

1 MATTHEW L. EMRICK (SBN 148250)
2 LAW OFFICES OF MATTHEW EMRICK
3 6520 Lone Tree Blvd., #1009
4 Rocklin, CA 95765
5 Telephone: (916) 337-0361
6 Facsimile: (916) 771-0200
7 matthew@mlelaw.com

8 Attorneys for Protestant,
9 City of Antioch

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11 **BEFORE THE STATE WATER RESOURCES**
12 **CONTROL BOARD**

13 HEARING IN THE MATTER OF
14 CALIFORNIA DEPARTMENT OF WATER
15 RESOURCES AND UNITED STATES
16 BUREAU OF RECLAMATION REQUEST
17 FOR A CHANGE IN POINT OF DIVERSION
18 FOR CALIFORNIA WATER FIX

19 **TESTIMONY OF DR. SUSAN**
20 **PAULSEN IN SUPPORT OF**
21 **PROTEST OF THE CITY OF**
22 **ANTIOCH, PHASE 1B.**

23 **(Exhibit: Antioch – 200)**

24 **QUALIFICATIONS**

25 My name is Susan Paulsen and I am a Registered Professional Civil Engineer in
26 the State of California (License # 66554). My educational background includes a
27 Bachelor of Science in Civil Engineering with Honors from Stanford University (1991), a
28 Master of Science in Civil Engineering from the California Institute of Technology
("Caltech") (1993), and a Doctor of Philosophy (Ph.D.) in Environmental Engineering
Science, also from Caltech (1997). My education included coursework at both
undergraduate and graduate levels on fluid mechanics, aquatic chemistry, surface and
groundwater flows, and hydrology, and I served as a teaching assistant for courses in
fluid mechanics and hydrologic transport processes.

I currently am a Principal and Director of the Environmental and Earth Sciences
practice of Exponent, Inc. ("Exponent"). Prior to that, I was employed by Flow Science

1 Incorporated, in Pasadena, California, where I worked for 20 years, first as a consultant
2 (1994-1997), and then as an employee in various positions, including President (1997-
3 2014). I have 25 years of experience with projects involving hydrology, hydrogeology,
4 hydrodynamics, aquatic chemistry, and the environmental fate of a range of constituents.
5 My Ph.D. thesis was entitled, "A Study of the Mixing of Natural Flows Using ICP-MS and
6 the Elemental Composition of Waters," and the major part of my Ph.D. research involved
7 a study of the mixing of waters in the Sacramento-San Joaquin Bay-Delta (the Delta)
8 using source water fingerprints. I also directed model studies to use the chemical source
9 fingerprinting to validate the volumetric fingerprinting simulations using Delta models
10 (including the Fischer Delta Model (FDM) and the Delta Simulation Model (DSM)). I have
11 designed and directed numerous field studies within the Delta using both elemental and
12 dye tracers, and I have designed and directed numerous surface water modeling studies
13 within the Delta.

14 For my testimony in this matter, I am familiar with and knowledgeable of Antioch's
15 water rights, water operations, and water diversion. I am familiar with Antioch's 1968
16 Agreement with the Department of Water Resources ("DWR"), as I have reviewed and
17 analyzed the 1968 Agreement for Antioch and have participated in meetings with DWR
18 regarding the Agreement and the extension of the Agreement (Exhibits Antioch-101 and
19 Antioch-102).

20 A copy of my curriculum *vitae* is included as Exhibit Antioch-201.

21 **SUMMARY OF TESTIMONY**

22 I was retained by the City of Antioch to assist the City in its evaluation of the
23 California WaterFix Project (WaterFix). My testimony includes comments on the changes
24 in hydrodynamics and water quality that are expected to occur after implementation of the
25 proposed WaterFix Project, and an assessment of whether the WaterFix Project will have
26 an impact on the supply and quality of water available to Antioch, which uses fresh water
27 from the Delta for potable municipal supply.

