Delta Nutrient Water Quality Modeling Workshop
Background Information

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The California Water and Environmental Modeling Forum (CWEMF) is developing a one-day workshop devoted to an overview of the aquatic plant nutrient-related water quality issues in the Sacramento/San Joaquin Delta. Its purpose is to engender a greater understanding of the nutrient-related water quality issues of the Delta and to better define the data and modeling needs, so that appropriate management programs can be developed for the Delta. G. Fred Lee, PhD, DEE and Anne Jones-Lee, PhD are taking the lead for organizing the workshop. Information on CWEMF activities and its other workshops is available at http://cwemf.org/.

Need for Workshop: The Sacramento/San Joaquin Delta receives sufficient loads of aquatic plant nutrients (nitrogen and phosphorus compounds) to stimulate aquatic plant growths that significantly impair the beneficial uses of Delta waters for aquatic life habitat and resources, recreation, and domestic water supply. However, aquatic plant nutrients are also essential to maintaining beneficial uses of Delta waters. Current understanding of nutrient sources and their relative beneficial and adverse impacts is inadequate to enable the determination of the amount of nutrient control that is needed from various sources to achieve the desired nutrient-related water quality at various locations in Delta tributaries, within the Delta, and in downstream water supply sources/reservoirs.

There is need for an appropriate water quality model(s) to be developed/adapted and utilized to quantitatively relate nutrient sources and loads to specific water quality problems. Such a model(s) would enable the formulation and evaluation of potential nutrient control strategies at various sources to minimize adverse water quality impacts while maintaining desirable characteristics, in the Delta and downstream waterbodies. In achieving those results, the modeling effort would provide a technically reliable framework for formulating a water quality management plan for nutrients in the Delta. That would, in turn, lead to the development of site-specific nutrient water quality criteria for Delta tributaries, the Delta, and those waterbodies that contain large amounts of Delta water.

Developing modeling approaches to relate nutrient sources to specific water quality problems and benefits will also provide a framework for defining the current deficiencies in data/information that are needed to assess the water quality responses to the loads of nutrients from the various sources, as well as nutrient-caused water quality impacts in the Delta and downstream of the Delta.

This workshop would be the first step toward achieving these goals. As discussed below, it will focus discussion on

- existing and desired nutrient-related water quality characteristics in the Delta watershed;
- nutrient sources, transport, transformation, and control in the Delta watershed and downstream waters;

- relationships between nutrient-related water quality and nutrient concentrations/loads – applicable and reliable modeling approaches;
- the scope of existing information needed for such modeling;
- appropriate use and limitations in use of model output; and
- impacts of other conditions and activities, such as clam grazing, and State and Federal water export projects, on algal/aquatic plant-related water quality characteristics of the Delta and downstream waters.

It is anticipated that the initial, overview workshop will be followed by one or more special workshops that focus on particular topic areas.

Topic Areas

Described below are the topics that are proposed to be covered in the initial or follow-up workshops.

Current Nutrient-Caused Water Quality Impacts

- Adverse impacts of aquatic plant nutrients from Delta watershed on water quality in Delta tributaries, the Delta, and domestic water supplies using Delta waters, including:
    - excessive growths of planktonic algae that lead to violations of dissolved oxygen (DO) water quality objectives (WQO) in Delta tributaries and within the Delta;
    - planktonic and attached algae, attached and floating macrophytes such egeria and water hyacinth, that interfere with recreational use of Delta water and also adversely impact aquatic life habitat;
    - major taste & odor problems for several water utilities, caused by algae
    - toxic algae (bluegreen)
- Location, magnitude, and significance of the problems
- Desirable impacts of aquatic plant nutrients on water quality
    - support of food web, habitat, nursery grounds

Defining Desired Aquatic Plant-Related Water Quality Characteristics

- Assessing desired nutrient-related water quality characteristics
    - balance between minimizing adverse impacts of nutrients on water quality and optimizing the beneficial effects of nutrients

Nutrient Source Issues

- Known sources and quantities of nitrogen and phosphorus compounds contributed on at least a monthly basis
- Potential sources in need of investigation/definition
- Nutrient export coefficients – estimation of nutrient loads based on land use and population within the Delta watershed
- Sediments as a source of nutrients
- Shallow groundwater
- Algal availability of nutrients from various sources – not all forms/sources of nitrogen and phosphorus are available to support aquatic plant growth

Nutrient Transport and Transformation

- Transport and transformation of nutrients from various the sources within Delta tributaries, within the Delta, and downstream of the Delta
- Impacts of transported nutrients at locations remote from sources

