloride Threshold is Met at CCPP		
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**

Table 13 **Number of days the E/I ratio exceeds the threshold specified in the D-1641 WQOs for Municipal and Industrial Use for the 16-year modeled record, and overall percent of time in exceedance (in parentheses).**

	Number of Days E/I Ratio Exceeds D-1641 Limits[d] (percent time ratio exceeds 35%)		
Scenario	EBC2[b,c]	NAA[a,c]	B1[a]
Redefined (E/I) excluding NDD flows	481 (8.2%)	349 (6.0%)	270 (4.6%)
D-1641 specifications	481 (8.2%)	349 (6.0%)	850 (14.6%)

[a] WaterFix model runs (05/2016)
[b] EIR/EIS model run EBC2 (2013), the existing condition model run most representative of current conditions
[c] Note that the E/I ratio calculations do not change for the NAA and EBC2 scenarios, because the NDD points do not exist for these scenarios.
[d] D-1641 limits Delta exports to 35% of Delta inflow between February and June (i.e., E/I < 0.35 from February-June), and to 65% of Delta inflow between July and January (i.e., E/I < 0.65 from July-January).

Opinion 6: The information provided in the Petition is insufficient for assessing the expected impacts of the WaterFix Project, but it appears that significant water quality degradation can be expected to occur.

END OF SLIDES