THE BRAKE PAD PARTNERSHIP

Compilation of Technical Reviewers' and Stakeholders Comments' on Bay Modeling Draft Work Plan

October 17, 2005

Background

Copper in the San Francisco Bay has been a pollutant of concern since the State of California listed the Bay as a high-priority impaired water body in 1996. In 1998, the State of California listed copper and several other metals as pollutants of concern for the San Francisco Bay. These listings triggered a regulatory requirement that water quality attainment strategies be developed for copper and the other pollutants of concern. Since then, site specific objectives for copper have been established for the bay south of the Dumbarton Bridge, and a copper water quality attainment strategies process is currently underway for the bay north of Dumbarton Bridge.

The Brake Pad Partnership's efforts are aimed at evaluating the potential impact of copper from brake pads on water quality in the South San Francisco Bay. On behalf of the Brake Pad Partnership, URS will conduct water quality modeling of copper originating from vehicle brake pad wear debris to better understand how copper in brake pad wear debris (BPWD) travels through the environment and the potential impacts on water quality in the San Francisco Bay for which copper is a pollutant of concern. This water quality modeling effort is being conducted as part of a larger study examining the potential impact of copper from brake pad wear debris released to the environment. The objective of the environmental transport and fate modeling is to predict how copper released from brake pads enters the Bay and affects both the short-term and long-term concentrations of copper in the Bay. The proposed approach is to identify existing models for air, watershed, and water quality, modify them if necessary to characterize the specific fate and transport of copper in brake pad wear debris, and combine them to allow evaluation of the fate and transport of brake pad debris from point of creation (automobiles) to point of eventual deposition (San Francisco Bay).

A hydrodynamic, sediment transport and water quality model has already been calibrated for San Francisco Bay and has been used previously to explain spatial and seasonal fluctuations in dissolved copper concentrations. This adapted MIKE 21 model will be used to predict seasonal and short-term changes in benthic and dissolved copper concentrations due to atmospheric and watershed loading of copper from brake pads. Since practical limitations prevent use of the MIKE 21 model over long time periods (i.e., decades), a compartmental model will be integrated with MIKE 21 to predict long-term changes.

URS will conduct the modeling of copper fate and transport in San Francisco Bay by developing model input information based on watershed model and air deposition results. URS will also conduct modeling to evaluate short-term impacts of copper from brake wear debris. URS will estimate short-term changes in brake pad-related copper concentrations in San Francisco Bay from the difference between two series of MIKE 21 model simulations. Each simulation is planned to cover a one-year period. The two planned simulation series include output from the atmospheric deposition and watershed runoff models as source loads, with and without the brake pad contribution. The differences in modeled San Francisco Bay dissolved and benthic copper concentrations between the runs will estimate the brake pad contribution.

Three environmental modeling studies are at the core of the Partnership's effort, including an air deposition model, watershed model and Bay model. The air deposition model will provide the following: 1) Estimates of the amount of air deposition of copper from BPWD directly onto the Bay, 2) Estimates of the deposition of copper from BPWD onto other parts of the watershed. The results of this modeling effort will provide inputs to the watershed model. The watershed model will estimate the amount of copper from brake wear debris that is discharged from the watershed in runoff, providing inputs to the Bay model, which will estimate short- and long-term concentrations of copper in the San Francisco Bay.

The air deposition model has two time scales. For the regional background, the model uses a 5-year average set of meteorology and the temporal resolution is going to be a month. For the local (Castro Valley creek watershed) scale model, the model is based on one-year daily meteorology that will be used to drive the model, with the goal to compare against air deposition monitoring data. The watershed and Bay model uses daily mean output values for multiple years, which may include roughly 1989-2003.

The Brake Pad Partnership Steering Committee is seeking an independent expert review of the Draft Work Plan for Bay modeling for the environmental fate and transport of copper from vehicle brake pad wear debris to ensure that the approach and results of this element of the Partnership's work are technically sound, to determine if there are feasible opportunities to strengthen this work, and to help build in-depth understanding of and confidence in the technical studies on the part of the Steering Committee and the stakeholder communities.

<u>Charge</u>

With the aim of meeting these objectives, the Steering Committee has developed the following questions on which it is seeking specific comments from the reviewers:

1. In your assessment, is the proposed methodology appropriate to the task of Bay modeling for the fate and transport of copper from vehicle brake pad wear debris in the environment? Are there any other approaches or modifications to the approach described here that you recommend?

2. Based on your experience with similar fate and transport of pollutant efforts, what kinds of advice do you have for the Bay modeler in conducting modeling for the

environmental fate and transport of copper and addressing both total and dissolved fractions if the data are amenable?