Nutrient Control Issues

- Cost and effectiveness of removal of nitrogen and phosphorus compounds from domestic wastewaters, urban and agricultural stormwater runoff, and irrigated agriculture tailwater and subsurface drain water discharges
    - Nutrient control at the source(s)
    - Control using herbicides
    - Role of invasive clams in controlling phytoplankton biomass in the Delta

Modeling Issues

- Relationships between nutrient-caused water quality impairment and the biomass of aquatic plants - planktonic algae, attached algae, attached macrophytes, floating macrophytes, and water quality problems;
- Relationships between nutrient loads/concentrations and biomass of aquatic plants;
- Review of the modeling approaches for relating aquatic plant nutrient loads/concentrations to excessive aquatic plant growths
    - deterministic models with possible preliminary application to Delta and downstream waterbodies
    - Vollenwieder-OECD statistical/empirical modeling approach with preliminary application to Delta and downstream waterbodies
    - strengths and weaknesses of deterministic and statistical/empirical modeling approaches for Delta

Role of Nutrients in Sediment Toxicity

- Low DO, ammonia, and hydrogen sulfide

State and Federal Delta Water Export Projects

- Impact of Projects' drawing low-nutrient water from Sacramento River through Delta on primary production of Delta and aquatic life resources
- Effects of eutrophication on fisheries
- Potential changes in aquatic plant production of various Delta channels as a result of the various schemes for modifying how the export projects export Sacramento River water
    - "peripheral canal impacts" on Delta nutrient-related water quality

Regulatory Issues for Controlling Nutrient-Related Water Quality Problems in the Delta

- CVRWQCB excessive "Biostimulatory Substances" water quality objective
    - Implementation of this WQO
- USEPA nutrient water quality criteria development
    - Current requirements and schedule for development

If you have an interest in further information on this workshop as it developed please contact G. Fred Lee at Gfredlee@aol.com.

Further Information

- Additional background information on many of the issues proposed for this workshop is available in papers and reports developed by G. F. Lee and his associates over the past 40 years. Those papers and reports are available on his website, www.gfredlee.com in the "Excessive Fertilization/Eutrophication section" at http://www.gfredlee.com/pexfert2.htm.
- A comprehensive
- A review paper covering many of these issues is,

  Lee, G. F. and Jones-Lee, A., "Developing Nutrient Criteria/TMDLs to Manage Excessive Fertilization of Waterbodies," Proceedings Water Environment Federation TMDL 2002 Conference, Phoenix, AZ, November (2002).
  http://www.gfredlee.com/WEFN.Criteria.pdf
- A comprehensive review of the management of excessive fertilization in the Central Valley is available as:

  Lee, G. F., and Jones-Lee, A., "Managing Nutrient (N & P) Water Quality Impacts in the Central Valley, CA," [Excerpts from: Lee, G. F. and Jones-Lee, A., "Review of Management Practices for Controlling the Water Quality Impacts of Potential Pollutants in Irrigated Agriculture Stormwater Runoff and Tailwater Discharges," California Water Institute Report TP 02-05 to California Water Resources Control Board/Central Valley Regional Water Quality Control Board, 128 pp, California State University Fresno, Fresno, CA, December (2002)], Report of G. Fred Lee & Associates, El Macero, CA (2002).
  Available at http://www.members.aol.com/CentralValleyNutrientMgt.pdf

Sources for Additional Information on Workshop Topic Areas

Aquatic Weed Problems in the Delta

California Department of Boating and Waterways spends approximately $7 million/yr for aquatic pest (weed) control in the Delta. (http://www.dbw.ca.gov/aquatic.asp).

Nutrient Sources

R. Dahlgren UCD reports and papers on nutrient concentrations and loads for SJR, Sacramento River, and Delta islands

Tetra Tech - http://www.swrcb.ca.gov/rwqcb5/available_documents/dw-policy/dwp-wkshp-roy.pdf?

Nutrient Export Coefficients

There is need to develop export coefficients for nutrients ($g/m^2/yr$) from various types of land use (e.g., various types of agricultural activity, urban areas, undeveloped land, forest, wetlands), as well as population equivalent contribution of nutrients (g/person/yr) from domestic wastewaters. This approach is discussed by,

Rast, W. and Lee, G. F., "Nutrient Loading Estimates for Lakes," *J. Environ. Engr. Div. ISCHIA* **109**:502-517 (1983). See also closure discussion, "Nutrient Estimates for Lakes," *Journ. Environ. Engrg*. **110**:722-724 (1984).
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Available Phosphorus Issues

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http://www.members.aol.com/duklee2307/Avail-P.pdf

Lee, G. F., "A Proposal for Assessing Algal-Available Phosphorus Loads in Runoff from Irrigated Agriculture in the Central Valley of California," Report of G. Fred Lee & Associates, El Macero, CA, November (2006).
http://www.members.aol.com/annejlee/AlgalAssayAvailP.pdf

