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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	SUR-REBUTTAL TESTIMONY OF BONNY L. STARR (EXHIBIT CITYSAC-36)

I, Bonny L. Starr, do hereby declare:

INTRODUCTION AND SUMMARY

1. I am a registered Civil Engineer with the State of California. I have worked as a consulting engineer in source water protection, drinking water quality and drinking water treatment since 1994. I offer my testimony in this proceeding on behalf of the City of Sacramento (Sacramento). A true and correct copy of my resume was previously submitted as Exhibit CITYSAC-9.

2. For the sur-rebuttal phase of Part 1 of this hearing, I was asked to evaluate testimony and exhibits offered by the California Department of Water Resources (DWR) during the rebuttal phase of Part 1 of this hearing relating to Sacramento's testimony, specifically including exhibits offered by Dr. Michael Bryan identified by DWR as Exhibits DWR-81, -33, -8, -8 Errata and -651 and exhibits offered by Doug Owen and identified as Exhibits DWR-82, -15, and -9. My written testimony for sur-rebuttal is limited in scope and nature to address only my most significant concerns.

3. I appreciate that DWR has performed some evaluation of the potential impacts to the drinking water users upstream of the Delta during the rebuttal phase of this hearing, as reflected in Dr. Michael Bryan's testimony. Sacramento's case-in-chief presented evidence relative to increases in cyanobacteria presence and disinfection by-product (DBP or DBPs) formation potentially resulting from source water temperature increases and hydrodynamic changes in river flow caused by operations of the California Water Fix ("CWF" or the "Proposed Project"). As I read Dr. Bryan's testimony, it challenges Sacramento's testimony as to the degree of risk or potential harm to Sacramento's water quality, rather than demonstrating that the Proposed Project does not present any risk or potential harm to Sacramento.

4. As more particularly described below, I disagree with the opinions on these topics presented by Dr. Bryan in his rebuttal testimony (DWR-81), and I affirm my prior testimony with regard to potential impacts to Sacramento's Water Treatment Plants (WTPs) related to the presence of cyanobacteria and DBP levels. Having reviewed Exhibit DWR-651, which is used to support his testimony, I am not persuaded by Dr. Bryan's testimony for the reasons noted in my testimony that follows. My opinions are based on my extensive experience dating back to 1994 with drinking water quality and treatment impact assessments. Dr. Bryan's background does not include drinking water quality or treatment impacts assessments.

5. Despite my overall disagreement with Dr. Bryan's conclusions and opinions, which is presented in the testimony that follows this paragraph, my review of Dr. Bryan's testimony and supporting documents reveals several areas of agreement. First, there is a general lack of scientific understanding on the cause of proliferation of cyanobacteria in the Sacramento / American River systems that could lead to the presence of cyanotoxins at levels of concern (DWR-651, p.3, 4th paragraph). Second, water temperature and velocity are critical drivers of cyanobacteria presence and DBP formation potential (DWR-651, p.3, bullets 1 and 2 and p.32, second paragraph). Third, flow can be used as a surrogate for velocity (DWR-81, page 9, lines 8-9, 21-22). Fourth, critical impacts for both cyanobacteria presence and DBP formation potential occur in the period May through October (DWR-651, page 9, fourth paragraph and DWR-81, page 5, lines 11-14). Finally, there are projected to be increases in temperature (DWR-651,

Appendices A and B) and reduction in velocity/flow (DWR-651, page 10, Table 1 and page 20, second paragraph) in the Lower Sacramento and Lower American rivers in the vicinity of Sacramento's WTPs under some of the CWF alternatives.

6. As more particularly described below, I disagree with Mr. Owen's rebuttal testimony (DWR-82), and I also affirm my prior testimony. I am not persuaded by Mr. Owen's testimony because his evaluation approach applies a theoretical model and theoretical predictions rendering unrealistic predictions of potential impact of temperature changes on Sacramento's DBP formation potential. I further disagree with Mr. Owen's testimony because real data is available and demonstrates actual increases in DBP levels in Sacramento's system for a 1.5°F increase in water temperature that are significantly higher than theorized by Mr. Owen's testimony.

COMPARISON POINTS

7. A key difference between my evaluations and Dr. Bryan's evaluations is the comparison point for determining the significance of effects or potential impacts of the Proposed Project. Dr. Bryan's testimony focuses on comparison to the modeled No Action Alternative (NAA), which is the projected water quality and conditions 10-15 years from initial planning, or 2020-2025. My testimony focuses on comparison to real-time, or existing, conditions. I chose to use real-time data and existing conditions because I believe real water quality data from 2014-2017 is more likely to represent comparable conditions in 2020 than those that are modeled projections from 2010.

