DRAFT

Charge to Modeling Science Work Group.

Background

In 2009 the California legislature passed the Delta Reform Act creating the Delta Stewardship Council. The mission of the Council is to implement the coequal goals of the Reform Act and provide a more reliable water supply for California while protecting, restoring, and enhancing the Delta ecosystem. The Council wrote and adopted a Delta Plan in 2013 to implement these goals. Chapter 6 of the Delta Plan deals with water quality and contains recommendations to implement the coequal goals of the Delta Reform Act. Recommendation # 8 states, in part,

> *"…the State Water Resources Control Board and the San Francisco Bay and Central Valley Regional Water Quality Control Boards should prepare and begin implementation of a study plan for the development of objectives for nutrients in the Delta … by January 1, 2014. Studies needed for development of Delta… nutrient objectives should be completed by January 1, 2016. The Water Boards should adopt and begin implementation of nutrient objectives, either narrative or numeric, where appropriate, in the Delta… by January 1, 2018.*

The potential problems identified in the Delta Plan includes assessing whether (1) decreases in algal abundance and shifts in algal species composition, (2) increases in the abundance and distribution of macrophytes, including water hyacinth and Brazilian waterweed, and (3) increases in the magnitude and frequency of cyanobacteria blooms are the result of changes in ambient nutrient concentrations in the Delta. White papers are being prepared on each of these topics assessing whether long term changes in ambient nutrient concentrations have contributed to these conditions and whether future changes in nutrient management might remedy the situation.

In the spring of 2014 Water Board staff wrote a new five-year Delta Strategic Work Plan to help prioritize Delta activities. The five-year plan was presented as an information item at the February 2014 Board meeting. Item five in the Strategic Plan lays out tasks, schedule and deliverables to begin implementing the nutrient recommendations in the Delta Plan (Figure 1). The Strategic Plan included the formation of a Technical Advisory

Committee and a Stakeholder Advisory Group (which was later combined into the Stakeholder and Technical Advisory Group or STAG) to help respond to Delta Plan recommendations and to identify additional issues of concern. The Water Board also formed several Science Work Groups to help develop white papers on the three identified nutrient related problems. White papers will include recommendations for research to resolve outstanding questions about the efficacy of nutrient management to control these problems. These recommendations will be incorporated into the Nutrient Research Plan. Draft white papers and a draft Nutrient Research Plan will be available for review by the STAG and the State Board's Independent Science Review Panel in 2015. A final Nutrient Research Plan addressing all review comments is anticipated to be completed and presented as an information item to the Central Valley Regional Water Board and, if requested, the Delta Stewardship Council in 2015.

Need for a Model

Both the STAG, in their draft charter, and Water Board staff recommend that the Research Plan include development of a hydrodynamic model linked to a suite of environmental modules for the Delta. The white papers and associated research will provide valuable information on whether ambient nutrient concentrations in the Delta contribute to present problems and can be managed in the future to remedy them. However, these one dimensional nutrient centric results cannot provide a holistic understanding of the effect of nutrient loads acting in combination with other physical and environmental factors on water quality and food webs in the Delta. Only a robust hydrodynamic model that is linked to a suite of environmental modules can accomplish this.

Investment in a suite of environmental modules that are linked through a hydrodynamic platform will provide multiple benefits. First, such a model would allow an understanding of the ecological significance of changes in nutrients from an ecosystem perspective. For example, an ecosystem perspective is essential to compare and understand the relative importance of clam and zooplankton grazing, transport (flow and settling, routing), light limitation, residence time, water temperature, introduced species and nutrients on algal biomass and algal species composition. A second benefit of such a model is that it would allow researchers to build and test management planning scenarios, based in part on future reductions in nutrient loads already "baked into" the system as the result of past regulatory and management decisions. For example, the model could be used to inform questions like, "*what will be the effect on blue green algal biomass if reductions in nutrients and a simultaneous increase in water temperature and water residence time occurred*"? Finally, a model will help in the

design of field experiments and in the interpretation of their results. All this information will be essential for evaluation, and if needed, the development of a robust nutrient management plan and associated nutrient objectives for the Delta. Development of such a model may also be useful for other researchers as they investigate non-nutrient related issues. At present there is no linked hydrodynamic environmental model that can perform these functions.