3. Would you recommend any modifications to the procedures to improve the usefulness of the Bay model?

4. Will the data generated by the air deposition model and watershed model provide appropriate inputs for the Bay modeling approach described in this work plan?

5. In your assessment, does the draft work plan sufficiently meet the goal of the Bay modeling effort to determine to what extent, if any, copper from brake pad wear debris affects short- and long-term concentrations of copper in the Bay? In addition, is the work plan capable for addressing the overall goal of the Brake Pad Partnership which is to provide data and assessment to determine whether:
    - Automobile brake pads are a significant source of copper to the South San Francisco Bay; or
    - Automobile brake pads are not a significant source of copper to the South San Francisco?

<u>Comments Received</u>

Comments of Kevin Reinert, AMEC Earth & Environmental (October 5, 2005)

Section 1 – this work plan discusses the whole Bay whereas the charge to reviewers addressed only the South Bay (comments dated 9-7-05)

Section 2 – good to see POTW and marina sources will be included, although MAF inputs to the Bay from commercial vessels should also be included (Coast Guard, moth-balled Navy fleet, etc.)

Table 2-2, 3rd row – air deposition model provides total copper when the Bay model will operate on dissolved – extra conversions needed – see next comment and comments on air deposition report

Table 2-2, 4th row – unfortunately, the watershed model will provide total concentrations, requiring the conversion to dissolved – what equations/approaches will be used for this conversion?

Table 2-2, 5th & 7th row – again, how will the total levels be converted to dissolved?

Section 2.2 – it would be better to select the model before the project begins rather than during so that the short term model can be more easily connected to the long term model. Of course it would have been better to have the selection made prior to data collection and the design of the air and watershed models in order to inform those processes.

Section 2.2.2 – verification is the title of this section, but no model can truly be verified nor validated; only positive validation trials can be demonstrated. Additionally, the text refers to calibration or parameterization of the model and not 'verification.'

Section 6 – the air deposition report and the watershed report (under development) should be added to the references.

The results of the Bay modeling will be quite interesting and useful to our overall understanding of copper in the Bay and our abilities to predict change.

Comments of Jerome Maa, Virginia Institute of Marine Science (October 13, 2005)

Mike 21 is a 2-D model, and thus, will not be able to address the salinity stratification and sediment transport issues in the South San Francisco Bay because there are navigation channels. Although quite a large portion of the South San Francisco Bay is shallow and relative flat, the connection of the south bay to other areas mainly goes through the channels. Therefore the selection of a 2-D model would not be a suitable one. It is not clear to this reviewer why a 3-D model is not applied yet. Actually, there are plenty of 3-D models available, for example, the EFDC (or HEM3D) from EPA is a widely accepted software free from EPA (www.epa.gov/athens/wwqtsc/html/efdc.html). USGS also has a quite sophisticated 3-D model UnTRIM (Casulli and Walters, 2000), which has been applied for the North San Francisco Bay four or five years ago (probably it is applied to the entire San Francisco Bay now). The reviewer understands that the budget may be an issue, but since there is no necessity (may be I am wrong on this) to do the job right now, may be the best way would be save the money and wait until it is the time to do and do it right.

The selection of sediment calibration parameters: settling velocity (ws), critical velocity (ucr), and resuspension rate (ε) is another major concern of this proposal. In this proposal, a minimum and maximum value of each parameter are suggested. There is no justification, however, on why these numbers are selected, and where these numbers should be used. For example, the settling velocity has a range of 0.04 to 6 m/d (a 1500 times in difference), but what is the true range of settling velocity? Is there any relationship between ws and suspended sediment concentration? How to determine the settling velocity at a particular location? The experience of this reviewer at the Chesapeake Bay shows that the range is within 500 times, and ws is a function of suspended sediment concentration. Since current available techniques are capable of measuring this parameter (*e.g.*, Sternberg *et al.*, 1999; Mikkelsen and Pejrup, 2001), why not measure it first in order to have a reasonably accurate range to work with. This seems not an important issue from a modeler's point of view. But it is actually very important for the BPP because the modeling results from using the measured data are much close to the truth. Any modeler can produce a "looks reasonable" result if they can freely choose the range of input parameters. For example, a modeler can select a high erosion rate and a high settling velocity, or a low erosion rate and a low settling velocity, to produce a similar suspended sediment concentration range at the calibration stations. But what happened for the sediment transport (*i.e.*, amount of copper transport) would be very different.

