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BEFORE THE CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

IN THE MATTER OF

CALIFORNIA DEPARTMENT OF WATER RESOURCES AND UNITED STATES BUREAU OF RECLAMATION FOR A PETITION FOR CHANGE FOR CALIFORNIA WATERFIX	TESTIMONY OF PRAVANI VANDEYAR (EXHIBIT CITY SAC - 6)

I, Pravani Vandeyar, do hereby declare:

INTRODUCTION

1. I am employed as the Water Quality Superintendent for the Department of Utilities of the City of Sacramento (Sacramento). I hold a Bachelor of Science and Master of Science in Chemistry. I have worked as a scientist in research and analysis, drinking water quality, drinking water treatment, and regulatory compliance since 1996. A true and correct copy of my resume is attached to this written testimony as Exhibit City Sac - 7. My resume accurately describes my education, professional registration, and work experience.

2. My testimony provides background on Sacramento's water quality and treatment processes as well as the potential for the proposed California WaterFix project to cause injury to Sacramento, as a legal user of water. The limited analysis provided by Petitioners for this proceeding regarding impacts on Municipal and Domestic Supply (MUN) water quality upstream of the Delta indicate that Sacramento's MUN source water quality has the potential to be adversely impacted, which in turn impacts Sacramento's treated drinking water supply. The

proposed California WaterFix project has the potential to cause material adverse impacts on Sacramento's source water quality and hence MUN supply.

3. When I refer to the California WaterFix, I am referring to the project set forth in this proceeding arising from the Petition for Change submitted on or about August 25, 2015 by the California Department of Water Resources (DWR) and the United States Bureau of Reclamation (Reclamation), which I refer to at times as the Proposed Project.

BACKGROUND

4. Sacramento's E.A. Fairbairn Water Treatment Plant (EAFWTP) uses the Lower American River for MUN supply, consistent with its beneficial use designation. The raw water is treated to meet all drinking water standards using conventional filtration processes with chlorine disinfection. Historically, I am not aware of any constituents or characteristics consistently present in the raw water that necessitate additional or advanced treatment processes. Folsom Reservoir stores water from the upper watershed, which influences the quantity and quality of the water in the Lower American River. My understanding is that water temperature varies greatly by season, with cold water from late fall through spring and warmer water during the summer and early fall, and that turbidity and total organic carbon (TOC) levels in the raw water are relatively low for surface water, and that levels have historically peaked during the winter storm season. The source water level of *E. coli* is primarily impacted by winter storm events and first flush events. The source water quality is evaluated by Sacramento every five years as part of the American River Watershed Sanitary Survey, most recently conducted in 2013 (Exhibit City Sac - 25).

5. Sacramento's Sacramento River Water Treatment Plant (SRWTP) uses the Sacramento River for MUN supply, consistent with its beneficial use designation. The raw water is treated to meet all drinking water standards using conventional filtration processes and chlorine disinfection. Historically, I am not aware of any constituents or characteristics consistently present in the raw water that necessitate additional or advanced treatment processes. My understanding is that Shasta and Oroville reservoirs store large amounts of runoff from the upper watershed and largely control the flows in the Sacramento and Feather Rivers. The SRWTP is

located just downstream of the confluence with the Lower American River, therefore the source water quality can also be highly influenced by the Lower American River. My understanding is that the water quality trends are similar to the American River, but with higher levels of solids loading, increased organic, bacterial, and metals content, and warmer water temperatures. The SRWTP intake is approximately 650 feet upstream of the 'I' Street Bridge, which I understand is the furthest upstream legal boundary of the Delta on the Sacramento River. The source water quality is evaluated by Sacramento every five years as part of the Sacramento River Watershed Sanitary Survey, most recently conducted in 2015 (Exhibit City Sac - 26).

