Review of CALFED
Proposal #2001- F208-3

Sediment and HG Fate and Transport Models to Guide Monitoring and Management in the Delta

Proposal number:2001-F208-3 **Short Proposal Title: Hg Fate and Transport Models for the Delta**

1a) Are the objectives and hypotheses clearly stated?

In the proposal, the objectives are clearly stated to "simulating sediment and Hg distributions in the Delta, link simulated MeHg concentrations to fish burdens, and estimate relative effects of management plans" with the use of numerical models. These objectives are very commendable to improve water quality and habitat in the Delta system. The hypotheses are explicitly listed, with impacts to management and restoration goals in the Delta.

1b1) Does the conceptual model clearly explain the underlying basis for the proposed work?
The conceptual model is summarized in figures 1, 2, and 3 as well as described in the text. The overall process of Hg transport and fate seems quite complex, and the use of the figures was a great benefit to describe the process, however I have several comments to make concerning some of the phases of the process. The process phases are: transport, transformation and cycling, speciation, and bio-uptake.

For transport, the discussion entails hydrodynamic advection of the water in the Delta. The Delta is a very complex network of channels, influenced by fresh water inflows as well as tidal influences. The discussion mentions these forcings, however, the western end of the Delta is influenced more by an approximately 12 hour repeating period, not a 25 hour period as mentioned. They also mention a longer term 19 year cycle as being important for very long period oscillations. This is true, however, there are probably greater influences due to the spring/neap 14.76 day cycle and the episodic storm events in the winter and spring, than the mentioned 19 year lunar nodal period. The Delta is comprised of over 700 miles of channels (Oltman, http://water.wr.usgs.gov/projects99/ca542.html). The main advection problems will be in the determination of the water surface elevations within the Delta system. It is the differences in water levels that drive the flows. Differences in water level between the Sacramento and the San Joaquin Rivers, propagation of the tidal signal, and pumping withdrawals from the Delta result in the complex flow patterns. The proposal does not seem to indicate working knowledge of the complex flow patterns in the Delta.

For the transformation and cycling, the Delta is characterized by a series of volumes. This is a sound approach for mass transformations, but the size of the volumes for mass conservation of Hg may differ than the size necessary for hydrodynamic simulations. The proposed 1-D hydrodynamic model will be used to simulate a 2-D (actually a 3-D) physical process. Therefore, the relation of the model grid sizing needs to be compared to the physical processes of Hg speciation, transformation, etc. No mention on a typical volume size is given. The writer does mention that the Delta will be "discretized in detail with about 500 reaches, representing channels as small as about 300 meters in length and 7 meters in width." I do not know if this means that the grid size will be 300 meters long. In addition to spatial variability, temporal changes need to be addressed. It is mentioned that model time steps will be "<1 hour to capture the dynamic mature of Delta currents." How does this time step compare to the dynamic nature of sediment transport or methylation? For example, the benthic element of surficial sediments is a continuously changing (dynamic) system, with a temporal variability on the order of minutes for deposition and re-suspension. Do these time steps compare favorably to methylation rates? Spatially, do hydrodynamic changes in bed shear stress and volume flow rates compare with spatial homogeneity in methylation rates?

Speciation is mentioned to be influenced by the presence of other chemical components in the water. Since speciation is the only link (figure 1) to biouptake, this step could be considered as a vital link between

available Hg and uptake. How much influence will there be if you use assumed water chemistry concentrations?

1b2) Is the approach well designed and appropriate for meeting the objectives of the project?
The approach is designed to be able to accommodate the objectives of the project. The objectives are to develop a numerical model to support adaptive management of Hg contamination in the Delta. The need to develop a numerical model to simulate all the physical processes in such a large and dynamic environment is essential. Once established, the model can then be utilized to ascertain the impact of various restoration and management scenarios.

However, it must be emphasized that a numerical model is only as good as the assumptions made in developing and calibrating the model. With this, a numerical model will require future calibrations to update bathymetry, Hg loadings, methylation rate assumptions, speciation assumptions, etc, all which will change due to advancement of current state of knowledge and changing environmental conditions. In this regard, the model will also be a necessary adaptive management tool.

1c1) Has the applicant justified the selection of research, pilot or demonstration project, or a full-scale implementation project?
The selection of a research project is justified in regards to modeling the complex Delta system and Hg transport and fate. The numerical model is proposed to be calibrated with available field data and collaborating with other CALFED projects.

1c2) Is the project likely to generate information that can be used to inform future decision making?
The project is very likely to generate information that can be used for future decision making. The model will be used to predict long term future results, which can be used to provide guidance for Hg management schemes in the Delta. Temporal and spatial changes in the Hg loadings can be accounted for in an adaptive management scheme with the development of a numerical model.

2a) Are the monitoring and information assessment plans adequate to assess the outcome of the project?
This project has expected deliverables of three reports describing the results of the numerical modeling and project phases. Additional deliverables include animation files, etc., of model output. There is no mention as to how the results of the numerical models will be assumed to be calibrated with "available field data." Are the results going to be compared with spectral analysis methods to show "in phase" relations of individual tidal constituents, such as the M2 (12.42 hour tidal signal)? Are we going to just see a series of plots that show field and model results with wiggly lines that match up? How will sediment results of the model be considered calibrated to measured field data? Are you using tidally averaged quantities, or tidal time scale variations of sediment? How about Hg concentrations? What is an acceptable level of calibration of the model to field data?