28 This testimony presents six primary Opinions in response to the SWRCB's Notice of

1 Petition:

- 2 • Opinion 1: Water was historically fresh at Antioch.
- 3 • Opinion 2: DWR's evaluation of the proposed WaterFix Project is inadequate.
- 4 • Opinion 3: WaterFix will result in substantial changes in Delta hydrodynamics and
5 degradation of Delta water quality.
- 6 • Opinion 4: The water quality degradation caused by WaterFix will impact the City's
7 operations.
- 8 • Opinion 5: Compliance with water quality standards is likely to become more
9 challenging in the future, and WaterFix will degrade water quality at the City's
10 intake.
- 11 • Opinion 6: The information provided in the petition is insufficient for assessing the
12 expected impacts of the WaterFix Project, but it appears that significant water
13 quality degradation can be expected to occur

14 I have prepared a Report that goes into further depth regarding the opinions set forth in
15 this testimony (included in Antioch's case as Exhibit Antioch-202) and that is incorporated
16 into this testimony.

17 TESTIMONY

18 **Opinion 1: Water was historically fresh at Antioch.**

19 DWR's testimony states that prior to the implementation of the State Water Project
20 (SWP) and Central Valley Project (CVP), "salinity intruded well into the interior of the
21 Delta during the irrigation season" (DWR-53 at p. 14), and DWR asserts that "historical
22 salinity was at times greater than current conditions" (DWR-53 at p. 15). Because DWR
23 does not examine or present historical salinity conditions prior to 1921, DWR may leave
24 the false impression that the Delta was historically a saline water body.

25 Antioch's use of water and Antioch's water right date to at least 1868, and
26 abundant evidence indicates that prior to the early 1900s, water at Antioch's intake would
27 have been fresh for most of the year, and the saltwater-freshwater interface would have
28 intruded into the Delta only during dry months of dry years. Changes in flow patterns

1 (including the diversion and storage of flows upstream of the Delta) and changes in
2 geomorphology (including channelization of the Delta and loss of tidal marsh) between
3 the late 1800s and the mid-1900s changed the salinity distribution within the Delta. The
4 marked decline in water quality in the early 1900s was documented in a 1920 California
5 Supreme Court Case (*Town of Antioch v. Williams Irrigation District*) and in reports
6 issued by the California Department of Public Works (predecessor to DWR) in 1931
7 (Exhibit Antioch-233) and by Means in 1928 (Exhibit Antioch-232). The continued decline
8 in water quality at Antioch's intake was established by DWR in 1960 (Exhibit Antioch-
9 215), and the State acknowledged its role in declining water quality when it entered into
10 an Agreement with the City of Antioch in 1968. The decline in water quality at Antioch's
11 intake is well-established and provides context for the City's concerns about additional
12 future water quality degradation.

13

14 **Opinion 2: DWR's evaluation of the proposed WaterFix project is inadequate.**

15 I have identified four primary reasons why DWR's evaluation of WaterFix is
16 inadequate. First, the modeling used to evaluate the WaterFix Project is flawed in that it
17 uses an inappropriate baseline condition. Specifically, DWR uses the No Action
18 Alternative, or "NAA" scenario, to represent "baseline conditions," even though DWR has
19 conducted modeling runs to describe the existing condition. My analysis indicates that
20 DWR's existing conditions model run EBC2 most accurately represents current salinity
21 conditions at Antioch. Because the NAA is a future scenario that includes 15 cm of sea
22 level rise, the NAA scenario generally has higher salinity than existing conditions,
23 resulting in a higher salinity "baseline" that masks some of the water quality effects of the
24 WaterFix project.

25 Second, WaterFix project operations are poorly defined. The range of potential
26 operations scenarios provided by DWR is broad, and DWR has not clearly indicated the
27 criteria by which the project would be operated, or the criteria by which project operations
28 would be changed over time. As a result, it is difficult to assess the potential impacts of

1 the Project to the City's water rights and water supply.

2 Third, the Adaptive Management and Monitoring Program (AMMP) is undefined
3 and would provide DWR broad flexibility in operations that could lead to significant
4 impacts to water quality. It appears that the AMMP may focus on impacts to fish species
5 rather than impacts to municipal and industrial users of water within the Delta.