6. The SRWTP and EAFWTP must comply with all federal and state primary and secondary drinking water standards, including the Surface Water Treatment Rules and Disinfectant/Disinfection By-Products Rules. These are all described in the California Code of Regulations (Title 22, Division 4, Chapters 15 through 17.5). Also, California Notification Levels and Archived Advisory Levels, as shown on the Division of Drinking Water (DDW) website[1], must be met if any of the constituents regulated by these standards are detected in the source water. For detectable constituents with no regulatory threshold, such as cyanotoxins, Sacramento must consider compliance with USEPA Health Advisories[2], if they exist, or other human health guidance values for drinking water. The SRWTP and EAFWTP are conventional filtration drinking water treatment plants as described in the direct testimony of James Peifer, P.E., Principal Engineer at the City of Sacramento Department of Utilities. (Exhibit City Sac - 1.)

7. Sacramento's treated water demands vary seasonally, as described in the direct testimony of James Peifer, P.E., Principal Engineer at the City of Sacramento Department of Utilities. (Exhibit City Sac- 1.) Water demands begin to increase in late spring, with peaks during summer, and demands taper off in the fall with timing dependent on rainfall. (Exhibit City Sac- 1.)

[1] http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/NotificationLevels.shtml
[2] http://www.epa.gov/dwstandardsregulations/drinking-water-contaminant-human-health-effects-information

8. Specialty water quality investigations were conducted by Sacramento in 2015 and 2016 regarding unusual water quality conditions in the source water related to drought conditions. This included evaluation of several phenomena that can be related to increased water temperature, lower river flows, and higher mean residence time, including treated water disinfection by-product (DBP) formation, presence of blue-green algae (also known as cyanobacteria), and presence of cyanotoxins (which can be released by cyanobacteria). Sacramento did not identify the presence of algal toxins in 2015, but did have low level detects of microcystin and anatoxin in the source water in 2016. In addition, algal concentrations were higher than historic levels and present at levels sufficient to complicate operation and maintenance at the water treatment plants and necessitate special efforts to ensure protection of public health in consultation with DDW. Based on my training and experience, algae, including cyanobacteria, can cause numerous complications to a MUN supply, including: taste and odor concerns, acute health impacts, increased organic carbon levels, and interference with treatment processes (such as filter clogging and increased disinfection requirements).

IMPACTS TO WATER QUALITY AT CITY OF SACRAMENTO INTAKES

9. As discussed in the direct testimony of Bonny L. Starr, P.E. (Exhibit City Sac - 8), a designated water quality expert for Sacramento, two key potential water quality impacts exist to Sacramento's MUN water supply from the Proposed Project's NDD Intakes operation:

- Reservoir operation changes causing increased source water temperatures contributing to blue-green algae growth in the source water and treated water DBP formation, and
- Increases in residence time/water column stability caused by changing river flows and associated lower river velocities, resulting in increased presence of blue-green algae in the source water.

Evidence of Impacts to Water Quality in the BDCP and Draft EIR/EIS

10. The operation of the Proposed Project's NDD Intakes on the Sacramento River near Clarksburg will necessitate different Sacramento River inflows to the Delta at different times of the year to meet downstream water quality objectives. My understanding is that operational scenarios H3 and H4 include higher spring or fall outflows from the Delta (Draft EIR/EIS

Chapter 3.6.4.2), including the Sacramento River system inflows. Higher spring outflow from the upstream reservoirs as part of Operational scenarios H2 and H4 is projected to result in lower reservoir storage in the Sacramento Valley and downstream river flows through the summer and fall months as compared to Existing Conditions[3]. The BDCP and Draft EIR/EIS documents show that under some of the NDD intake proposed operational scenarios there are significant increases in water temperature and reductions in river flow (discussed in the direct testimony of Bonny Starr [Exhibit City Sac - 8]), over longer periods of time. These changes can cause conditions that increase the presence of blue-green algae in the MUN supply for Sacramento's intakes and increased levels of treated water DBPs.

Temperature Effects and Impacts on MUN Supply

11. I am not aware of the Proposed Project evaluating impacts on water temperature for MUN which is a significant error because temperature is a key driving water quality constituent to the MUN beneficial use, affecting source water quality, drinking water treatability, and treated water quality. Even small increases in water temperature can impact MUN uses by altering source water quality (such as increasing pathogen or algal growth), changing treated water quality (such as accelerating DBP formation), and impacting treatment facilities (such as altering existing processes or potentially requiring additional or alternative processes). Without such analysis the Proposed Project proponents cannot demonstrate that operation of the NDD Intakes will not injure Sacramento's MUN water quality and supply.

