CSPA-6

G. FRED LEE, PhD, BCEES, F.ASCE
G. Fred Lee & Associates
El Macero, California
530-753-9630
gfredlee33@gmail.com

On Behalf of California Sportfishing Protection Alliance

BEFORE THE

CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

HEARING IN THE MATTER OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND UNITED STATES BUREAU OF RECLAMATION REQUEST FOR A CHANGE IN POINT OF DIVERSION FOR CALIFORNIA WATER FIX	TESTIMONY OF G. FRED LEE

I, G. Fred Lee, do hereby declare:

Overview

The California Department of Water Resources (DWR) and the US Department of the Interior Bureau of Reclamation (USBR) have asserted that the proposed diversion of up to 9,000 cfs of Sacramento River water at the proposed North Delta WaterFix diversion intakes on the Sacramento River will not cause adverse impacts on Delta water quality/beneficial uses. The WaterFix project testimony of Parviz Nader-Tehrani (dwr_66WQ) stated on page 3 lines 11 and 12:

"*The focus of my testimony is on possible changes to water quality and water levels.*"

A critical review of his testimony, however, shows that the consideration of "water quality impacts" of the proposed WaterFix tunnel diversions is very narrowly defined to consider only meeting minimum requirements of D-1641, which focus on salinity (EC) for only part of the Delta. Also modeled was the chloride concentration in a small area of the Western Delta. Explicitly not considered with that limitation is the wide range of existing and potential pollutants that impair the water quality/beneficial uses of substantial areas of the Central Delta and that stand to be impacted by the proposed WaterFix diversions. That limitation in definition of what are considered to be water quality impacts is also not in keeping with the Porter Cologne Water Quality Control Act definitions of water quality and beneficial uses. California State Water Resources Control Board Porter Cologne Water Quality Control Act January 2016

[http://www.waterboards.ca.gov/laws_regulations/docs/portercologne.pdf] defines "water quality" and "beneficial uses" as follows:

> *CHAPTER 2. DEFINITIONS [13050. - 13051.] (Chapter 2 added by Stats. 1969, Ch. 482.) § 13050.[Definitions]*
> *(f) "Beneficial uses" of the waters of the state that may be protected against quality degradation include, but are not limited to, domestic, municipal, agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves.:*
> *(g) "Quality of the water" refers to chemical, physical, biological, bacteriological, radiological, and other properties and characteristics of water which affect its use.*

Furthermore, the California WaterFix – Water Right Change Petition and Water Quality Certification Process (updated July 21, 2016) Fact Sheet [http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/docs/ca_waterfix_factsheet.pdf] included with this testimony as Exhibit CSPA-57 states,

> *"In order for the State Water Board to approve a change petition, the petitioner must: 1) demonstrate that the change will not initiate a new water right or injure any legal users of water; and 2) provide information on how fish and wildlife would be affected by the change and identify proposed measures to protect them from any unreasonable impacts of the change."*

The so-called "water quality impact" evaluation made by the Petitioners does not meet those conditions.

A technically reliable evaluation of potential water quality/beneficial use impairment consequences of the proposed WaterFix project should incorporate the broadest sense of potential adverse impacts. Any impairment of the beneficial uses of Delta waters by people and for fish, and aquatic and terrestrial life needs to be included in the assessment in order to provide greater assurance that water quality/beneficial uses of the Delta will not be adversely impacted by the Delta WaterFix project. Simply asserting that minimum D-1641 requirements will be met is not adequate to provide assurance that water quality/beneficial uses of the Delta will not be harmed.

At the WaterFix petition hearing, several cross-examiners of the DWR/USBR witnesses questioned the fact that the current proposal being considered does not address the broad range of constituents that could be impacted by the proposed WaterFix Sacramento River diversions around the Delta. The response by the DWR/USBR members and their consultants was that those issues are covered in the BDCP draft EIR/EIS. I discussed these issues in comments I submitted on the Bay Delta Conservation Plan (BDCP) Draft EIR/EIS Chapter 8 – Water Quality, Chapter 25 – Public Health document cited below

and incorporated into this testimony as Exhibit CSPA-58.

Exhibit CSPA-58. Lee, G. F., and Jones-Lee, A., "Comments on Bay Delta Conservation Plan (BDCP) Draft EIR/EIS Chapter 8 – Water Quality, Chapter 25 – Public Health, July 25, 2014," Comments submitted as part of comments provided by California Sportfishing Protection Alliance, Stockton, CA to Ryan Wulff, NOAA National Marine Fisheries Service, Sacramento, CA, July 28 (2014). http://www.gfredlee.com/SJR-Delta/Comments_BDCP_draftEIR_EIS_July2014.pdf

My comments included my overall assessment as follows:

"*Overall Assessment*

Overall, the draft BDCP EIR/EIS and approaches used in its development are inadequate in scope and reliability for evaluating the potential impacts of diverting substantial amounts of Sacramento River water around or through the Delta on chemical constituents and water quality in Delta channels. The draft EIR/EIS basically used model output of expected changes in the concentrations of a few water quality parameters … at a few selected locations in the Delta as was done for this draft EIR/EIS. The approach used does not adequately or reliably consider the range of water quality impacts caused by the wide variety of potential pollutants present in the various Delta channels, that can be expected to result from the removal of large amounts of high-quality Sacramento River water from the Delta by this project."

"*An area of the Delta of importance and with which Dr. Lee is particularly familiar is the Central Delta where the Sacramento River mixes with the San Joaquin River below Columbia Cut*."

This area was not adequately evaluated in the Draft EIR/EIS. Additional information on this area is covered in this testimony.

In response to the request for comments on the Water Quality Section of BDCP/California WaterFix RDEIR/RDEIS (*Appendix A – Revisions to the Draft EIR/EIS - Chapter 8 – Water Quality – 508*) [http://baydeltaconservationplan.com/RDEIRS508/Ap_A_Rev_DEIR-S/08_WQ-508.pdf] we also submitted comments to the CA Department of Water Resources (DWR), which provide additional information on this issue. Those comments referenced below are included herein as Exhibit CSPA-59.

Exhibit CSPA-59. Lee, G. F., and Jones-Lee, A., "Comments on the Water Quality Section of BDCP/California WaterFix RDEIR/SDEIS," Comments submitted to CA Department of Water Resources by G. Fred Lee & Associates, El Macero, CA, October 28 (2015). [http://www.gfredlee.com/SJR-Delta/Comments_BDCPWaterFix.pdf]

Those comments discuss the unreliability of the approach used in developing the BDCP

draft EIR/EIS for addressing water quality impacts. Since the evaluation made of "water quality impacts" of the proposed diversion at the North Delta intakes described in the testimony of Parviz Nader-Tehrani (dwr_66WQ) followed the same approach as that described for Alternative 4A in the RDEIR/SDEIS, those comments apply equally well to the proposed diversion of Sacramento River.

My comments on the WaterFix RDEIR/SDEIS and BDCP EIR/EIS Chapter 8 provide additional background and information on potential water quality/beneficial use impacts of the proposed WaterFix tunnel diversion project. They discuss the fact that the draft EIR/EIS and the WaterFix RDEIR/SDEIS documents fail to adequately and reliability discuss the issues that need to be considered in evaluating the potential impacts of the proposed WaterFix Tunnel diversion project.

Summary of Findings

Overall, I find that the assessment made by the CA Department of Water Resources and the US Bureau of Reclamation concerning the water quality/beneficial uses impacts of the Delta WaterFix north Delta diversions of the Sacramento River falls far-short of adequately evaluating the potential impacts of the proposed "WaterFix Tunnel Project" for diverting Sacramento River water around the Delta.

Expertise and Experience

The finding presented in this testimony are based on my more than 50 years of professional experience and my investigations of Delta water quality issues, which is briefly summarized below and in my Summary Resume (Exhibit CSPA-5), and discussed in the document reference below incorporated into this testimony as Exhibit CSPA-60.