6 Finally, DWR asserts that the WaterFix Project will provide additional operational
7 flexibility that will lead to improvements in meeting water quality and flow objectives in the
8 Delta. However, DWR's analysis is based on long-term averages from model simulation
9 results, and neither DWR's calculated long-term averages nor the underlying modeling
10 performed by DWR support the assertion that compliance will be improved after
11 implementation of the WaterFix Project.

12

13 **Opinion 3: WaterFix will result in substantial changes in Delta hydrodynamics and**
14 **degradation of water quality at Antioch.**

15 DWR's testimony indicates that Operational Scenario Boundary 1 would result in
16 an average of about 1,200,000 acre-feet per year of additional exports, while Scenarios
17 H3 and H4 would result in about 500,000 acre-feet per year of additional exports.
18 (Although Boundary 2 would result in less water exported from the Delta, it appears
19 unlikely, based on DWR's testimony, that it would be implemented.) Because the
20 diversion points for the proposed WaterFix Project would be located on the Sacramento
21 River, the proposed WaterFix Project would export more Sacramento River water from
22 the Delta than is exported under existing conditions. By removing both more water and
23 more high quality Sacramento River water from the Delta, the WaterFix Project would
24 change the composition and quality of water within the Delta and increase the residence
25 time of water in the Delta, resulting in degraded water quality.

26 My analysis of DWR's model results shown that the Boundary 1 Scenario of the
27 proposed WaterFix Project will cause a significant increase in salinity at Antioch's intake
28 in almost all months of almost all year types. Per Antioch's 1968 Agreement with the

1 State, water is defined as “useable” when it has a chloride level less than 250 mg/L as
2 measured at slack current after higher high tide. Project Scenario Boundary 1 will cause
3 a reduction in the number of days useable water is available at the City’s intake relative
4 to both existing conditions and the NAA; the number of useable days will be reduced in
5 twelve of the sixteen years in DWR’s model period, with the greatest impact in wet,
6 normal, and dry year types.

7 In addition to salinity, other water quality impacts are anticipated to occur at
8 Antioch’s intake location as a result of the proposed WaterFix project. For example,
9 bromide is directly correlated with chloride, such that an increase in chloride
10 concentrations at the City’s intake will correspond to an increase in bromide
11 concentrations at the City’s intake. Both the RDEIR/SDEIS (Exhibit SWRCB-3) and
12 DWR’s testimony (Exhibit Antioch-206) indicate that bromide concentrations are
13 expected to exceed relevant water quality thresholds (of 50, 100, or 300 µg/L bromide) at
14 Antioch’s intake. Although DWR asserts that the City’s 1968 Agreement with the State
15 will mitigate for bromide impacts, that Agreement references chloride only.

16
17 **Opinion 4: The water quality degradation caused by WaterFix will impact the City’s**
18 **operations.**

19 When water at the City’s intake is too saline, the City must purchase water from
20 Contra Costa Water District (CCWD) either to replace water that cannot be diverted at
21 the City’s intake or to provide fresh water for blending with water that is diverted from the
22 City’s intake but is too saline to use alone. My analysis of DWR’s model results shows
23 that as a result of the increase in salinity at Antioch’s intake, the City will need to
24 purchase water more often after implementation of the WaterFix Project. My calculations
25 show that over the expected 50-year life of the project, the City would need to spend at
26 least \$ 46 million under Scenario B1 (relative to existing conditions, and expressed in
27 2016 dollars). Expenditures would be greatest in a future year similar to 1987, the
28 simulation year in which the greatest quantity of additional water would need to be

1 purchased by the City; in this year, the City's expenditures would increase for Scenario
2 B1 relative to the existing condition by \$ 2 million.

3 Although certain advanced water treatment processes can remove or enhance the
4 removal of bromide from drinking water supplies (e.g., membrane filtration,
5 electrochemical removal, adsorption), the City's water treatment plant does not currently
6 employ these processes. The City has been working with engineers to estimate the cost
7 of such a treatment facility, and the preliminary information available to the City indicates
8 that a treatment plant with a 6-8 mgd treatment capacity would have a capital cost on the
9 order of \$ 150 million.