12. The chart of the raw water temperature at the EAFWTP on the Lower American River and the storage volume of Folsom Reservoir from 2010 through 2015 shows that as reservoir storage volume decreases, the downstream water temperature increases significantly (Exhibit City Sac - 27). Lower reservoir levels resulted in water temperatures greater than 20°C in the summer and fall at the EAFWTP. The figure shows that when Folsom Reservoir storage levels were much lower, and potentially representative of lower storage levels which will result

[3] BDCP/California Water Fix RDEIR/SDEIS Appendix A, Chapter 5, Section 5.3.3, Page 5-22, Table 5-7

from the NDD Intakes operation, the frequency of temperature samples greater than 20°C was much higher. The chart of the raw water temperature at the SRWTP on the Sacramento River and the percent of storage volume of Shasta, Oroville, and Folsom reservoirs from 2010 through 2015 shows a similar trend (Exhibit City Sac - 28). I understand the peak temperatures to have been even higher (up to 28°C) and lasted even longer, more than six months.

13. In October 2015, Sacramento, along with several other Sacramento River drinking water utilities, had a Technical Memorandum prepared by Palencia Consulting Engineers on Cyanotoxins in the Sacramento River Watershed (Exhibit City Sac - 29) at the request of the DDW. The memorandum presents information on the potential presence and risk of cyanobacteria, and possibly cyanotoxins, in the Sacramento River watershed. It was noted that water temperatures below 15°C, or 59°F, are not conducive to significant growth of algae and cyanobacteria, and temperatures above 20°C, or 68°F, can result in strong growth. The presence of algae and cyanobacteria are of concern for drinking water safety because they are a source of organic carbon in the water as well as a source of cyanotoxins. In June 2015, when upstream storage had decreased significantly and water temperatures increased, the SRWTP developed algae in the grit basin so monitoring was conducted to determine the species, which included identification of *Anabaena* (a cyanobacterium). Additional monitoring was conducted to verify the presence of cyanotoxins (Anatoxin, Microcystin, and Cylindrospermopsin). Due to increased source water algae levels through the summer and fall months, cyanotoxin monitoring was completed at both SRWTP and EAFWTP from August through November 2015 (Exhibit City Sac - 30). None were detected. Additional data was collected in 2016 (Exhibit City Sac-30) when similar hydrologic conditions occurred, and there were low level detects of anatoxin a in the Lower American River in July and August 2016 and low level detects of microcystin YR in the Lower American River and Sacramento River in August 2016. The above-described conditions that generated the algae, and associated cyanotoxins, are of major concern for water quality to utilities providing drinking water such as Sacramento.

14. An increase in water temperature, and the resultant increased disinfection byproduct reaction rates, necessitates an increase in chlorine feed to oxidize matter in the source

water and ensure sufficient residual chlorine in the treated water. Increased disinfection byproduct reaction rates result in increased treated water levels of DBPs (of concern are total Trihalomethanes [TTHM] and haloacetic acids [HAA5]) as described in Integrated Design of Water Treatment Facilities.[4] Disinfection kinetics and disinfection by-product formation are complex, including temperature as a driving factor, as described in the World Health Organization Environmental Health Criteria 216 for Disinfectants and Disinfection Byproducts, Chapter 2 (Exhibit City Sac - 31). The American River Watershed Sanitary Survey 2013 Update - Section 3 (Exhibit City Sac - 25) investigated impacts of water temperature increases at Folsom Reservoir on treated water DBP levels for a local water agency, San Juan Water District, and found that a 5˚F increase in water temperature resulted in a treated water TTHM average increase of 37 percent and a treated water HAA5 average increase of 20.6 percent.