TEMPERATURE AVERAGES

8. Dr. Bryan's testimony and supporting documents present a discussion on the potential effects of water temperature at Sacramento's WTPs. However, this discussion, which relies on the USBR Temperature Model, is flawed because that data provides mean monthly temperatures and temperature impacts for the Sacramento River at Knights Landing, which does not include the Feather or American River impacts seen at Sacramento's WTPs, nor is there any characterization of the frequency and duration of peak temperatures (such as those greater than

19°C that may lead to algal blooms). A mean monthly temperature is insufficient in determining temperature impacts for cyanobacteria growth and DBP formation, since cyanobacteria only need 1.5 to 5.2 days to double (as noted in DWR-651, p. 4, first paragraph), and DBP samples are collected on one day. For these reasons, consideration of short term temperature peaks is more relevant and informative than considering mean monthly temperatures.

9. The use of modeling projections at Knights Landing, near River Mile 90, does not include the impacts caused by the Feather River (Oroville) and American River (Folsom) influences which may potentially be significant related to temperature impacts in the summer and fall months at Sacramento's WTPs (CITYSAC-8, page 15, lines 21-25).

10. The evaluation presented in DWR-651 focuses on a comparison of modeled mean monthly temperatures for cyanobacteria presence and average annual temperatures for DBP formation, not a review of discrete water temperatures including peaks and durations of occurrence, and therefore does not sufficiently evaluate the potential temperature impacts to cyanobacteria presence and DBP formation caused by operation of CWF.

11. Dr. Bryan's use of an annual average temperature in determining the relative scale of temperature impact on DBP formation is incorrect. Disinfection kinetics are defined through multi-parameter, exponential equations. The use of an average annual temperature does not correctly account for seasonal peaks in temperature, as well as other relevant conditions to DBP formation, and the quarterly nature of DBP compliance calculations. Also, the models referenced and used in the prediction of Trihalomethanes (TTHM) increases were inappropriately applied; and no calculations or clarifications were presented with regard to which equations were used from each study, and which site-specific assumptions were made by Dr. Bryan for Sacramento's WTPs and distribution system in calculating TTHM concentration increases. In my opinion, for the reasons noted above, Dr. Bryan's analysis did not provide a "reasonable estimate" of temperature effects on Sacramento's DBP formation.

12. Mr. Owen's testimony focuses on providing an opinion on the impact of a 1°F increase in water temperature on DBP formation at Sacramento's WTPs. Mr. Owen presents selected DBP information obtained from Sacramento's Consumer Confidence Reports (CCRs)

and then applies a theoretical model to obtain a predicted percentage change in levels of TTHMs and haloacetic acids (HAA5). His theoretical predictions show a maximum increase of 2.3 percent for TTHMs and 1.3 percent for HAA5 for a 1°F increase in water temperature, which he states would not result in compliance issues for Sacramento. As part of my evaluation of Mr. Owen's approach, I obtained the average annual surface water temperature at Sacramento's WTPs for each of the years cited (CITY SAC-37). Between 2012 and 2013 the maximum locational running annual average (LRAA) for TTHM increased 6 ug/L (from 57 to 63 ug/L), or 10.5%, and the maximum LRAA for HAA5 increased 8 ug/L (from 26 to 34 ug/L), or 30.7%. The annual average temperature was 61.7°F in 2012 and 63.2°F in 2013, for an increase of 1.5°F. It also should be noted, as per the CCRs referenced by Mr. Owen, that there was a significant reduction in average TOC between the two years, over 30 percent (1.9 mg/L to 1.3 mg/L), which eliminates TOC levels as a potential causative variable. DBP increases were also seen over the other years as water temperatures continued to increase, but TOC levels remained stable. These actual increases in DBP levels in Sacramento's system (10.5%/30.7%) for a 1.5°F increase in water temperature are an order of magnitude greater than those predicted by Mr. Owen with the theoretical models (2.3%/1.3%) for a 1°F increase in water temperature. These results, based on actual data, indicate that Mr. Owen's theoretical modeling insufficiently predicts the potential impact of temperature changes on Sacramento's DBP formation potential.

FLOW AND VELOCITY AT SACRAMENTO'S WATER TREATMENT PLANTS

13. Dr. Bryan's testimony and supporting documents present a discussion on the potential effects of water flow and velocity at Sacramento's WTPs. No velocity evaluation in the vicinity of Sacramento's WTPs was originally presented in the BDCP, DEIR/EIS, RDEIR/SDEIS, or FEIR/EIS. The use of DSM2 to estimate velocity in the Sacramento River at RM 58 in DWR-651 provides general estimates on average velocity, but assumes a constant river cross-section which does not account for areas of asymmetrical bathymetry which could result in localized areas of lower velocity. As such, Dr. Bryan's water flow and velocity analysis is generalized, and in my opinion it is an oversimplification and potentially inaccurate to extrapolate

general estimated velocity based on constant river cross-sections, which do not exist throughout the entire system, to support Dr. Bryan's specific conclusion as to velocity at Sacramento's WTPs.