10
11 **Opinion 5: Compliance with water quality standards is likely to become more**
12 **challenging in the future, and WaterFix will degrade water quality at the City's**
13 **intake.**

14 DWR's model results show that the proposed WaterFix Project can be expected to
15 lead to increased difficulty in complying with water quality and flow criteria in the Delta.
16 Compliance under existing conditions is already challenging, as indicated by the recent
17 issuance of orders in response to Temporary Urgency Change Petitions (TUCPs) by the
18 State Water Board, and sea level rise is likely to make compliance more challenging in
19 the future.

20 My analysis of DWR's model results shows WaterFix operations will result in
21 additional exceedances of with D-1641 Water Quality Objectives for chloride for
22 municipal and industrial beneficial uses relative both to existing conditions and to the
23 NAA (future no project) scenario. For example, D-1641 provides a water quality objective
24 for chloride of 250 mg/L, expressed as a maximum mean daily limit, to be met at all times
25 at a number of locations within the Delta. My analysis indicates that this threshold will be
26 exceeded at Contra Costa Pumping Plant #1 more frequently under WaterFix Scenario
27 B1 than under either the existing condition or the NAA. For example, Scenario B1 would
28 exceed this threshold for 124 days in 1989 and for 117 days in 1991; in contrast, the

1 existing condition would exceed this threshold for 77 and 76 days in 1989 and 1991,
2 respectively.

3 D-1641 includes water quality objectives for municipal and industrial beneficial
4 uses of 150 mg/L, to be met at either Contra Costa Pumping Plant #1 or at the City of
5 Antioch's intake location. D-1641 specifies that the "maximum mean daily" chloride
6 concentration of 150 mg/L must be met for a specific number of days during the calendar
7 year, to be provided in "intervals of not less than two weeks duration." DWR does not
8 assess compliance with this objective at Antioch's intake, preferring instead to evaluate
9 compliance with this objective at Pumping Plant #1, which is less subject to the influence
10 of salinity from San Francisco Bay. Nonetheless, it is instructive to evaluate salinity at
11 Antioch's intake relative to this objective. This threshold is rarely met at Antioch's intake
12 (in only 3 of 16 years under existing conditions, and in only 1 of 16 years for the NAA and
13 B1 model scenarios); in addition, the number of days above this threshold is predicted to
14 increase substantially for Scenario B1 relative to both the existing condition and the NAA.

15 Finally, DWR proposes to re-interpret the export-to-inflow (E/I) ratio requirements
16 of D-1641 such that the amount of water exported from the new WaterFix intakes on the
17 Sacramento River would not be included in the calculation of exports or inflows. This
18 calculation change would have the effect of removing an important control on the amount
19 of water exported from the Delta. My analysis of DWR's modeling shows that
20 exceedances of the existing E/I objective (calculated using total exports and total inflows)
21 will occur more frequently in the future under Scenario Boundary 1. Taken together,
22 DWR's model results indicate that the WaterFix Project, particularly Scenario Boundary
23 1, will degrade water quality within the Delta.

24

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

28 Based on my experience and in consideration of the information presented by the

1 petitioners, it is my opinion that the modeling and analysis presented by petitioners is not
2 a sufficient or reasonable basis for assessing the impacts to water quality that will occur
3 at the intake operated by the City of Antioch (a municipal drinking water supplier). As
4 detailed throughout this report, there is a wide range in the potential operations of the
5 proposed WaterFix Project and significant uncertainty in how those operations will be
6 modified over time. Petitioners have stated that Scenario Boundary 1 (B1) should be
7 used as the basis for evaluating impacts to water users in the Delta. My analysis of
8 operations Scenario B1 indicates that significant deterioration of water quality can be
9 expected to occur at the City's intake as a result of the implementation of the WaterFix
10 Project.

11 Executed on August 31, 2016 in Pasadena, CA.

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15 _____
16 Susan Paulsen
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