The suite of water quality modules needed for the model will depend on the types of questions being asked. Potential questions are included in Table 1. This list will need to be revised and expanded by the Modeling Work Group and STAG. Each of the other three science work groups have been asked at their first meeting to review Table 1 and provide additional questions for the modeling group to consider. The present list has been divided into questions that are of immediate concern and others that are of longer term significance. Information on both time scales is important as development of a nutrient management plan and adoption of nutrient objectives are intended to protect aquatic resources now and in the future in the Delta.

A preliminary list of hydrodynamic platforms that might be coupled with water quality modules is included in Table 2. Some important criteria for the preferred suite of hydrodynamic and water quality modules are listed in Table 3. The STAG and Modeling Science Work Group should review and expand on both Tables 2 and 3.

Charge to the Modeling Science Work Group.

The purpose of the Modeling Science Work Group is to provide advice to the Water Board, STAG and other interested parties on model selection criteria and on the characteristics of the institution(s) where the model and water quality modules would be housed. The deliberations and recommendations of the work group will be captured in a white paper. The white paper will not recommend the preferred suite of models nor the institution responsible for maintaining the model. Instead, the Modeling Science Work Group will (1) examine and expand upon the types of questions that the model will need to inform, (2) assemble a list of important criteria the preferred hydrodynamic platform and its water quality modules should possess, (3) assemble a list of available hydrodynamic and water quality models, (4) evaluate available models against these criteria, discussing the pros and cons of each suite of models and the improvements that would need to be made to develop a functional hydrodynamic linked environmental model, (5) provide advice, if possible, on the cost and amount of time required to successfully develop a linked hydrodynamic water quality model. Finally, (6) integrating the various models, validating and calibrating them is likely to be an expensive, multi-year, multi-phased effort. The work group should provide advice on

how to successfully phase model development and identify key tasks that should be included at each phase of the project. Actual model selection would be left to the funding authorities to determine in a competitive bid process.

Similarly, the Modeling Science Work Group will not recommend the institution responsible for developing and housing the model. The work group will (1) assemble a list of potential institutions interested in being responsible for developing and maintaining the model and (2) assemble a list of criteria the preferred institution should possess. Again, selection of the institution responsible for developing and maintaining the model would be left to the funding institutions.

Work Group Process

Three sessions are envisioned for the Modeling Science Work Group. Philip Trowbridge, San Francisco Estuary Institute, and Water Board staff will jointly organize the meetings, take notes and be responsible for drafting the white paper. The first meeting would be an organizational session with four main objectives.

- Ensure that all members understand the charge, the amount of commitment involved and what the final products should look like.
- Review and solicit additional questions (Table 1) to help inform the suite of models needed.
- Determine whether the proposed membership of the Science Work Group (Table 4) needs additional expertise to produce a robust product.
- Recommend how the work group would like to structure subsequent meeting(s) to provide advice on model selection criteria, characteristics of the institution likely to host the model and phasing of model development.

The work group may wish to give the San Francisco Estuary Institute and Regional Board staff homework assignments at the first meeting to help facilitate a successful second session. The first meeting could be by Web-Ex or in person. The work group should come to the organizational meeting with their schedule so the second session can be scheduled.

The second session may need to be one or more days depending upon the efficiency with which the modeling work group can come to consensus on modeling recommendations. The format of the second set of meetings would depend on the structure recommended by the work group during the first meeting. San Francisco Estuary Institute and Water Board staff would record the deliberations and recommendations of the modeling work group and summarize these in a draft white

paper. The draft paper would be recirculated to the Modeling Work Group to insure it accurately captured their recommendations. A final session may be scheduled to review suggested changes to the white paper after comments from the STAG and from the State Board Independent Science Review Panel have been received. The final meeting could be by Web-Ex or in person.