15. As described in the direct testimony of Bonny Starr (Exhibit City Sac - 8) the Proposed Project includes changes to reservoir storage operations and subsequent changes to downstream river flows, especially in the summer and fall, which will result in increased water temperatures in the Sacramento and American River in the vicinity of Sacramento's intakes. The increased temperature and reduced flows would result in conditions that support increased algae and cyanobacteria in the source water. Increased temperature will also cause increased formation of DBPs in the treated water. Both the presence of algae or cyanobacteria and potential for increased levels of DBPs in treated water would alter the water quality at Sacramento's intakes materially, resulting in impacts to the treatability of Sacramento's MUN supply from the Sacramento and American Rivers.

Residence Time Effects and Impacts on MUN Supply

16. Residence time effects were presented in the BDCP (Chapter 5.3.3.2 and Appendix 5C.5) as modeled by the DSM2 Particle Tracking Model, but the information provided was largely limited to those impacts identified in the Delta (since the model does not include

[4] Susumu Kawamura, *Integrated Design of Water Treatment Facilities* (New York, New York: John Wiley & Sons, Inc., 1991), 518-520.

areas upstream of the Delta) and were based upon the original BDCP project. North Delta impacts presented in the BDCP are in the area located closest to Sacramento's intakes. As discussed in the direct testimony of Bonny Starr (Exhibit City Sac - 8) the BDCP determined that the longest residence times are in the summer/fall[5] and the analysis also noted that under the high outflow scenario (HOS), which represents Delta outflow conditions similar to the high spring outflow that is identified in California WaterFix[6], there was a 10 percent increase in the average residence time difference for the North Delta region[7].

17. An increase in residence time is important to the water quality of the MUN supply because it represents reduced water velocity and increased stability of the water column, each of which contributes to the increased growth potential for algae and cyanobacteria. Increases in residence time in the North Delta region may result in propagating impacts up the Sacramento River to Sacramento's MUN supply.

Evidence of Impacts to Water Quality in the California WaterFix and RDEIR/SDEIS

18. The RDEIR/SDEIS Section 4 presents additional model results for Alternative 4A in the Early Long Term (ELT) for operational scenarios H3 and H4. Hydraulic data includes reservoir storage and downstream river flows. New information was provided regarding potential *Microcystis* impact to the MUN use in the Delta in Revisions to the Draft EIR/EIS Chapter 8, but not to the upstream areas. The RDEIR/SDEIS asserts that hydrodynamic conditions of upstream rivers are not conducive to bloom formation (Section 8.1.3.18). However, based on real data and conditions at Sacramento intakes this assertion is incorrect (also discussed in the direct testimony of Bonny Starr [Exhibit City Sac - 8]).

19. Through its effects on water temperature and residence time in Sacramento's source waters, the Sacramento and American Rivers, operation of the Proposed Project's NDD Intakes will exacerbate the risk of hazardous cyanobacteria and elevate costs associated with

[5] BDCP, Appendix 5C, 5C.5.4.4.1, page 5.C.5.4-83, lines 21-23
[6] BDCP, Appendix 5C, 5C.0, pages 5C.0-1 through 5C.0-3
[7] BDCP, Appendix 5C, 5C.5.4.4.2, page 5.C.5.4-90, lines 5-8

treatment and maintenance caused by other algae and aquatic macrophytes. These impacts are discussed later in this testimony.

Temperature Effects and Impacts on MUN Supply

20. There was no supplemental evaluation provided for temperature impacts on the MUN beneficial use in the California Water Fix or RDEIR/SDEIS. The RDEIR/SDEIS acknowledges the key drivers for *Microcystis* as water temperatures greater than 19°C, low water velocities, and high water clarity. (RDEIR/SDEIS, *p. 8-45)*

21. Temperature in the Sacramento and American Rivers at the EAFWTP and SRWTP intakes was discussed previously, and can exceed 20˚C during the summer and fall. The data review presented in the direct testimony of Bonny Starr (Exhibit City Sac - 8) indicates that the frequency and duration of water temperatures exceeding 20˚C at both EAFWTP and SRWTP is strongly influenced by upstream reservoir storage. California Water Fix, through operation of the NDD Intakes, will result in reservoir storage pattern and volume changes, and river flow changes, especially in the late summer and fall period. Reduced upstream reservoir storage during this period will contribute to longer periods of temperature exceeding 20˚C in the vicinity of Sacramento's intakes and extend periods of increased risk of *Microcystis* growth in the vicinity of the EAFWTP and SRWTP intakes.