> Exhibit CSPA-60. Lee, G. F., and Jones-Lee, A., "Experience in Reviewing Delta Water Quality Issues," G. Fred Lee & Associates, El Macero, CA, April 3 (2011). http://www.gfredlee.com/SJR-Delta/GFLAJL-Delta-EXP-REV.pdf

I have a BA degree from San Jose State University in environmental health Sciences, MSPH from the University of North Carolina Chapel Hill, and a PhD degree in 1960 from Harvard University in Environmental Engineering with minors in water chemistry and public health. I was elected Fellow of the American Society of Civil Engineers in 2009 and selected as the Outstanding Senior Life Member by the Sacramento Section of ASCE in 2010. Additional information on my qualifications is available on my website, www.gfredlee.com.

I have spent my five-decades-long professional career applying my professional expertise in environmental engineering, aquatic chemistry, and water quality/public health to investigating and managing water quality problems affecting domestic water supply water quality and other beneficial uses of surface, ground, estuarine, and nearshore marine waters. I began working on Delta water quality issues in 1989 when I served as a

consultant to evaluate water quality characteristics that would be expected in the Delta Wetlands, Inc. proposed Delta island water supply reservoirs. For that work my colleague and wife, Dr. Anne Jones-Lee, and I used data collected by DWR staff and the USGS on Delta water quality characteristics to assess the anticipated utility of and water quality in proposed Delta island reservoirs.

Among my qualifications to undertake that work was my service in the 1970s as the US EPA-appointed US representative to the steering committee for the international OECD Eutrophication Study. That study involved the monitoring of about 200 waterbodies in 22 countries in western Europe, North America, Japan, and Australia for their aquatic plant nutrient loads and associated water quality responses. It was an approximately $50-million effort conducted over five years; I had the responsibility for synthesizing and evaluating the data on the US portion of those studies, and subsequently was instrumental in the assessment and documentation of the predictive capabilities of the nutrient load–response models developed. We have published several papers/reports on the results of these studies including:

Exhibit CSPA-61. Jones, R. A., and Lee, G. F., "Recent Advances in Assessing the Impact of Phosphorus Loads on Eutrophication-Related Water Quality," Journ. Water Research 16:503-515 (1982).
http://www.gfredlee.com/Nutrients/RecentAdvWaterRes.pdf

Using my substantial experience, including in the OECD Eutrophication Study and post-OECD study of the nutrient-related water quality in more than 750 waterbodies in many areas of the world, we concluded that the proposed Delta Wetlands island water supply reservoirs would have severely degraded water quality. The anticipated poor quality would be due to excessive growths of algae and aquatic plants supported by the substantial amounts of nutrients (N and P compounds) in the Delta channel waters that would be used to fill the reservoirs relative to the morphological and hydraulic residence time of the water in the proposed reservoirs. Several years later DWR staff came to similar conclusions on the predicted water quality in the Delta Wetlands-proposed water supply reservoirs.

At the time I conducted the Delta Wetlands work, I held the position of Distinguished Professor of Civil and Environmental Engineering at the New Jersey Institute of Technology (NJIT) as well as Director of the Site Assessment and Remediation Division of the multi-university Hazardous Waste Research Center; Dr. Anne Jones-Lee served as Associate Professor of Civil and Environmental Engineering at NJIT. In those capacities we taught and conducted research on various aspects of the impacts of chemicals on water quality. In the summer/fall of 1989 I retired from 30 years of university teaching/research and we established our full-time environmental quality consulting practice, G. Fred Lee & Associates, in El Macero, CA (near Davis, CA). In that practice we specialize in water quality evaluation and management, hazardous chemical site

investigation/remediation, and water quality impacts of solid waste management.

In 1999 we became advisors to William Jennings, DeltaKeeper, on the low-dissolved oxygen (DO) conditions that occur in the San Joaquin River (SJR) Deep Water Ship Channel (DWSC) near the Port of Stockton. By 2000 our role on that issue expanded to advising the SJR DWSC Low-DO TMDL Steering Committee on the low-DO problems in the DWSC. We were selected by that Steering Committee to rewrite the originally rejected proposal for CALFED support to investigate and assess the causes, implications, and potential remedies for the SJR DWSC low-DO issues. We worked with Dr. C. Foe of the Central Valley Regional Water Quality Control Board (CVRWQCB) staff and other proposed project investigators to revise the proposal, and were subsequently selected by the Steering Committee and CALFED to be the principal investigators for the about $2-million project. In addition to serving as project coordinators, we developed the reports cited below (and incorporated into this testimony as Exhibits CSPA-62 and CSPA-63) that synthesized the findings of the 12 project investigators as well as insights derived from the technical literature and our experience and expertise in working on similar issues at other locations.

Exhibit CSPA-62: Lee. G. F., and Jones-Lee, A., "Synthesis and Discussion of Findings on the Causes and Factors Influencing Low DO in the San Joaquin River Deep Water Ship Channel near Stockton, CA: Including 2002 Data," Report Submitted to SJR DO TMDL Steering Committee/Technical Advisory Committee and CALFED Bay-Delta Program, G. Fred Lee & Associates, El Macero, CA, March (2003). http://www.gfredlee.com/SJR-Delta/SynthesisRpt3-21-03.pdf

Supplemental reports included:

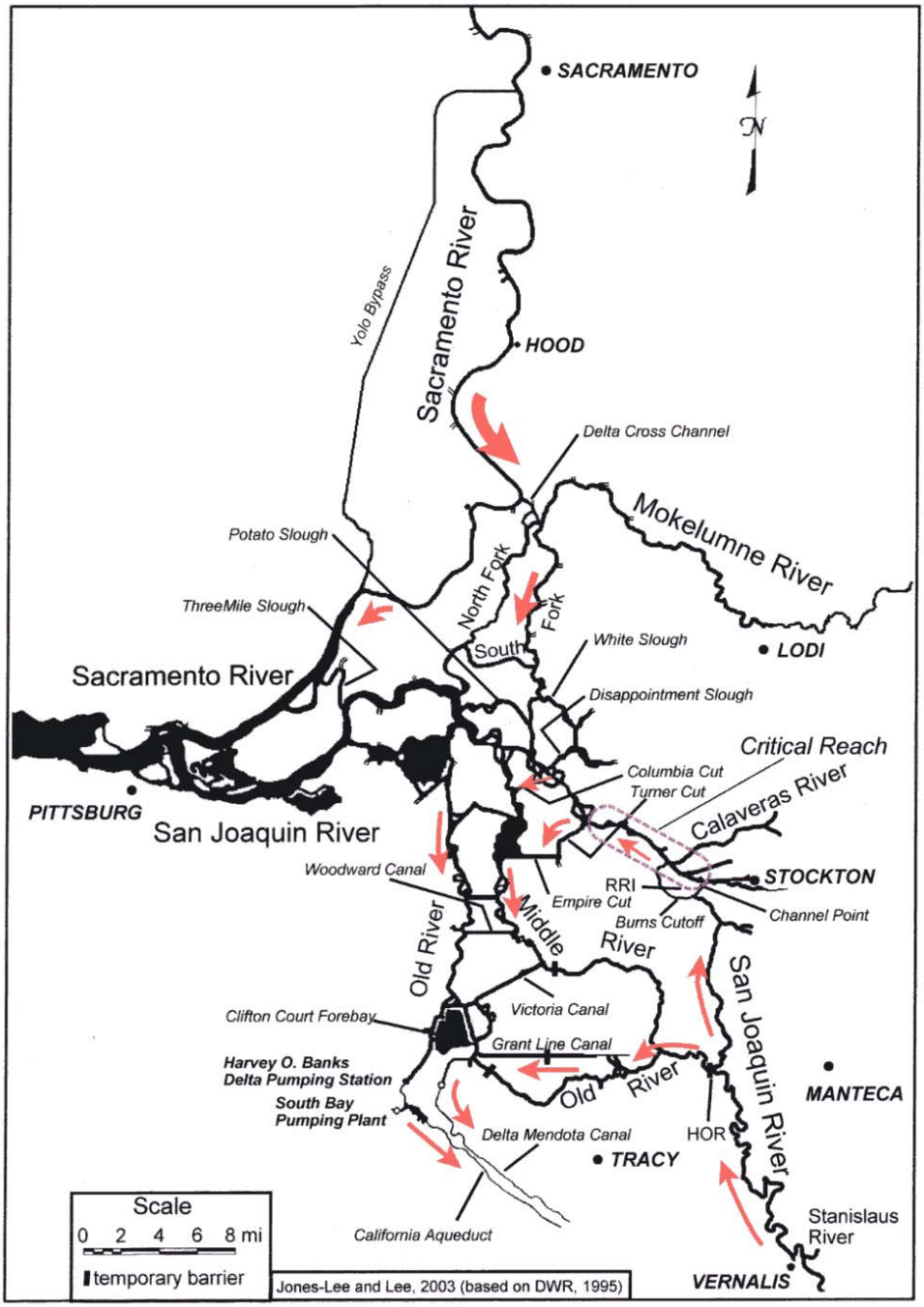
Exhibit CSPA-63: Lee, G. F. and Jones-Lee, A., “Supplement to Synthesis Report on the Low-DO Problem in the SJR DWSC,” Report of G. Fred Lee & Associates, El Macero, CA, June (2004). http://www.gfredlee.com/SJR-Delta/SynthRptSupp.pdf