Products of the work group process will include:

1. Science Work Group white paper and prioritized research recommendations.
2. STAG comments and recommendations.
3. State Board Independent Science Panel comments and recommendations
4. Final white paper and research plan after comments from the State Board Independent Science Panel and STAG have been received and addressed.

This package is intended to support the transparency of the process and ensure that Regional Water Board staff and other interested parties have a complete suite of information needed for their consideration and decision making.

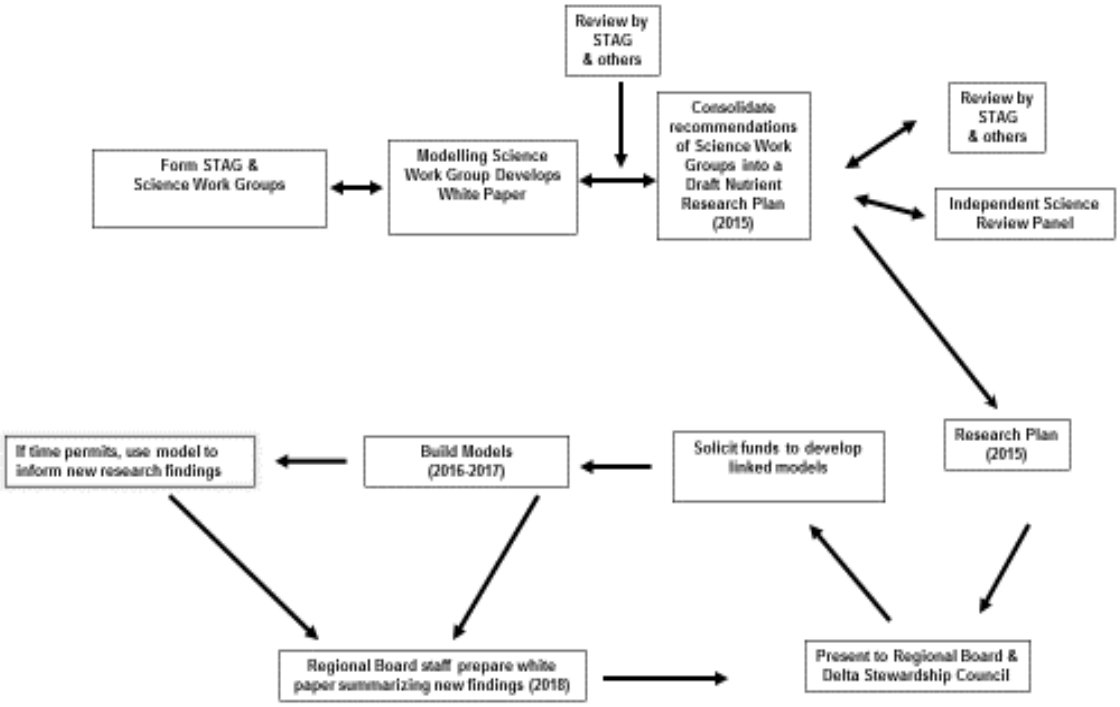

Figure 1. Tasks and schedule for developing and implementing the Nutrient Research Plan as outlined in the 2014 Delta Strategic Work Plan. Staff will solicit input at a 2018 Regional Board meeting whether nutrient objectives are needed for the Delta and whether staff should begin their development.

Table 1. Potential list of the type of questions that a hydrodynamic linked suite of environmental models might inform. The Science Work Groups and STAG should review and propose additional questions for evaluation. Purpose of compiling a list of questions is to insure that the appropriate hydrodynamic platform and suite of water quality modules are selected for use in the Delta.

