

**Background Information on SJR Upstream Oxygen Demand Control Issues**  
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**SJR DWSC Low DO 2000-2004 Studies**

During the June 24, 2010 SJR TWG meeting, G. Fred Lee offered insights into the low-DO problems in the SJR Deep Water Ship Channel (DWSC) based on his experience and results of studies conducted during 2001-2004. His comments addressed a variety of issues including:

- Relative loads of oxygen-demanding materials from upstream sources, including algal BOD and the city of Stockton wastewater treatment plant discharges of ammonia, as a function of flows of the SJR at Vernalis and in the DWSC
- Oxygen depletion in the DWSC as a function of oxygen-demand loads and SJR flows
- Travel times through the DWSC as a function of flow in the SJR DWSC developed by R. Brown
- DO water quality objectives for the DWSC
- Origin of the upstream oxygen-demand load in the SJR in Mud and Salt Sloughs developed by Drs. C. Foe and G. Fred Lee
- DO depletion in the DWSC as a function of water column depth and time of day
- How the operation of the pumps for the State and Federal Delta water export projects impacts the oxygen demand load and DO depletion in the DWSC
- Low DO in the South Delta channels as influenced by SJR algal biomass at Vernalis and in the South Delta channels

These, and additional related, aspects are discussed in the “Synthesis Report” that Lee and Jones-Lee developed from the 3-year, \$2.5 million CALFED-supported studies by 12 investigators of the SJR low-DO TMDL issues. The Synthesis Report and supplements are available as:

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>

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>

Additional papers and reports on these issues are available at [www.gfredlee.com](http://www.gfredlee.com) in the Watershed Studies, SJR Watershed Program and Delta sections at: <http://www.gfredlee.com/psjriv2.htm>

The Synthesis Report also discusses the need to evaluate the potential benefits of controlling upstream phosphorus discharges to Mud and Salt Sloughs to reduce the “seed” planktonic algal biomass that leads to the high algal oxygen demand in the SJR as it enters the DWSC.

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\* Prepared for San Joaquin River Technical Work Group, Report of G. Fred Lee & Associates, El Macero, CA .

## **Excessive Fertilization of SJR and Delta**

A variety of aspects of water quality problems caused by excessive fertilization of the SJR and Delta were discussed in the California Water Environmental Forum (CWEMF)-sponsored “Delta Nutrient Workshop” organized by Lee and Jones-Lee. Synopsis and overview information on the issues addressed are available:

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](http://www.gfredlee.com/SJR-Delta/CWEMF_WS_synopsis.pdf)

“Overview of Delta Nutrient Water Quality Problems: Nutrient Load – Water Quality Impact Modeling,” Agenda for Technical Workshop sponsored by California Water and Environmental Modeling Forum (CWEMF), Scheduled for March 25, 2008 in Sacramento, CA (2008).

[http://www.gfredlee.com/SJR-Delta/CWEMF\\_Workshop\\_Agenda.pdf](http://www.gfredlee.com/SJR-Delta/CWEMF_Workshop_Agenda.pdf)

on the CWEMF website [www.cwemf.org](http://www.cwemf.org) at:

[[http://www.cwemf.org/workshops/DeltaNutrientsWrkshp/Nutrientworkshop\\_files/CWEMF\\_WS\\_synopsis.pdf](http://www.cwemf.org/workshops/DeltaNutrientsWrkshp/Nutrientworkshop_files/CWEMF_WS_synopsis.pdf)] and

[<http://www.cwemf.org/workshops/NutrientLoadWrkshp.pdf>]

Additional information on potential impacts of controlling phosphorus loads/discharges on algal biomass in waterbodies that contain surplus algal-available P compared to growth-rate-limiting P concentrations was provided in the workshop presentation by Dr. Erwin Van Nieuwenhuysse as well as in the Lee and Jones-Lee workshop synopsis.