Figure 1, also identified as Exhibit CSPA-64 of this testimony, is a map of the area of the Delta, showing the San Joaquin River (SJR), Turner Cut, and Columbia Cuts as well as arrows showing the direction of flow in River and Delta channels, pertinent to this testimony.

During the SJR DWSC low-DO study we found that the low-DO condition rarely occurred downstream of Turner Cut. That finding prompted me to organize several sampling cruises of Delta channels including Turner Cut and Columbia Cut. DeltaKeeper provided the boat and crew for the cruises. The cruises of the Central Delta, presented in the following referenced report included in this testimony as Exhibit CSPA-65, confirmed that the SJR DWSC water is drawn into the Central Delta primarily via Turner Cut and to a lesser degree via Columbia Cut.

Exhibit CSPA-65. Lee, G. F., Jones-Lee, A. and Burr, K., "Summary of Results from the July 17, 2003, and September 17, 2003, Tours of the Central Delta Channels," Report of G. Fred Lee & Associates, El Macero, CA (2004). http://www.gfredlee.com/SJR-Delta/Central-Delta-Tours.pdf

Figure 1 – Exhibit CSPA-64.
Map of the Delta Showing Flow Direction



Inadequacies of WaterFix Impact Assessment

Impacts of DWR/USBR North Delta Exports

A key component of understanding the impacts of the DWR and USBR North Delta exports on Central Delta water quality comes from the DWR water quality sampling cruises on the San Joaquin River from Prisoners Point in the western Delta to the Port of Sacramento. Those sampling runs occur each summer through the fall. An example of the results of those runs are the following graphs (labeled here as Figures 2 and 3, and included in this testimony as Exhibit CSPA-66 and Exhibit CSPA-67, respectively) that were made available by Jenna Rinde, Environmental Scientist Department of Water Resources Division of Environmental Services Bay-Delta Monitoring and Analysis Section West Sacramento, CA [jenna.rinde@water.ca.gov]. The results of the DWR SJR DWSC sampling runs are available from DWR and should have been analyzed by DWR/USBR as part of evaluating the impact of the North Delta diversions on Delta water quality.

Figure 2 – Exhibit CSPA-66.
Dissolved Oxygen Summary Report for the Stockton Ship Channel:
15 August 2016 DWR crew [from: jenna.rinde@water.ca.gov]

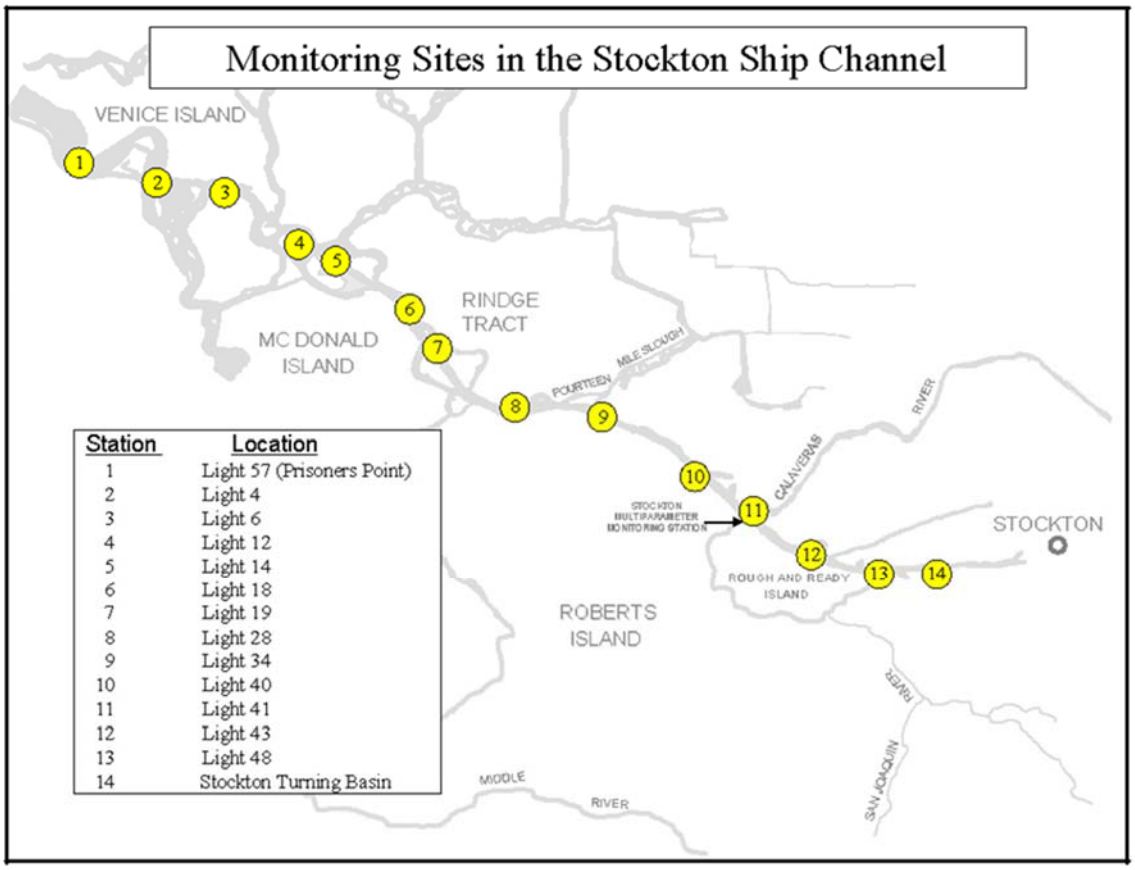
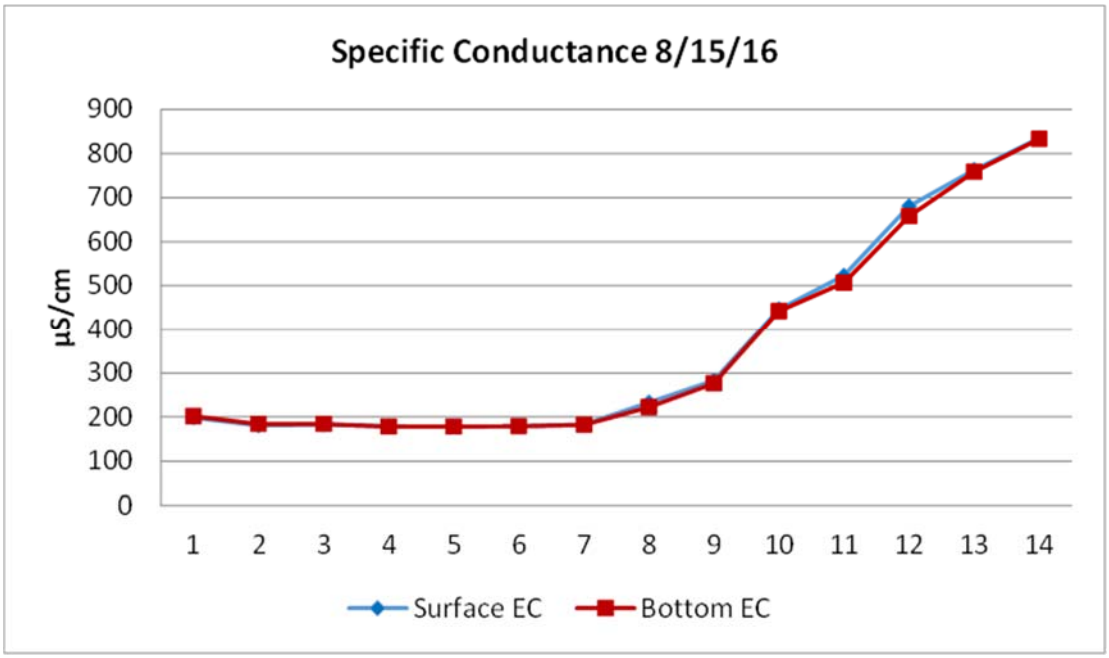