Short-Term Nutrient Related Questions	
1	What are the main sources and loads of nutrients to the Delta now? How are they transformed seasonally and spatially in the system?
2	What will be the main source of nutrients in the Delta after all permitted NPDES upgrades have been implemented? What will be the new concentrations seasonally and spatially in the system?
3	How will permitted reductions in nutrient loads from NPDES & agriculture change algal biomass and algal species composition seasonally in different areas of the Delta?
4	How will permitted reductions in nutrient loads from NPDES & agriculture change the distribution and abundance of macrophytes in different areas of the Delta?
5	How will permitted reduction in nutrient loads from NPDES & agriculture change the magnitude and frequency of cyanobacterial blooms in different areas of the Delta?
Long-Term Nutrient Related Questions	
1	How will warmer water temperatures and increasing residence time affect the magnitude and frequency of summer cyanobacterial blooms?
2	How will changes in Delta hydrology (new diversion points, changes in the timing and magnitude of river flow, changing residence time) alter nutrient processing, algal biomass and algal species composition in the Delta?
3	What is the relative importance of nutrient loads, grazing, light limitation and river flow on algal biomass and algal species composition in the Delta? What affect would a range of nutrient load management options have on algal biomass and species composition?
4.	What are the main factors affecting the abundance and distribution of macrophytes in the Delta. How is macrophyte abundance predicted to change in the future as a results of changes in various factors?

Table 2. List of available hydrodynamic model platforms.

Model	Description
SELFE	3-dimensional hydrodynamic model with CoSINE modules for NO3, NH4, 2 phytoplankton species, and 2 zooplankton grazers. DWR involved in model development and calibration.
Suntans	3-dimensional unstructured grid, open source, hydrodynamic module calibrated for Delta, funded by CALFED.
Cascade II	Deltares model being developed in collaboration with USGS Menlo Park. Has hydrodynamic and sediment modules.
DSM2	Calibrated 2-dimensional hydrodynamic model for Delta. Has nutrient, chlorophyll and dissolved oxygen modules. Developed and maintained by DWR.
Delta EFDC Water Quality Model	Calibrated 3-dimensional hydrodynamic model for Delta. Has nutrient, algal biomass, 3 algal species, dissolved oxygen, sediment transport and water clarity. Developed at Virginia Institute of Marine Sciences, local calibration supported by the U.S. Army Corps of Engineers.
UnTRIM Bay-Delta model	3-dimensional hydrodynamic and sediment model of the Bay-Delta Estuary. Not in the public domain

Table 3. Preliminary list of desirable criteria for the linked hydrodynamic and water quality modules.

Public domain, peer reviewed, open source
Model successfully employed elsewhere
Compatible with Cascade II and other water quality modules selected by the San Francisco Regional Board for use in Suisun and San Pablo Bays.
Calibrated hydrodynamic and water quality model for the Delta
Model training available locally for end users
Water quality models include modules for nutrients, water temperature, multiple algal species (including diatom and cyanobacteria), sediment transport, light penetration, vertical mixing, macrophyte production and zooplankton and clam grazing
Spatial scalability—model can be started at a simple, coarse grained, large-cell version, with finer scale resolution and complexity added as the need arises and data allow.
Temporal scalability—model can accommodate time scales from hourly to decadal.

Table 4. Potential list of Individuals for the Modeling Science Work Group.

Individual	Agency	Modeling Work Group
David Senn	San Francisco Estuary Institute	X
Joe Domagalski	US Geological Survery	X
Chris Enright	Delta Stewardship Council	X
Lisa Thompson	Sac Regional County Sanitation District	X
Bill Fleenor	UC Davis	?
Phil Trowbridge	San Francisco Estuary Institute	X
Edward Gross	Resource Management Associates	?
Michael Deas	Watercourse Engineering, Inc	?
Frances Chung	Department of Water Resources	?
Lisa Lucas	U.S. Geological Survey	?

Key: X = Individual agrees to participate in work group. ? = Individual has been identified as a potential candidate to participate in work group