One additional point needs to be made. The "field data" that is used as boundary conditions and internal calibration points must first be analyzed to determine the source of variability in the field data. For example, if sediment data at an interior location is used for calibration, and the sediment is influenced by wind re-suspension, then either you need to add wind to your model or remove it from the field data. Additionally, water level data is influenced not only by the tide, but also by changes in atmospheric pressure, wind, and fresh water inflows. If a water level boundary condition is assumed at the western end of the Delta, the time series of "field data" needs to analyzed to separate out the individual forcings. A harmonic re-creation of the water level at the western end of the Delta is not appropriate as a boundary condition during high flow periods, because the high flows will alter the water level, making a prediction here inaccurate. If field data is used as a boundary condition during high flows, then how will the model be used to predict future results?

2b) Are data collection, data management, data analysis, and reporting plans well-described, scientifically sound and adequate to meet the proposed objectives?
Data collection is not proposed in this project. However, the project appears to be well coordinated with other data collection CALFED projects, which will supply information on Delta Hg processes. Data

management for this project appears to be well organized and the results of the numerical modeling will be made available in various formats. The timing of the reporting is deemed to be sound and adequate.

3) Is the proposed work likely to be technically feasible?
The proposed work is technically feasible. However, for the project timeline it is stipulated that in 7 months (Feb 2001 - Sept 2001) the staff will: 1) become familiar with the use and applications of the numerical model (I am assuming Mike 11); 2) obtain all relevant field data and develop input files for geometry, flow, water level, and sediment; 3) generate a grid for the Delta; 4) produce a model to simulate hydrodynamics and sediment transport processes in the complex Delta system; and 5) calibrate the model for hydrodynamics and sediment transport to other field data. The proposal includes the assistance of DHI representatives in establishing the model, and performing the model calibrations. In my estimation, this will be a difficult goal to attain in 7 months. Additionally, future work may require the need for a 2-D component to include wetlands restoration areas. It was not clear if this will constitute additional work or if it is included in this scope of work.

4) Is the proposed project team qualified to efficiently and effectively implement the proposed project?
The proposed team appears to be capable to handle the objectives and goals set forth in the proposal, especially with the initial assistance of DHI representatives. All listed team members appear to be qualified for their specific abilities to make this project feasible. However, it is felt that it may be difficult to develop a calibrated hydrodynamic and sediment transport model of the Delta in the proposed 7 month time line. Spatial and temporal resolution of the model needs to be considered in the overall proposed scope of work, not just for the hydrodynamics and sediment transport. For example, is the suggested 1 hour time step of the model short enough to handle the complex interaction at the water/benthic interface to appropriately model Hg interactions? The answer to this question may not be achieved until year 2 of the project.

Miscellaneous comments
Results of the numerical model are essential to the outcome of this proposal. Developing and calibrating a reliable and accurate model is of utmost necessity. I did not see much information on temporal or spatial grid sizes to accurately assess if this model will be able to quantify the hydrodynamics, and suspended sediment transport in the Delta system. The proposal states "Models allow extrapolation, or interpolation, of a small data set to an entire ecosystem over long periods of time." I do not agree with this statement. Models are only as good as the assumptions you made to develop them, and only as good as the field data used to manipulate the resistance and mixing coefficients to match field data (process called calibration). Results from a short period of time do not reflect long term changes. You cannot use short term results to argue that your model will be valid for a long period of time.

The Delta is influenced by fresh water inflows and tidal forcings. The fresh water inflows act on time scales of days to weeks. And each year these are different. The tidal forcings have short periods on the order of hours to long term periods of 14 day, and yearly periods. Data from a short time period cannot account for all of the temporal variations. Recent studies by Schoellhamer and Dinehart (http://water.wr.usgs.gov/program/sfbay/calfedsed/) at the USGS have shown that sediment transport in the Sacramento River may be based more on episodic events rather than long term transport. If you calibrate the model to field data acquired during the winter storms, you also need to compare results to steady fresh water inflow periods. The proposed model must show that it can handle both short term and long term variability. Other model concern: How will this 1-D model account for point sources? The proposal suggests possible point sources, will these be considered immediately well mixed in the entire "aquatic element"?

The proposal additionally states "As part of an adaptive management scheme, it is important to develop numerical models early in the process …" I agree with this. It is necessary to develop a model, and the selection of which model to use and how it is "calibrated" is essential in the entire process. Additionally, the sediment transport routines are stated as "not being applied to the Delta as yet." Since it is being assumed that "both total Hg and MeHg may be tracked along with sediments," it must be ensured that the correct modeling choices are being made early in the process.

Overall Evaluation Summary Rating	Provide a brief explanation of your summary rating
☐ Excellent ☐ Very Good ☐ Good ☐ Fair ☐ Poor	Summary Rating = good.

Brief Explanation of summary:

Summary rating is based on the fact that the need for this model is very justifiable, and is definitely in accordance with ERP. Additionally, there appears to be a strong cooperative effort between this proposal and other CALFED funded projects. However, I have concerns that it may not be feasible to develop this model on such a short time line. Additionally, since the Hg transport will be assumed to be related highly to sediment, the hydrodynamics and then sediment transport must first be soundly based before any results of Hg transport can be deemed accurate.