Figure 3 – Exhibit CSPA-67.
Specific Conductance of the DWSC on 8/15/16 [from: jenna.rinde@water.ca.gov]



Based on the specific conductance (EC) measurements made at Stations 1 through 7 in the San Joaquin River during this and the other DWR sampling cruises during the summer and fall for many years, it is clear that Sacramento River water is drawn across the Central Delta to the South Delta export pumps at the Banks and Jones pumping stations. The EC of the SJR on the August 15, 2016 sampling date and most other sampling dates was on the order of 700 to 750 uS/cm at stations 12 and 13 where the SJR enters the Deep Water Ship Channel. There is no SJR water in the Deep Water Ship Channel downstream of Station 7 all, of the upstream SJR DWSC water and its high load of pollutants is drawn into the Central Delta. As discussed below associated with the operation of the WaterFix diversions of the north diversion location the South Delta export pumps will still withdraw at least 45% of the exported water from the South Delta. Therefore, there will continue to be a strong pull of Sacramento River water to the South Delta that will still draw SJR water and its pollutants into the Central Delta.

The current flow of Sacramento River and SJR water is such that the South Delta export pumps pull Sacramento River water into the Central Delta via Turner Cut and Columbia Cut, which dilutes pollutants in the SJR DWSC as it is drawn into the Central Delta. Further information about this phenomenon and its water quality implications is provided in our reports on these issues on our website (in the SJR-Delta section at http://www.gfredlee.com/psjriv2.html).

Potential impacts of the WaterFix Tunnel diversions of Sacramento River on pollutant

concentrations can be understood by examining the SWRCB 303-d list of impaired waterbodies in the Delta.

The SWRCB website for "Impaired Water Bodies", [http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2012.shtml] (Exhibit CSPA-68) states,

> "*Listing a water body as impaired in California is governed by the Water Quality Control Policy for developing California's Clean Water Act Section 303(d) Listing Policy. The State and Regional Water Boards assess water quality data for California's waters every two years to determine if they contain pollutants at levels that exceed protective water quality criteria and standards. This biennial assessment is required under Section 303(d) of the Federal Clean Water Act."*

Table 1 (Exhibit CSPA-69) lists water-quality-limited segments of the Sacramento River, SJR Deep Water Ship Channel, and the Central Delta that were identified on the USEPA Approved 303(d) list that appears on the SWRCB website at http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/impaired_waters_list/2008_2010_usepa_303dlist/20082010_usepa_aprvd_303dlist.pdf
According to D. McClure (CVRWQCB staff), personal communication to G. Fred Lee, August 24, 2016), that listing is the current listing.

Table 1 – Exhibit CSPA-69.
Current US EPA 303(d) List of Water-Quality-Limited Segments
Sacramento River, SJR Deep Water Ship Channel,
and the Central Delta

Sacramento River

Region	Waterbody Name	Pollutant	Pollutant Category
5	Sacramento River (Knights Landing to the Delta)	Chlordane	Pesticides
5	Sacramento River (Knights Landing to the Delta)	DDT (Dichlorodiphenyltrichloroethane)	Pesticides
5	Sacramento River (Knights Landing to the Delta)	Dieldrin	Pesticides
5	Sacramento River (Knights Landing to the Delta)	Mercury	Metals/Metalloids
5	Sacramento River (Knights Landing to the Delta)	PCBs (Polychlorinated biphenyls)	Other Organics
5	Sacramento River (Knights Landing to the Delta)	Unknown Toxicity	Toxicity

SJR Deep Water Ship Channel (Stockton Ship Channel) and Central Delta

5	Delta Waterways (Stockton Ship Channel)	Chlorpyrifos	Pesticides
5	Delta Waterways (Stockton Ship Channel)	DDT	Pesticides
5	Delta Waterways (Stockton Ship Channel)	Diazinon	Pesticides
5	Delta Waterways (Stockton Ship Channel)	Dioxin	Other Organics
5	Delta Waterways (Stockton Ship Channel)	Furan Compounds	Other Organics
5	Delta Waterways (Stockton Ship Channel)	Group A Pesticides	Pesticides
5	Delta Waterways (Stockton Ship Channel)	Invasive Species	Miscellaneous
5	Delta Waterways (Stockton Ship Channel)	Mercury	Metals/Metalloids
5	Delta Waterways (Stockton Ship Channel)	Organic Enrichment/Low Dissolved Oxygen	Nutrients
5	Delta Waterways (Stockton Ship Channel)	PCBs (Polychlorinated biphenyls)	Other Organics
5	Delta Waterways (Stockton Ship Channel)	Pathogens	Pathogens
5	Delta Waterways (Stockton Ship Channel)	Unknown Toxicity	Toxicity
5	Delta Waterways (central portion)	Chlorpyrifos	Pesticides
5	Delta Waterways (central portion)	DDT (Dichlorodiphenyltrichloroethane)	Pesticides
5	Delta Waterways (central portion)	Diazinon	Pesticides
5	Delta Waterways (central portion)	Group A Pesticides	Pesticides
5	Delta Waterways (central portion)	Invasive Species	Miscellaneous
5	Delta Waterways (central portion)	Mercury	Metals/Metalloids
5	Delta Waterways (central portion)	Unknown Toxicity	Toxicity

The SWRCB/USEPA 303(d) list of water quality objectives violations is limited compared to a comprehensive list of the constituents and areas of the Delta that are experiencing impaired water quality. The current water quality monitoring program for Delta waters is grossly deficient compared to that needed to adequately evaluate current water quality standard violations. These deficiencies have been recognized for many years as discussed in numerous reports and submitted comments, including those listed below. While there have been several attempts to significantly improve the current water

quality monitoring program for Delta waters, deficiencies remain.
These issues are discussed in the following Exhibits:

Exhibit CSPA-70: Lee, G. F. and Jones-Lee, A., "Overview of Sacramento-San Joaquin River Delta Water Quality Issues," Report of G. Fred Lee & Associates, El Macero, CA (2004). http://www.gfredlee.com/SJR-Delta/Delta-WQ-IssuesRpt.pdf

Exhibit CSPA-71: Lee, G. F., and Jones-Lee, A., "Overview—Sacramento/San Joaquin Delta Water Quality," Presented at CA/NV AWWA Fall Conference, Sacramento, CA, PowerPoint Slides, G. Fred Lee & Associates, El Macero, CA, October (2007).
http://www.gfredlee.com/SJR-Delta/DeltaWQCANVAWWAOct07.pdf

Exhibit CSPA-72: Lee, G. F., and Jones-Lee, A., "Delta Water Quality Standards Violations" and "Comments on Water Quality Sections of the Delta Vision Strategic Plan, Third Staff Draft – dated August 14, 2008," Submitted to Delta Vision Blue Ribbon Task Force, Sacramento, CA. Report of G. Fred Lee & Associates, El Macero, CA, September 1 (2008). http://www.gfredlee.com/SJR-Delta/DeltaVisionWQViolations.pdf

Those reports review Delta water quality issues and discuss the need for a more comprehensive water quality monitoring program in the Delta channels. In order to begin to eliminate the deficiencies in the Delta water quality assessment, the Central Valley Regional Water Quality Control Board has initiated a program to develop a comprehensive water monitoring program for Delta channels. [http://www.swrcb.ca.gov/centralvalley/water_issues/delta_water_quality/comprehensive_monitoring_program/].

It is clear that the SJR DWSC at Turner Cut has high pollutant concentrations/loads that are drawn into the Central Delta primarily via Turner Cut. The Sacramento River is also drawn into the Central Delta at Turner Cut where it mixes with the SJR DWSC water. The operation of the proposed WaterFix northern intake diversion of Sacramento River will reduce the volume/flow of Sacramento River presently available to dilute the pollutants derived from the SJR DWSC water that enters the Central Delta. The net result is that with the proposed WaterFix north diversion, the pollutants in Turner Cut will have an increased adverse impact on Central Delta water quality beneficial uses.

The DWR/USBR evaluation of "water quality impacts" of the proposed WaterFix project fails to discuss the fact that the tunnel diversion will at times deprive the Central Delta of several thousand cfs of Sacramento River water that currently dilutes the SJR flow and its pollutant loads that enters the Central Delta at Turner and Columbia Cuts.

The DWR/USBR assessment of "Delta water quality impacts" that will be caused by the WaterFix relied on model predictions of exceedance of water quality standards (objectives) for EC at current water quality monitoring locations in the Delta. That approach is not reliable for assessing current water quality in the Delta, much less for evaluating the anticipated impact of altering the amount of Sacramento River water that enters the Delta channels.

USGS Review of Effects of Delta Flow Diversions

Several scientists with the USGS discussed impacts of flow manipulations, barriers, and exports on Delta water quality in their paper referenced below and incorporated into this testimony as Exhibit CSPA-73.

Exhibit CSPA-73. Monsen, N., Cloern, J., and Burau, J., "Effects of Flow Diversions on Water and Habitat Quality: Examples from California's Highly Manipulated Sacramento-San Joaquin Delta," San Francisco Estuary & Watershed Science, 5(3):1-16, July (2007). http://repositories.cdlib.org/jmie/sfews/vol5/iss3/art2

They summarized their work in their abstract:

"We use selected monitoring data to illustrate how localized water diversions from seasonal barriers, gate operations, and export pumps alter water quality across the Sacramento-San Joaquin Delta (California). Dynamics of water-quality variability are complex because the Delta is a mixing zone of water from the Sacramento and San Joaquin Rivers, agricultural return water, and the San Francisco Estuary. Each source has distinct water-quality characteristics, and the contribution of each source varies in response to natural hydrologic variability and water diversions. We use simulations with a tidal hydrodynamic model to reveal how three diversion events, as case studies, influence water quality through their alteration of Delta-wide water circulation patterns and flushing time. Reduction of export pumping decreases the proportion of Sacramento- to San Joaquin-derived fresh water in the central Delta, leading to rapid increases in salinity. Delta Cross Channel gate operations control salinity in the western Delta and alter the freshwater source distribution in the central Delta. Removal of the head of Old River barrier, in autumn, increases the flushing time of the Stockton Ship Channel from days to weeks, contributing to a depletion of dissolved oxygen. Each shift in water quality has implications either for habitat quality or municipal drinking water, illustrating the importance of a systems view to anticipate the suite of changes induced by flow manipulations, and to minimize the conflicts inherent in allocations of scarce resources to meet multiple objectives."

Their Table 1, presented below, shows the concentrations of various constituents in the SJR at Vernalis. The concentrations of some of those constituents will be increased in the DWSC as a result of wastewater discharge to the SJR by the city of Stockton wastewater treatment plant. That discharge occurs just upstream of the DWSC.

Exhibit CSPA-73 Table 1. Water quality comparison between the Sacramento River, San Joaquin River, and In-Delta Agricultural Return water for water years 1999-2001.

Water Quality Parameter	Sacramento at Freeport [1]	San Joaquin at Vernalis	In-Delta Agricultural Return Water [2]
Specific Conductance (mmhos cm^{-1})	144 ± 28	621 ± 183	562 ± 206
pH	7.8 ± 0.2	8.0 ± 0.4	6.8 ± 0.4
Alkalinity (mg $CaCO_3$ L^{-1})	55 ± 12	85 ± 24	83 ± 18
Dissolved Oxygen (mg L^{-1})	9.8 ± 1.4	9.6 ± 1.4	5.5 ± 2.1
Nitrite+Nitrate (mg N L^{-1})	0.12 ± 0.05	1.62 ± 0.59	
Orthophosphate (mg P L^{-1})	0.024 ± 0.007	0.107 ± 0.054	
Dissolved Organic Carbon (mg C L^{-1})	1.84 ± 0.53	2.83 ± 0.47	14.1 ± 7.7
Total Dissolved Selenium[3] (nmol L^{-1})	0.91 ± 0.27	8.6 ± 2.5	Negligible[4]

[1] USGS Water Quality Database (WY1999-WY2001) for Sacramento (USGS 11447650) and San Joaquin (USGS 11303500) rivers unless otherwise noted.

[2] California Department of Water Resources Municipal Water Quality Investigations Program (WY1999-WY2001) for Bacon Island Pumping Plant (DWR B9V75881342), and Twitchell Island Pumping Plant 1 (DWR B9V80661391) (CDWR 2003); DOC data only from Bacon Island. Different crops produce varying levels of DOC, agricultural return water DOC is expected to vary significantly throughout the Delta.

[3] Sacramento river average from two studies (1984-2000). San Joaquin average from 1997-2000 sampling period. (Cutter and Cutter 2004)

[4] Personal communication AR Stewart, 14 May 2003

They highlighted the importance of considering the effects of manipulations of the Delta water on impacts of pollutants on page 12 of their paper:

"Processes that change concentration fields of pollutants are ecologically important because the toxicity and accumulation of pollutants in food webs are concentration dependent. The new pyrethroid pesticides are extremely toxic to invertebrates with sublethal effects at concentrations measured in parts per trillion (Oros and Werner 2005); the herbicide diuron inhibits phytoplankton photosynthesis in the Delta at concentrations > 2 ug L-1 (Edmunds et al. 1999); phytoplankton accumulate methyl mercury at concentrations 10,000 times those in water (Davis et al. 2003); bioaccumulation of toxic metals (e.g. copper, cadmium, silver, chromium) in invertebrates and fish depends on concentrations of those elements in water and prey (Luoma and Rainbow 2005). We have learned empirically how individual diversions

modify salt concentrations across the Delta, but we have not yet considered how they modify distributions of land-derived pollutants and their threats to wildlife or human health."