Residence Time Effects and Impact on MUN Supply

22. Information about NDD intakes effects on mean residence time in the Delta is presented in the RDEIR/SDEIS Section 8 in the context of the Proposed Project's potential to increase the geographic extent and abundance of the hazardous cyanobacterium *Microcystis*. The data review presented in the direct testimony of Bonny Starr (Exhibit City Sac - 8) indicates that increases in mean residence time in the North Delta would occur year-round, with significant increases in the fall. The SRWTP intake is immediately upstream from the North Delta boundary, and would likely be affected by this residence time increase. Increases in residence time in the North Delta increases the probability that *Microcystis* blooms may occur upstream in locations

where resulting cyanobacteria, or their cyanotoxins, could enter the SRWTP and/or EAFWTP intakes.

INJURY TO SACRAMENTO CAUSED BY CALIFORNIA WATERFIX

23. I have utilized my training and experience to evaluate the pending Petition for Change to implement the California WaterFix in this proceeding. Based upon my training and experience, coupled with my review of material related to this proceeding, I am concerned that implementation and operation of the Proposed Project will injure Sacramento in one or more ways. Overall, the Proposed Project's NDD Intakes potential operation will result in changes to reservoir storage operations and changes to downstream river flows, especially in the summer and fall. The summer and fall are currently the period of highest water temperature at the EAFWTP and SRWTP and typically exhibit the lowest flows in the Sacramento and American Rivers. This is also the period of maximum water demand requiring highest production from both water treatment plants. The Proposed Project environmental documents show that storage at Shasta, Oroville, and Folsom reservoirs will be reduced more frequently to lower volumes in the summer and fall. River flows in the Sacramento, Feather, and American Rivers also are projected to be lower more frequently in the summer and fall.

24. Reductions in reservoir storage volumes and river flows will result in injury to Sacramento by impacting the water quality of the American and Sacramento River source waters. The three major categories of injury are reduced availability of sufficient source water quality; increased operation and maintenance costs to treat water to potable standards; and costs associated with installation of new capital improvements as targeted treatment technologies.

Reduced Availability of Sufficient Source Water Quality

25. Projected reductions in storage volume and river flow caused by operation of the Proposed Project will increase water temperature and residence time in the rivers downstream of the major reservoirs, including the Sacramento and American Rivers in the vicinity of Sacramento's intakes.

26. Increased water temperatures in the summer and fall will cause water quality impacts at Sacramento's drinking water treatment plants in two significant ways: increased presence of algae (which is organic matter and may potentially include cyanobacteria) and increased rate of disinfection byproduct reaction kinetics leading to increased levels of DBPs in the treated water.

27. Increased residence time in the North Delta region, which reflects reduced water velocity and increased stability of the water column, has the potential to propagate upstream to Sacramento's intakes. Similar to increases in water temperature, increased residence time also contributes to the increased growth potential for algae, potentially including cyanobacteria.

28. An increased frequency of algae blooms, including cyanobacteria such as *Microcystis,* in the fall and summer at the EAFWTP and SRWTP intakes would have a direct impact on Sacramento's available periods of adequate quality supply water. Since pre-chlorination can make the presence of cyanotoxins worse in treated water, Sacramento would need to further investigate and monitor the treated water to verify levels. If cyanotoxins could not be removed to levels below the USEPA Health Advisories, Sacramento would need to evaluate the continued use of the source water during the algae bloom. Since the summer and fall are peak demand periods, it could be very difficult for Sacramento to meet system demands without one or both of its surface water treatment plants. Thus, the water quality impact becomes a water supply impact.

29. Increased water temperature and increased algae, thus organic carbon, in the source water in the summer and fall months both contribute to increased DBP formation potential in the treated water. This could reduce the ability of the City to utilize the surface water during seasonal periods and continue to meet DBP regulations using current treatment processes, thus causing a water supply impact.