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http://www.members.aol.com/annejlee/AvailPEPASymp06.pdf

Impact of Nutrients on Delta Water Quality

CVRWQCB Drinking Water Policy
http://www.swrcb.ca.gov/rwqcb5/available_documents/dw-policy/index.html

Lee, G. F. and Jones-Lee, A., "Nutrient-Related Water Quality Concerns in the Sacramento and San Joaquin Rivers and Delta," Report of G. Fred Lee & Associates, El Macero, CA, September (2006). http://members.aol.com/annejlee/NutrWQDelta.pdf

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, June (2004).
http://www.members.aol.com/apple27298/Delta-WQ-IssuesRpt.pdf

Eutrophication Water Quality Issues

Jones-Lee, A. and Lee, G. F., "Eutrophication (Excessive Fertilization)," In: Water Encyclopedia: Surface and Agricultural Water, Wiley, Hoboken, NJ, pp 107-214 (2005).
http://www.members.aol.com/annejlee/WileyEutrophication.pdf

Eutrophication and Fisheries

Lee, G. F. and Jones, R. A., "Effects of Eutrophication on Fisheries," Reviews in Aquatic Sciences **5**:287-305, CRC Press, Boca Raton, FL (1991)
http://www.gfredlee.com/fisheu.html

SJR DWSC DO Issues

SJR DWSC DO TMDL Studies
http://sjrdotmdl.org/studies.html

Modeling Oxygen Demand in the SJR DWSC – C. Chen
http://sjrdotmdl.org/library_folder/final_modeling_report1.pdf

CVRWQCB SJR DWSC DO TMDL
http://www.waterboards.ca.gov/centralvalley/programs/tmdl/sjr_do/index.html

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 and CALFED Bay-Delta Program, G. Fred Lee & Associates, El Macero, CA, March (2003).
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http://www.members.aol.com/duklee2307/SynthRptSupp.pdf

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http://www.members.aol.com/GFLEnviroQual/LowDOSummaryDec2004.pdf

Management Practices for Nutrients in Irrigated Runoff

Lee, G. F. and Jones-Lee, A., "Review of Management Practices for Controlling the Water Quality Impacts of Potential Pollutants in Irrigated Agriculture Stormwater Runoff and Tailwater Discharges," California Water Institute Report TP 02-05 to California Water Resources Control Board/Central Valley Regional Water Quality Control Board, 128 pp, California State University Fresno, Fresno, CA, December (2002).
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http://www.gfredlee.com/ag_p-1_012002.pdf

Lee, G. F. and Jones-Lee, A., "Assessing the Water Quality Significance of N & P Compound Concentrations in Agricultural Runoff," Invited presentation to the Agrochemical Division, American Chemical Society national meeting, San Francisco, CA, September (2006).
http://www.members.aol.com/annejlee/N-PRunoffACS.pdf

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Deterministic Modeling of Water Quality

Bowie, G., Mills, W., Porcella, D., Campbell, C., Pagenkopf, J., Rupp, G., Johnson, K., Chan, P., Gherini, S., and Chamberlin, C., "Rates, Constants, and Kinetics Formulations in Surface Water Quality Modeling," (2nd ed), EPA/600/3-85/040, US EPA Office of Research & Development, Athens, GA, June (1985).

Chapra, S., Surface Water-Quality Modeling, McGraw-Hill, New York (1997).

Schnoor, J., Environmental Modeling – Fate and Transport of Pollutants in Water, Air, and Soil, Wiley, New York (1996).

Thomann, R., and Mueller, J., Principles of Surface Water Quality Modeling and Control, Harper & Row, New York (1987).

Vollenwieder OECD Nutrient Modeling

Jones, R. A. and Lee, G. F., "Recent Advances in Assessing the Impact of Phosphorus Loads in Eutrophication-Related Water Quality," J. Water Res. 16:503-515 (1982).
http://www.members.aol.com/annejlee/RecentAdvWaterRes.pdf

Jones, R. A. and Lee, G. F., "Eutrophication Modeling for Water Quality Management: An Update of the Vollenweider-OECD Model," World Health Organization's Water Quality Bulletin 11(2):67-74, 118 (1986). http://www.gfredlee.com/voll_oecd.html

Lee, G. F.; Rast, W. and Jones, R. A., "Eutrophication of water bodies: Insights for an age-old problem," Environmental Science & Technology 12:900-908 (1978).
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http://www.members.aol.com/annelhome/PredictiveCapabilityOECD.pdf

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Nutrients and Sediment Toxicity

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Nutrient Criteria Development

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Please bring to the attention of G. Fred Lee any additional references that are pertinent to Delta Nutrient Water Quality Problems and their management.

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