Their Table 1 shows that the Sacramento River water has a much lower concentration of several potential pollutants compared to the SJR.

DISB Review

On September 30, 2015 the Delta Independent Science Board (ISB) submitted to the Delta Stewardship Council (DSC) its final comments on the partially Recirculated Draft Environmental Impact Report/Supplemental Draft Environmental Impact Statement (RDEIR/SDEIS) for the Bay Delta Conservation Plan/California WaterFix. The ISB comments were reviewed by the DSC on October 23, 2015 and accepted by the Council. Those comments and letter of submittal of the comments to the DSC and CA Department of Fish and Wildlife, are available at [http://deltacouncil.ca.gov/docs/final-delta-isb-comments-partially-recirculated-draft-environmental-impact-reportsupplemental] and are incorporated into this testimony as Exhibit CSPA-74. The letter of transmittal summarized the overall conclusion of the ISB concerning the technical merit and deficiencies of the partially RDEIR/SDEIR for the Bay Delta Conservation Plan/California WaterFix by stating:

"We focused on how fully and effectively it considers and communicates the scientific foundations for assessing the environmental impacts of water conveyance alternatives. The review is attached and is summarized below."

"The effects of California WaterFix extend beyond water conveyance to habitat restoration and levee maintenance. These interdependent issues of statewide importance warrant an environmental impact assessment that is more complete, comprehensive, and comprehensible than the Current Draft."

The ISB comments (Exhibit CSPA-74) included a section "Water Quality (Chapter 8)" that summarized several deficiencies in the WaterFix draft REIR/SEIS Water Quality discussion of the impacts of the Sacramento River Tunnel Diversion project. Comments included the following, referencing pages of Chapter 8:

"*8-75, line 6: The failure to consider dissolved P (DP) should be addressed; there is much greater uncertainty. The adherence of some P to sediment does not prevent considerable discharge of P as DP. Also on page 8-95 line 40, qualify predictions due to lack of consideration of DP.*"

Additional information on these issues is available in Dr. Erwin van Nieuwenhuyse's presentation at the California Water Environmental Modeling Forum (CWEMF) nutrient modeling workshop. The PowerPoint slides of his presentation are incorporated into this testimony as Exhibit CSPA-75.

Exhibit CSPA-75. vanNieuwenhuyse, E., "Response of Chlorophyll to Reduced Phosphorus Concentration in the Delta and the Rhine River," Presentation at CWEMF Technical Workshop, Sacramento, CA, March 25 (2008). http://www.cwemf.org/workshops/DeltaNutrientsWrkshp/VanNieuwenhuyse.pdf

In that presentation, Dr. van Nieuwenhuyse summarized his paper (incorporated in this testimony as Exhibit CSPA-76):

CSPA-76. van Nieuwenhuyse, E., "Response of Summer Chlorophyll Concentration to Reduced Total Phosphorus Concentration in the Rhine River (Netherlands) and the Sacramento– San Joaquin Delta (California, USA)," Can. J. Fish. Aquatic, Sci. 64(11):1529-1542 (2007). [http://www.ingentaconnect.com/content/nrc/cjfas/2007/00000064/00000011/art00006]

and described the response of average summer chlorophyll concentration in the Central Delta to an abrupt and sustained reduction in phosphorus discharge from the Sacramento County Regional Sanitation District wastewater treatment facility. His paper and presentation provides important information on the impact of Sac Regional phosphorus discharge on Delta planktonic algae in the Delta.

As discussed in the van Nieuwenhuyse's workshop presentation and published paper, and in my presentation at the CWEMF Technical Workshop on Overview of Delta Nutrient Water Quality Problems: Nutrient Load – Water Quality Impact Modeling, [http://www.cwemf.org/workshops/NutrientLoadWrkshp.pdf], "Developing Site-Specific Nutrient Criteria & Allowable Discharge Limits," [http://www.cwemf.org/workshops/DeltaNutrientsWrkshp/GFredLeeOverview.pdf] (incorporated into this testimony as Exhibit CSPA-77), backup information, papers referenced in his presentations, and in

Exhibit CSPA-78. Lee, G. F., and Jones-Lee, A., "Synopsis of CWEMF Delta Nutrient Water Quality Modeling Workshop – March 25, 2008, Sacramento, CA," Report of G. Fred Lee & Associates, El Macero, CA, May 15 (2008). http://www.gfredlee.com/SJR-Delta/CWEMF_WS_synopsis.pdf

it is well established that reducing the phosphorus load and in-waterbody concentrations effects reductions in the phytoplankton biomass in Delta waters. This occurs even in situations in which the available phosphorus concentrations in the waterbody remain surplus compared to growth-rate-limiting concentrations. The decrease in planktonic algae in the Delta associated with decreased phosphorus loads to the Delta must be discussed in a creditable discussion of the impact of nutrients and the impact of Sacramento River diversions on Delta water quality.

The amount of dissolved phosphorus transported into the Central Delta by the

Sacramento River has a significant impact on the phytoplankton population in the Central Delta. The proposed WaterFix project's diversion of Sacramento River water will reduce the amount of Sacramento River water that enters the Central Delta and thereby impact the phosphorus input to the Central Delta and the phytoplankton population in that area of the Delta. The reduction in dilution of phosphorus concentration in the Central Delta leads to impaired water quality and adverse impacts/injuries to the public/users of Central Delta waters. Such uses that stand to be adversely impacted include fishing, boating, swimming, aesthetic quality of water, owing to increased algae and aquatic plants, odors, low DO, ag intake screens plugging, sediment toxicity, floating scum, and other effects of phosphorus and flow alterations.

I have spent over 50 years investigating impacts of phosphorus concentrations and loads and water inflow on the amount of algae, blue-green algae/bacteria, and aquatic weeds such as water hyacinths and Egeria in hundreds of waterbodies in the US, and other countries in western Europe, Japan, and including an Antarctic ice-covered lake. I have published more than 100 papers/reports on these studies. Many of my papers and reports on this work are available on my website, www.gfredlee.com. Summaries of some of the pertinent work I have done in this area are incorporated in this testimony as Exhibit CSPA-79. In general, increasing aquatic plant biomass adversely affects a waterbody's water quality/beneficial uses and injures public interests.

While the DWR and USBR claimed that the diversion of Sacramento River around the Delta through the WaterFix tunnels will not adversely affect users of the Delta, that claim cannot be made without proper evaluation of impact of the North Delta water diversions and associated changes in phosphorus loading and phytoplankton populations in the Delta. This issue should have been discussed in the DWR USBR WaterFix evaluation of the impact of the WaterFix North Delta diversions on Delta water quality/beneficial uses. The DWR USBR WaterFix evaluation of tunnel diversions on Delta water quality is significantly deficient in its failure to evaluate the importance of dissolved inorganic phosphorus as a key component in impacting Delta water quality, especially Central Delta aquatic plant-related water quality

South Delta Old River

In our low-DO studies of the DWSC we found that the diversion of SJR into Old River at the Head of Old River resulted in more severe low-DO problems in the DWSC. Major diversion of SJR at that location reduced the SJR flow through the DWSC and increased the residence time of SJR water and oxygen-demanding materials in the DWSC leading to greater low-DO problems. In order to investigate this matter, I organized a cruise of the Old River channels in the Southern Delta. The DeltaKeeper provided the boat and crew; members of the CVRWQCB and US EPA staff also participated in this cruise.