At the SJR TWG meeting, Lee comment on the need to consider controlling phytoplankton biomass in the SJR in order to meet anticipated US EPA planktonic algal chlorophyll concentrations levels considered to impair the uses of the SJR. The Lee Jones-Lee Stormwater Runoff Water Quality Newsletter Vol.13 no. 3 [<http://www.gfredlee.com/newsindex.htm>] reviews US EPA efforts to develop regional/national numeric nutrient criteria. In time, the US EPA’s approach for developing nutrient criteria will be applied to the excessive fertilization of the SJR and the Delta. The anticipated numeric nutrient criteria/allowed planktonic algal chlorophyll levels will be significantly lower than the levels that occur in the SJR now, and could be on the order of 20 ug/L chlorophyll.

## **Impact of Altered SJR and Sacramento River Flow**

As Lee noted at the SJR TWG meeting, the flow patterns of the SJR and Sacramento River will likely change significantly in the future with the implementation of the Bay Delta Conservation Plan (BDCP). He and Jones-Lee discussed how the south Delta export projects have impacted Delta water flow patterns and Delta water quality, as part of the evaluation of how the pre-Wanger decision altered the export of water from the Delta by the state and federal export projects, for the SWRCB review for establishing Public Trust flows in the Delta:

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](http://www.gfredlee.com/SJR-Delta/Impact_Diversions.pdf)

The BDCP is currently entertaining the potential diversion of up to 15,000 cfs of Sacramento River water around the Delta in a new channel (peripheral canal and/or tunnel); the final recommendation for altered flows of the Sacramento River and SJR is to be developed by the BDCP steering committee by November 2010. Implementation of the BDCP recommendation will greatly change water quality in the Delta, especially with regard to how SJR-associated pollutants (including nutrients) impact water quality in the Delta, including DO depletion in the DWSC, southern Delta channels and the central Delta. To date, however, the BDCP steering committee has not begun to properly address water quality issues and implications in its development of flow alterations for the Sacramento River and SJR into and through the Delta. Information on the BDCP's activities in this regard is available at <http://baydeltaconservationplan.com/default.aspx>. The BDCP steering committee holds public meetings at about two-week intervals; participation in the meetings is via telephone hookup.

***SWRCB Public Trust Delta Flows.*** The SWRCB Public Trust's decisions concerning the amount of SJR and Sacramento River flow that must be devoted to protecting the aquatic resources of the Delta and upstream areas influenced by Delta flows will significantly influence future SJR flow patterns into and through the Delta, and thus the impact of upstream SJR algal oxygen demand on DO depletion in the DWSC and other areas of the Delta. Information on the SWRCB Public Trust deliberations is available at [http://www.swrcb.ca.gov/waterrights/water\\_issues/programs/bay\\_delta/deltaflow/](http://www.swrcb.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/).

***Delta Stewardship Council.*** The decisions concerning future flows of the Sacramento River and SJR into and through the Delta will be determined by the Delta Stewardship Council [website <http://www.deltacouncil.ca.gov/>]; those decisions will undoubtedly be challenged through litigation. The flows into and around the Delta will thus be established based on the outcome of that litigation. The Delta Stewardship Council meetings are public and are webcast.

The issues mentioned herein should be considered in the CVRWQCB in developing SJR upstream oxygen demand control program.

Questions on these reports/issues may be directed to G. Fred Lee at [gfredlee@aol.com](mailto:gfredlee@aol.com).