Same comments for the critical velocity and resuspension rate. This reviewer would like to point out that these two parameters can be well measured since 1995 using an *in-situ* device (Maa *et al*., 1998) or a semi *in-situ* devices (Roberts *et al*., 1998). The spatial and temporal variability of these two parameters can also be addressed by using 2 the above mentioned devices, and thus highly recommended before carrying out the modeling study. The proposed modeling effort seems ignoring the spatial and temporal variability of these two parameters, at least it is not addressed on how to deal with the very possible different erosion rate and ucr in the South San Francisco Bay. What are the bases on how to select these numbers? It would be naive to believe that one erosion rate can fit the entire south bay.

Without a reasonable good database on the sediment characters (*i.e.*, ws, ucr, and ε), the simulation results do not have too much meaning because it would be hard to convenience the BPP (and others) that the simulated results are going to happen in reality.

This reviewer is not an expert in chemical processes, and for this reason, the portion of copper transport is not reviewed.

Suspended Sediment (SS) load and metal concentration load from watersheds can be better simulated. The proposed use of only high and low flows seems too rough. Is there an equation to correlate the SS load to daily average discharge? This reviewer knows that this kind of equation is available for the Chesapeake Bay watersheds (from USGS), so please check USGS and find out is there a similar equation available for the San Francisco Bay watershed?

Is there any ground water flux that can take the adsorbed copper from buried sediment to the bay? In this proposal, the diffusion process is addressed, but the ground water flux may be more important, if exists. It is recommended that the possibility of ground water flow should be checked. USGS may have a summary of this information.

References:

Sternberg, R.W., I. Berhane, A.S. Ogston. 1999. Measurement of size and settling velocity of suspended aggregates on the northern California continental shelf. *Marine Geology*, 154, 43-53.

Mikkelsen, O.A. and M. Pejrup. 2001. The use of a LISST-100 laser particle sozer for in-situ estimates of floc size, density and settling velocity. *Geo-Marine Letters*, 20, 187-195.

Maa, J.P.-Y., L. Sanford and J.P. Halka, 1998. Sediment resuspension characteristics in the Baltimore Harbor. *Marine Geology*, 146:147-145.

Casulli, V. and R.A. Walters, 2000. An unstructured grid, three-dimensional model based on the shallow water equations, *Inter. Journal Numerical Methods in Fluids*, 32, 331-348.

Roberts, J., R. Jepsen, D. Gotthard and W. Lick. 1998. Effects of particle size and bulk density on erosion of quartz particles, *Journal of Hydraulic Engineering, ASCE*, 124(12), 1261-1267.

Comments of Brent Topping, USGS, Menlo Park (October 14, 2005)

<u>Response to Charge Questions:</u>

1. In your assessment, is the proposed methodology appropriate to the task of Bay modeling for the fate and transport of copper from vehicle brake pad wear debris in the environment? Are there any other approaches or modifications to the approach described here that you recommend?

    - **As indicated in the comments within the PDF, my main concern is the assumption that diffusion controls the benthic flux of solutes from the porewater into the overlying water. The active benthic community of clams, worms and other biota create significant bioturbation that can greatly enhance benthic flux through advection.**

2. Based on your experience with similar fate and transport of pollutant efforts, what kinds of advice do you have for the Bay modeler in conducting modeling for the environmental fate and transport of copper?

    - **Based on the reference I mentioned within the PDF comments, it's possible that diffusion-only estimates could underestimate the benthic flux by an order of magnitude. And, as indicated in Topping and Kuwabara, 2003, benthic flux of a metal (in this case nickel) can be *the* dominant source to the Bay, at least during the low-flow season.**
    - **However, these fears are somewhat assuaged by the fact that our benthic flux studies to date (Kuwabara et al., 1996; Topping et al., 2001) have shown variable benthic flux for copper. Unlike nickel, which has shown consistently positive flux (out of the sediment), copper has been variable in direction. So, the data published thus far doesn't warrant concern, but it's a limited dataset, and it's possible that periodically the biologically-enhanced benthic flux could be a significant factor.**

3. Would you recommend any modifications to the procedures to improve the usefulness of the Bay model?

- **However, to be safe, I would track the contribution of the benthic flux component of the model throughout. (Not being a modeler, I'm not sure if that's possible). If it never exceeds 5% of the copper source, it would probably be safe to conclude that it's NOT the dominant source at any time. I say 5% because if it was an order of magnitude higher than diffusive estimates, it would be 50%.**

4. Will the data generated by the air deposition model and watershed model provide appropriate inputs for the Bay modeling approach described in this work plan?