A summary of our findings from our cruise of the South Delta Channels were presented

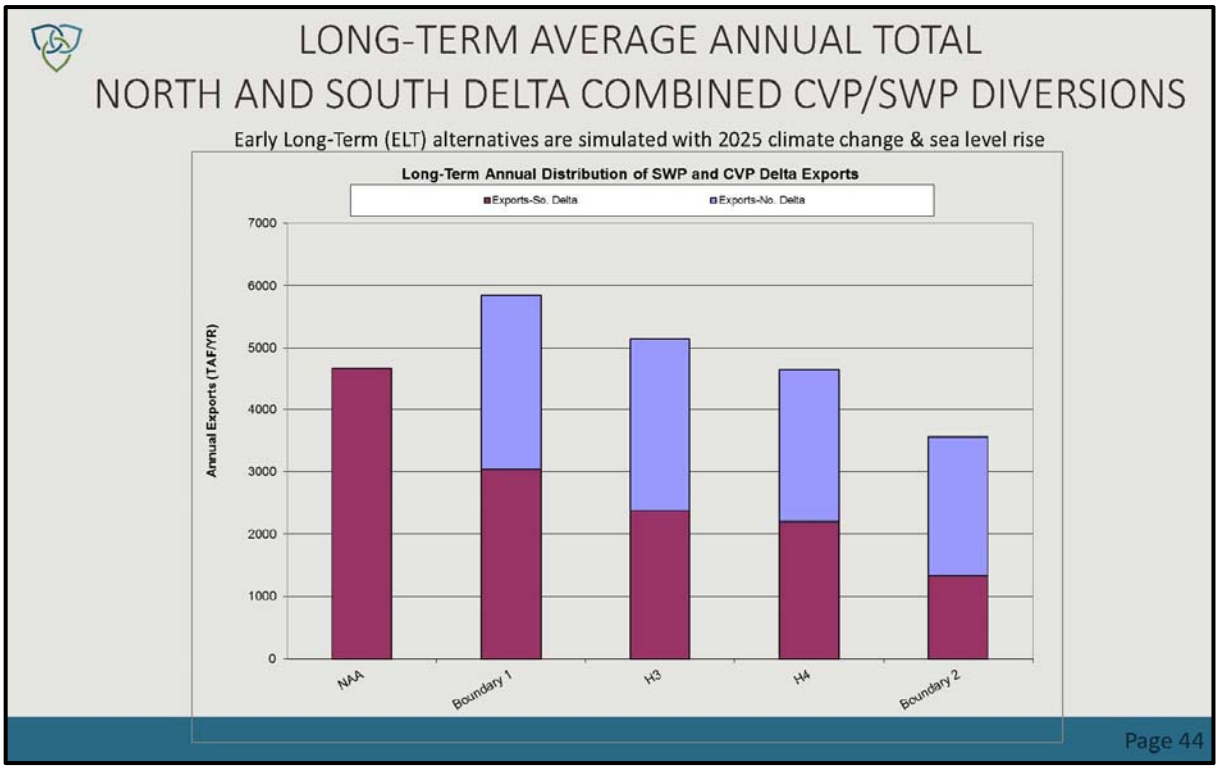
in our report that is incorporated into this testimony as Exhibit CSPA-80.

Exhibit CSPA-80. Lee, G. F.; Jones-Lee, A. and Burr, K., "Results of the August 5, 2003, Tour of the South Delta Channels," Report of G. Fred Lee & Associates, El Macero, CA, February (2004). http://www.gfredlee.com/SJR-Delta/South-Delta-Tour.pdf

During the South Delta cruise we found that a large fish kill had recently occurred in the South Delta Channel near the Tracy Blvd bridge. According to the DWR continuous DO monitoring of that channel, the dissolved oxygen had been very low in the channel the night before the cruise; that condition likely led to the fish kill. That low-DO condition results from the low flow in the channel, which results from the presence of the DWR barrier at the western end of that part of the Old River Channel, which is impacted by the pumping at the Banks and Jones export pumps.

Associated with the operation of the proposed WaterFix North Delta water diversions on the Sacramento River, the amount of water exported at times by the South Delta diversions will be decreased. That relationship is shown on page 44 of Exhibit DWR_5_errata show below.

Exhibit DWR_5_errata



That exhibit shows that under the various proposed alternatives for WaterFix operation, the amount of South Delta water exported will be less than that which occurs during

NAA (the no action alternative). Such reduced pumping from the South Delta can be expected to reduce the flow of water through the South Delta channel at the barrier and thereby increase the residence time of water in the channel between the Tracy Blvd bridge and the barrier. Increased residence time of water in that area will likely, at times, cause even greater DO depletion than would occur under the no action alterative. This is potentially another significant adverse impact of the proposed North Delta diversion of Sacramento River water that should have been evaluated by DWR and USBR for the proposed WaterFix project.

Unrecognized and Unregulated Pollutants

I have had considerable experience in developing, evaluating, and appropriately applying water quality criteria, standards, and objectives including service as an invited peer-reviewer for the National Academies of Science and Engineering "Blue Book" of water quality criteria, American Fisheries Society peer-review panel for the US EPA "Red Book" of water quality criteria, and US EPA invited peer-reviewer of the "Gold Book" of water quality criteria. A summary of my experience in this area is presented in Exhibit CSPA-81:

> Exhibit CSPA-81. G. Fred Lee and Anne Jones-Lee Expertise and Experience in Water Quality Standards and NPDES Permits Development and Implementation into NPDES Permitted Discharges [http://www.gfredlee.com/exp/wqexp.html]

It is well known that relying only on the exceedance of a limited number of water quality objectives, as has been done by the DWR and USBR in evaluating the impact of the North Delta Sacramento River diversions, is highly unreliable for evaluating the impact of the diversion on water quality/beneficial uses of the Delta.

One of the important deficiencies in the water quality monitoring and evaluation of the Delta in the assessment of potential impacts of the proposed project on Delta water quality/beneficial uses is that unrecognized and unregulated pollutants are not considered. The Delta receives substantial amounts of unrecognized, unregulated chemical pollutants that impact human health, water quality and the other beneficial uses of water. Water quality management programs focus on about 100 to 200 out of the many tens of thousands of chemicals used in commerce and discharged to waterbodies. There is ever-increasing concern about the impacts of the large number of unmonitored, unregulated, and unrecognized chemicals in receiving waters, especially those such as the Delta that receive large amounts of agricultural runoff and domestic inputs. In April 2009, a California Ocean Protection Council et al. workshop, "Managing Contaminants of Emerging Concern in California: A Workshop to Develop Processes for Prioritizing, Monitoring and Determining Thresholds of Concern," was held in Costa Mesa, CA; a report on issues and discussions at that workshop was made available in September (2009) [http://www.nwri-usa.org/pdfs/CACCECReport.pdf]. Figure 4 (incorporated into this testimony as Exhibit CSPA-82), derived from that report, presents a summary of

current information on numbers of chemicals from various sources that are of concern as potential pollutants.

Figure 4 – Exhibit CSPA-82.
Numbers of Chemicals Registered for Commercial Use in the US

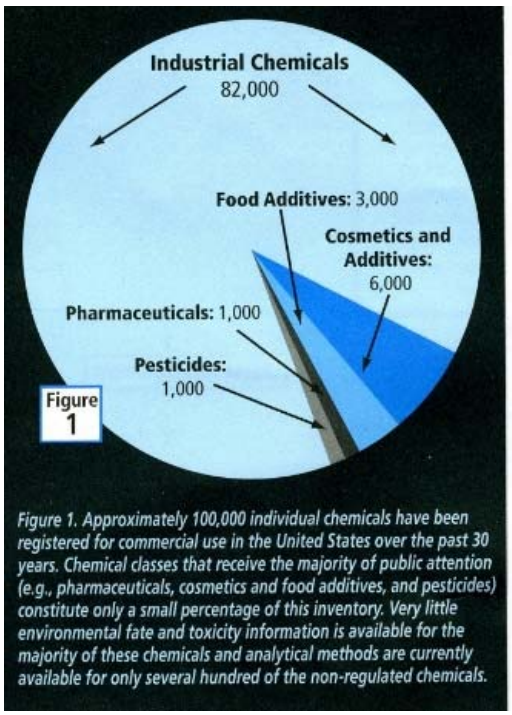


Figure 1. Approximately 100,000 individual chemicals have been registered for commercial use in the United States over the past 30 years. Chemical classes that receive the majority of public attention (e.g., pharmaceuticals, cosmetics and food additives, and pesticides) constitute only a small percentage of this inventory. Very little environmental fate and toxicity information is available for the majority of these chemicals and analytical methods are currently available for only several hundred of the non-regulated chemicals.