14. Particularly absent in Dr. Bryan's testimony is the fact that in June, July and September of drought years and September of all years there are CWF alternatives that have lower daily maximum velocity than the NAA and most are below 1.25 fps (DWR-651, p.10, Table 1). Also, some scenarios show daily maximum velocity <1.25 fps up to 10-15 percent more frequently than the NAA (DWR-651, pages 11-18, Figures 1-12), which is 3-5 days per month and enough time for cyanobacteria to bloom. The analysis on the American River relied on the use of flow as a surrogate since no velocity data was available. Dry and critical years show increased frequency of flows less than 1,000 cfs in CWF alternatives as compared with the NAA, most pronounced in June through September (DWR-651, p. 20-21 and Appendix C).

15. Finally, while both flow and velocity and temperature effects are assessed, there is no consideration in DWR's rebuttal testimony of the cumulative impact of these effects, which also results in an inadequate identification and evaluation of the real potential impacts to Sacramento's water quality from the Proposed Project.

MODELING AND THEORETICAL PROJECTIONS

16. Dr. Bryan's testimony and the supporting materials are largely predicated on theoretical assumptions to determine the significance of the potential impacts on Sacramento's WTPs. In his testimony, he focuses on the lack of historical detection of cyanobacteria in the Sacramento and American Rivers, which minimizes the actual detects of cyanotoxins at Sacramento's WTPs in 2016 (DWR-81, page 6, lines 27-28). All of his opinions also are based on qualified evaluations, using such terms as "unlikely," "relatively," "similar," and "not necessarily."

17. It is precisely the lack of general scientific understanding of cyanobacteria and related causes of cyanobacteria that makes the actual detections of cyanotoxins critically important to an evaluation of the Proposed Project's potential impacts to Sacramento's WTPs, and theoretical assumptions that fail to account for actual detects are necessarily flawed.

CONCLUSION

18. In summary, I do not agree that the impact of increased cyanobacteria presence on Sacramento's WTPs can be determined by a comparison of the relative frequency of monthly mean temperatures and water velocity/flow as compared to the NAA. This evaluation is flawed as it doesn't account for short periods of high temperature or low flow conditions that support bloom formation (less than three days).

19. Additionally, I do not agree that the impact of temperature on DBP formation at Sacramento's WTPs has been correctly assessed by using average annual temperatures and estimating increases in DBP concentrations using raw water or other site-specific models. This evaluation could not be fully reviewed since calculations and assumptions were not provided in Dr. Bryan's testimony or supporting materials, and it appears flawed since it does not represent site-specific water quality and treatment conditions at Sacramento's WTPs and does not reflect DBP formation at the points of regulatory compliance in the distribution system. Mr. Owen's testimony is significantly contradicted by actual temperature and DBP data for Sacramento's WTPs.

20. Dr. Bryan acknowledges the potential for changes in flow and temperature caused by CWF operations and the potential for increase of cyanobacteria presence and DBP formation (for example, Exhibit DWR-81, pp. 10:26-11:2), which could have subsequent effects on or impacts to Sacramento's WTPs. However, I do not agree with Dr. Bryan's determination that these effects are not potentially significant. It remains my opinion, as stated in my prior testimony and this sur-rebuttal testimony, and based on my extensive experience with drinking water quality and treatment impact assessments, that these potential effects could hinder Sacramento's ability to use the Sacramento and American Rivers for water supply.

Executed on this 9th day of June, 2017 in Sacramento, California.

Bonny Starr

Bonny L. Starr, P.E.

NOTICE OF AVAILABILITY
and
STATEMENT OF SERVICE

CALIFORNIA WATERFIX PETITION HEARING
Department of Water Resources and U.S. Bureau of Reclamation
(Petitioners)

I hereby certify that I have this day submitted to the State Water Resources Control Board and caused a true and correct copy of the following document(s) to be uploaded to the Board's FTP site at https://ftp.waterboards.ca.gov/?u=water fix download&p=waterfix123.

SUR-REBUTTAL TESTIMONY OF BONNY L. STARR **(EXHIBIT CITY SAC-36)**

This Notice of Availability and Statement of Service was served **by Electronic Mail** (email) upon the parties listed in Table 1 of the **Current Service List** for the California WaterFix Petition Hearing, dated May 31, 2017, posted by the State Water Resources Control Board at http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/service_list.shtml:

I certify that the foregoing is true and correct and that this document was executed on June 9, 2017.

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