    - **It's always difficult to estimate inputs from an entire watershed/ air mass, but this should provide a reasonable estimate.**

5. In your assessment, does the draft work plan sufficiently meet the goal of the Bay modeling effort to determine to what extent, if any, copper from brake pad wear debris affects short- and long-term concentrations of copper in the Bay? In addition, is the work plan capable for addressing the overall goal of the Brake Pad Partnership which is to provide data and assessment to determine whether:
    - Automobile brake pads are a significant source of copper to the South San Francisco Bay; or
    - Automobile brake pads are not a significant source of copper to the South San Francisco?

    - **I think it will be a welcome addition to the understanding of metal dynamics in the Bay in general, and to the Brake Pad question in particular. Thank you for allowing me to review this plan.**

Kuwabara, J.S., Chang, C.C.Y., Khechfe, A.I. and Hunter, Y.R., 1996, Implications of dissolved sulfides and organic substances for the chemical speciation of trace contaminants in the water column of San Francisco Bay, California, in Hollibaugh, J.T., ed., San Francisco Bay: the Ecosystem: Amercian Association for the Advancement of Science, Pacific Division, San Francisco, p. 157-172.

Topping, B.R., Kuwabara, J.S., Parchaso, F, Hager, S.W., Arnsberg, A.J., and Murphy, F., 2001, Benthic flux of dissolved nickel into the water column of South San Francisco Bay: U.S. Geological Survey Open-file Report 01-89, 50 p.

Topping, B.R. and Kuwabara, J.S., 2003, Dissolved-nickel and benthic flux in South San Francisco Bay: a potential for natural sources to dominate: Bulletin of Environmental Toxicology and Chemistry, v. 71, p. 46-51

Comments of Kelly Moran, representing Bay Area Storm water Management Agencies, TDC Environmental (October 14, 2005)

Below are my comments on the Bay Modeling draft work plan. As I expected, the workplan--which is based on the well-vetted modeling URS did for San Francisco--looks like it is headed in the right direction to answer the BPP's questions. I thought the figures and tables were helpful, particularly in that they communicate a lot of information very efficiently.

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(1) Long-Term model selection. While I fully understand the reasons for URS's plan to defer selection of the long-term model, I believe that there needs to be a bit of discussion and review of the model selection decision before it is finalized. There are several possible approaches to this that might serve the BPP's needs. I recognize that we do not wish to create additional work for URS, but I also know that it could be far more cost-effective to review the decision in advance of production of the report than to defer review until after the report is complete, because the review could raise important issues for the BPP. Arleen Feng tells me that recent discussion of the CEP's box model (the one under development by SFEI that URS refers to in its memorandum) has increased regional interest in such models--and has increased regional understanding of possible limitations of such models based on their design. This experience highlights the need to ensure stakeholder comfort with the model selection, to reduce the risk of unanticipated problems during the peer/stakeholder review of the modeling draft report.

I suggest that we ask URS to prepare a short memorandum next spring about the model selection that we can circulate to interested parties and peer reviewers to identify and resolve any issues prior to completion of the modeling. I don't believe that this would be substantial additional work, as the model selection normally would have been part of the workplan. The main focus of the memo should be on the pros and cons of the various options and the reasons for selection of the preferred model.

(2) Additional recent data. The Clean Estuary Partnership has generated some Bay copper monitoring data in addition to data collected by the RMP. These data and some analysis of them are presented in two reports (North of Dumbarton Bridge Copper and Nickel Site-Specific Objective (SSO) Derivation; North of Dumbarton Bridge Cu and Ni Development and Selection of Final Translators). I'm not sure if there will be data of use to URS in these reports, but want to make sure URS reviews them and uses any relevant data.

(3) Reliance on SFO modeling. This workplan relies extensively on the work URS previously did for the City and County of San Francisco's proposal to expand San Francisco airport. The details of the model and answers to many of the reviewers' likely questions are contained in the reports that URS prepared for SFO. While I recognize that the level of detail of the SFO reports is high, I think that it is essential that the information in these reports is available to reviewers not familiar with the SFO modeling. One way of handling this would be to place the relevant documents on the BPP web site

(e.g., section 5 of the Final Technical Report and the few most meaningful figures & tables--a subset of the dozens of figures and tables included in the SFO report). I think including a summary (if one exists that would be appropriate for this purpose) as an appendix to the workplan would be really helpful.

(4) Figure of modeling area. A common question of BPP participants is "exactly what part of the Bay are we modeling". It would be very helpful to include a simple figure showing the exact area covered by the model in the workplan to make it easy to answer this question. If URS doesn't have such a figure already, the watersheds figure could probably serve this purpose if it had a line on it showing the Bay area covered by the model.