Source:
Published in *Estuary News* 18(6) December (2009).
[http://www.sfestuary.org/pages/newsletter.php]
(Based on Figure 1 in: Muir, D., and Howard, P., "Are There Other Persistent Organic Pollutants? A Challenge for Environmental Chemists," *Environ. Sci. & Technol.* 40:7157-7166 (2006);
subsequently updated in: "Managing Contaminants of Emerging Concern in California: Developing Processes for Prioritizing, Monitoring, and Determining Thresholds of Concern," Report of California Ocean Protection Council et al. workshop, "Managing Contaminants of Emerging Concern in California: A Workshop to Develop Processes for Prioritizing, Monitoring and Determining Thresholds of Concern," Costa Mesa, CA, April 28-29 (2009);
[http://www.nwri-usa.org/pdfs/CACCECReport.pdf]
and updated further for *Estuary News*.)

As illustrated in Figure 4, only a very small number of chemical pollutants in municipal, urban, industrial, and agricultural wastewaters and runoff that are discharged to the tributaries of the Delta are regulated. There is a vast arena of potential pollutants in wastewaters and runoff that can impact water quality. In addition to concern for potential impacts of individual unregulated chemicals and unrecognized pollutants, also ignored in the WaterFix water quality/beneficial use evaluation are potential additive and synergistic impacts between and among regulated and unregulated chemicals that can impact water quality.

The approach used by DWR and USBR to claim that the WaterFix Tunnel diversions of large amounts of Sacramento River water around the Delta for use by agriculture and for domestic purposes will not be adverse to Delta water quality/beneficial uses is, at best, highly shortsighted. While the Sacramento River water no-doubt contains some unregulated pollutants, in general it is of much higher quality than San Joaquin River water; diminution of Sacramento River water flow will certainly diminish water quality at the confluence of the Sacramento and San Joaquin Rivers. I have discussed these issues in numerous publications including the following:

Exhibit CSPA-83. Lee, G. F., and Jones-Lee, A., "Enhanced Delta Flows Needed to

Help Control Water Quality Impacts of Delta Pollutants," Testimony for CA State Water Resources Control Board Public Workshop: Comprehensive (Phase 2) Review & Update to Bay-Delta Plan Workshop 1: Ecosystem Changes and the Low Salinity Zone, Sacramento, CA, September 5, 2012, Report of G. Fred Lee & Associates, El Macero, CA, August 17 (2012). http://www.gfredlee.com/SJR-Delta/Lee_Testimony_BayDelta_Workshop_1.pdf

Exhibit CSPA-84. Lee, G. F., and Jones-Lee, A., "Discussion of Water Quality Issues That Should Be Considered in Evaluating the Potential Impact of Delta Water Diversions/Manipulations on Chemical Pollutants on Aquatic Life Resources of the Delta," Report of G. Fred Lee & Associates, El Macero, CA, February 11 (2010). http://www.gfredlee.com/SJR-Delta/Impact_Diversions.pdf

Exhibit CSPA-85. Gross, E.S., Lee, G. F., Simenstad, C. A., Stacey, M., Williams, J.G., (Expert Panel Members), "Panel Review of the CA Department of Fish and Game's Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta," DFG Water Rights Program Documents Senate Bill X7 1 DFG Implementation, Submitted to California Department of Fish and Game, October (2010). http://www.gfredlee.com/SJR-Delta/Final_Panel_Review_DFG_BOFC_Draft.pdf Also available at http://www.dfg.ca.gov/water/water_rights_docs.html

Exhibit CSPA-86. Lee, G. F., and Jones-Lee, A., "Review of Need for Modeling of the Impact of Altered Flow through and around the Sacramento San Joaquin Delta on Delta Water Quality Issues," and "Summary: Water Quality Modeling Associated with Altered Sacramento River Flows in & around the Delta," Report to CWEMF Stormwater Committee, by G. Fred Lee & Associates, El Macero, CA, March (2009). http://www.gfredlee.com/SJR-Delta/Model-Impact-Flow-Delta.pdf

As discussed in those papers, diverting large amounts of Sacramento River as proposed by DWR and USBR will deprived the Delta of dilution needed to benefit water quality in the Delta.

Impact on City of Stockton SJR DWSC Water Supply Intake Water Quality

During the hearing an attorney representing the City of Stockton cross-examined the DWR/USBR Petitioner witnesses on the anticipated impact of the proposed WaterFix northern diversion of Sacramento River water on the quality of the City of Stockton water supply intake located on the DWSC near Station 5 (Exhibit CSPA-66). The Petitioner witnesses were unable to answer that question, evidently because it had not been evaluated.

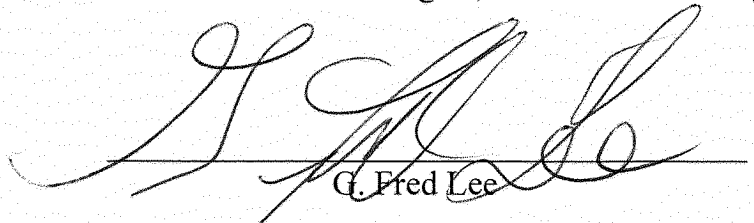
As discussed in my testimony, the water in the DWSC near Station 5 during the summer

and fall has been found by DWR SJR water quality monitoring cruises to be Sacramento River water based on the EC of that water. This is the result of the South Delta export pumps' drawing Sacramento River water across the DWSC. The proposed North Delta WaterFix intakes would, at times, significantly reduce the amount of Sacramento River water that is drawn through the Delta to the South Delta intake pumps. Based on my many years of professional experience in evaluating impacts of raw water quality on water treatment and the quality of the treated water, reducing the amount of Sacramento River water at the city's intake will be strongly detrimental to the city's ability to produce a high-quality treated water supply. The impact of the proposed diversion of Sacramento River water on the quality of water taken by the City of Stockton SJR DWSC intake should have been properly evaluated in assessing the impact of the proposed WaterFix tunnel diversion on raw water supply water quality.

Summary of Key WaterFix Operation Impacts

- Amount of P Entering Turner Cut Influenced by Amount of SJR DWSC Water Entering
  - Affected by South Delta Export Pumping of South Delta Water
  - WaterFix Operations Will Impact Amount of P Entering Central Delta
    - Will Impact Aquatic Plant Growth & Water Quality/Beneficial Uses of Central Delta
- Less Water Entering Turner Cut Will
  - Increase Residence Time of Pollutants in Central Delta
  - Increase Water Quality Impacts/Harm from Aquatic Plants
- P Carried into Central Delta via Sacramento River
  - Impacts Phytoplankton Growth & Impacts/Harms Central Delta Water Quality
- Operation of Proposed WaterFix Diversions Will
  - Increase Pollutant Concentrations in Central Delta
  - Increase Residence Time of Pollutants in Central Delta
  - Increase Water Quality Impacts/Harm to Users of Central Delta Water
  - Increase Water Quality Impacts/Harm to South Delta Old River Channel Users Due to Increased Water/Pollutant Residence Time
- **All of These Impacts/Harms to Delta Water Users Should Have Been Evaluated by DWR/USBR in Its Petition to Change Point of Diversion of Sacramento River Water**

Executed on 31st of August, 2016 in El Macero, CA



G. Fred Lee