G. Fred Lee

## **Suggested Approach for Subsequent SJR DWSC Studies**

The 2000-2004 studies on the origin of the oxygen demand that leads to low DO in the DWSC determined that ammonia/organic N discharged by the city of Stockton wastewater treatment plant was at times especially during low SJR flow through the DWSC, a major source of oxygen demand in the DWSC. The other major source of oxygen demand was the algal biomass that develops in the SJR upstream of Vernalis. As a result of the city of Stockton's nitrifying its domestic wastewater effluent, that source of oxygen demand has been greatly reduced/eliminated. As reported in the Lee and Jones-Lee 2003 Synthesis Report and follow-on reports, phosphorus discharged from agricultural sources to Mud and Salt Sloughs serves as "seed" for the large amount of algal biomass that enters the SJR from those sloughs. Controlling that source of phosphorus has the potential to reduce the amount of algae-associated oxygen demand contributed to the DWSC and thus improve the low-DO conditions that develop there. There is need for focused studies devoted to evaluating the potential for reducing the phosphorus loads to Mud and Salt Sloughs as a means of reducing the oxygen demand to the DWSC from upstream sources. Those studies should be coordinated with the Grasslands studies into the further control selenium discharges to the SJR required by the CVRWQCB since controlling selenium discharges will also likely impact phosphorus discharges.

### **Aeration to Control Low DO in the DWSC**

In the mid-2000s there was discussion by some that there would be no need to reduce the input of algae-related oxygen demand to the SJR since the low-DO problem in the DWSC could be controlled by aeration of the DWSC. An aeration demonstration project has shown that it is possible to reduce, but not necessarily eliminate, low-DO conditions in the DWSC by operation of one or more aeration systems. At this time the ability and effectiveness of aeration of the DWSC to eliminate violations of the DO water quality objective in the DWSC remains uncertain. Further, and most importantly, the upstream responsible parties for the SJR upstream oxygen demand have not indicated that they would fund the construction and operation of an aeration system to control the DO WQO violations in the DWSC.

### **Impacts of SJR Algae-Related Oxygen Demand on Low DO in South Delta Channels**

Even if aeration of the DWSC could eliminate the low-DO problem in the DWSC without control of SJR upstream algal oxygen demand, there will still be need to control the impact of the SJR algal biomass that is drawn down Old River through the Head of Old River that contributes to low-DO problems in the South Delta channels.

### **Nutrient Criteria Development**

Another issue that will need to be evaluated is the high algal biomass in the DWSC at Vernalis and upstream of Vernalis. That algal biomass will likely need to be controlled in order to keep planktonic algal chlorophyll concentrations below about 20 ug/L, the nutrient-related WQO that is expected to eventually be developed by the SWRCB/USEPA.

Therefore, independent of the ability of aeration of the DWSC to eliminate violations of the DO WQO in the DWSC, there is need for studies to evaluate the potential for controlling algal biomass in the SJR to address other water quality problems caused by excessive fertilization of the SJR. It is suggested that the CVRWQCB appoint a committee to work with the CVRWQCB

staff in developing a proposed upstream nutrient control study plan to evaluate the potential impact of phosphorus control on algal biomass in the SJR at Vernalis.

**Impact of SJR and Delta Flow Manipulations on  
Water Quality Problems in the Southern Delta and the DWSC**

The 2000-2004 studies of the low-DO problem in the DWSC demonstrated that the flow of SJR through the DWSC significantly impacts the magnitude of the DO depletion in the DWSC. The current Bay Delta Conservation Plan and the SWRCB are considering a variety of plans to greatly impact how the SJR and the Sacramento River flow into and through the Delta. Such flow manipulations have the potential to impact algal growth in the SJR upstream of Vernalis which, in turn, will impact DO depletion in the DWSC and the South Delta as well as many other water quality issues in the Delta. It will, therefore, be important for the CVRWQCB and others carefully review the potential impacts of the range of SJR and Sacramento River flows that evolve from the BDCP and SWRCB deliberations on DO and other water quality issues in the SJR, DWSC, and the South Delta.

It is suggested that the CVRWQCB staff appoint a committee to develop a modeling approach that can be used to evaluate the potential impact of proposed flow manipulations on DO depletion in the DWSC and South Delta. That modeling approach would serve as the framework for developing the studies that will need to be conducted to evaluate the impact of changes in SJR and Sacramento River flows on water quality in the SJR and DWSC/Delta.

Questions or comments on these issues should be sent to [gfredlee@aol.com](mailto:gfredlee@aol.com).