Increased Operations and Maintenance Costs

30. An increased frequency of algae blooms, including cyanobacteria such as *Microcystis,* in the fall and summer at the EAFWTP and SRWTP intakes would have direct

impacts on Sacramento's monitoring requirements and treatment required. If the source water quality degrades and/or changes significantly, Sacramento may need increased monitoring or enhanced treatment to meet federal and state drinking water quality standards and protect public health.

31. If any cyanobacteria were detected in Sacramento's MUN supply from the American or Sacramento River, due to Proposed Project caused water quality and hydraulic conditions (warm water and low flows), then additional monitoring would need to be conducted to verify the potential presence of cyanotoxins in the water. This would increase laboratory costs.

32. Factors increasing the risk to Sacramento's MUN water supply from *Microcystis* (lower river flows and increased residence time, higher temperatures), are also factors that will favor growth of phytoplankton, benthic algae (which drift), and floating macrophytes. Macrophyte and algae removal from Sacramento's intakes and treatment plants incurs incremental costs to Sacramento through increased intake maintenance, increased disinfectant dosing, increased filter cleaning, and increased solids removal, handling, and disposal. Decreased river flows and source water quality will result in increased intake screen biofouling and the need to clean the intake screens, using divers. This will increase operations and maintenance costs. Decreased source water quality will require Sacramento to evaluate, and possibly increase, its need and usage of coagulants, polymers, and other chemicals used in the treatment process. This may increase operations and maintenance costs. Decreased source water quality from algae blooms would require Sacramento to increase in-plant management by increasing chlorine disinfection and filter backwashing procedures. This would increase operations and maintenance costs. Decreased source water quality, from increased solids loading or algae blooms, will result in the need for additional processing of residual solids, trucking, and landfill utilization. This will increase operations and maintenance costs.

New Capital Improvement Costs

33. Both the SRWTP and EAFWTP are conventional filtration plants with chlorine disinfection. The selection of treatment processes is based on historic and current source water

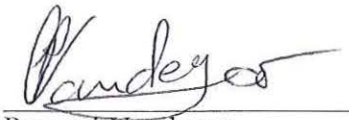
quality. The facilities are not designed to address specialty contaminants, such as cyanotoxins, or waters with high levels of temperature or organic carbon.

34. An increased frequency of algae blooms, including cyanobacteria such as *Microcystis,* in the fall and summer at the EAEAFWTP and SRWTP intakes would have the following direct impacts on the City's treatment required. Cyanobacteria, and their associated cyanotoxins, have variable treatment effectiveness as described in the Cyanotoxins in the Sacramento River Watershed Technical Memorandum (Exhibit City Sac - 29). The effectiveness of conventional filtration depends on the cellular nature of the cyanotoxins (intracellular versus extracellular). There is significant risk of pre-chlorination to cyanotoxin presence, since the chlorine breaks open the bacteria cells and releases the cyanotoxins, so it is discouraged from use during blooms. Currently Sacramento implements pre-chlorination at both the EAFWTP and SRWTP. This would need to be revised to an alternate disinfectant strategy if algae blooms became regular or more frequent. This may require Sacramento to plan, construct, and operate new disinfection facilities.

35. Increased water temperature and increased algae, thus organic carbon, in the source water in the summer and fall months both contribute to increased DBP formation potential in the treated water. The increases in these factors could lead to longer periods of high DBP formation, which may result in higher compliance values. If compliance values approach the drinking water standards for DBPs, then Sacramento would need to investigate the necessity of implementing an alternative disinfection strategy at its water treatment plants, and potentially its entire water supply system, to ensure that standards are met and public health is protected. Sacramento has considered future addition of intermediary alternative disinfection, such as UV or ozone, as a primary disinfectant. The conversion to an alternate primary disinfectant would require significant capital costs for the construction of new plant facilities and increased operation and maintenance costs. Implementation of an alternative disinfection strategy would require careful evaluation and planning to prevent distribution system water quality issues for Sacramento and its wholesale agencies. Depending on the water quality impacts, other pre-

oxidants and secondary disinfection alternatives may need to be considered.

Executed on this 31st day of August, 2016 in Sacramento, California.



Pravani Vandeyar