UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

May 12, 2000

OFFICE OF
WATER

MEMORANDUM

SUBJECT: An SAB Report: Review of the Biotic Ligand Model of the Acute Toxicity of Metals (EPA-SAB-EPEC-00-006)

FROM: J. Charles Fox
Assistant Administrator (4101)

TO: Chair
Science Advisory Board

Dr. Terry F. Young, Chair
Ecological Processes and Effects Committee

Dr. Charles A. Pittinger, Acting Chair
Ecological Processes and Effects Committee

I would like to thank the Ecological Processes and Effects Committee (EPEC) of the Science Advisory Board (SAB) for its review of the Biotic Ligand Model (BLM) as part of the Agency's integrated approach to metals assessments in surface waters and sediments. The Committee responded to all the questions posed in the charge in a clear manner, and provided the Office of Water (OW) with several recommendations for guiding future BLM research efforts.

I am encouraged by your favorable response to the BLM in its early stage of development. With this endorsement the Agency can move forward with the development of the BLM and its applications in the water quality criteria program.

Attached are detailed responses to the SAB's specific recommendations and comments. As requested, a diskette with an electronic copy of our responses is also attached. If the SAB has any questions regarding the responses, please contact Jeanette Wiltse, the Director of the Health and Ecological Criteria Division in the Office of Water at 202-260-7317.

cc: Office of Research and Development

Attachments

Attachment

I. General Recommendations

A. Scientific and Theoretical Foundation

Comment
The scientific underpinnings of the BLM appear to be sound. The strength of the model lies in the fact that it is built upon a mechanistic paradigm with a strong physiological basis, i.e., predicting binding at the site of action (gill in fish) and the mechanism of acute toxicity (blockage of sodium and calcium uptake) for metals (copper and silver).

Agency Response
The Agency agrees.

B. Nationally Recommended Aquatic Life Criteria

Comment
It appears both premature and somewhat impractical to use the BLM model to revise the protocol for developing national ambient water quality criteria at this time. It is possible, however, that significant enhancements in the model's accuracy and applicability will be made in the near future so that the BLM can be incorporated into the CMC [criterion maximum concentration] and CCC [criterion continuous concentration] protocols.

Agency Response
The Agency agrees that, at the time of the April 1999 Review, the Agency did not have sufficient information to support immediate use of the BLM to develop updated national aquatic life criteria. However, the Agency believes that ongoing BLM work, funded primarily through the Water Environment Research Foundation (WERF) and coordinated with EPA's own research, should provide the information necessary to support the replacement of empirical hardness-adjusted criteria with BLM-adjusted criteria. See Responses II-B-1, II-C-2 and II-D-1 for more detail on WERF's research efforts.

The Agency believes that the BLM can be practically incorporated into nationally recommended aquatic life criteria. There may be some uncertainty about how this would be accomplished because the Agency did not present its methodologies to the SAB. To clarify, the Agency has never attempted to calibrate its normalization models to fit every species used in the criteria derivation and would not begin such an attempt now.

EPA intends to follow the same general procedure for normalizing its criteria using the BLM as it does for normalizing its criteria using an empirical hardness correction. Based on the existing criteria derivation Guidelines (Stephan et al. 1985), the Agency's prerequisites for using the BLM (or any other approach) to adjust nationally recommended criteria for site-specific water quality parameters will be the following: (1) the BLM must be calibrated for acute toxicity tests with at least two species, for which

the water quality parameters included in the model vary over a sufficient range; and (2) the ability of the model to normalize the available toxicity data for other species will be evaluated.

Again, following the existing criteria derivation guidelines, EPA will apply the acute relationship to the chronic criterion, unless the data persuade otherwise. To derive a different water quality normalization (that is, a different BLM) for chronic toxicity, the existing guidelines call only for calibration with a single species, while again checking the ability of the model to normalize the remaining data.

Because the freshwater copper criterion is to be the first criterion to use the new mechanistic BLM approach for adjusting for water quality, EPA may provide for copper more than the minimum needed to support a water quality adjusted criterion. Nevertheless, EPA does not intend to set new more difficult acceptance criteria for using the BLM than for using the empirical hardness approach. EPA does not see any benefit in delaying the replacement of the single-parameter empirical approach, which is sharply criticized from both ends of the stakeholder spectrum, with the improvements of the BLM approach.

C. Site-specific Copper Criteria

1. *Comment*
The model should presently be reserved for calculation of site-specific modifications to acute toxicity criteria, i.e., in estimating the criterion maximum concentration. The data are not sufficient to support the current use of the BLM in estimating chronic water quality criteria (i.e., the criterion continuous concentration). However, we recognize that for copper the CMC and CCC are not widely different and the ACR [acute-to-chronic ratio] is typically less than 2.0.

Agency Response
Although the Agency agrees that the BLM has not yet been validated for chronic toxicity, it could also be said that the current empirical hardness-based formula has also not been validated for chronic toxicity. As noted in the previous response, EPA cannot see any benefit in setting the acceptance criteria for the BLM approach higher than for the existing approach.

Either deriving chronic criteria by applying an ACR to BLM-calculated acute criteria or deriving chronic criteria directly from BLM-normalized chronic toxicity is fully consistent with our current procedures, as follows: (1) The criteria derivation guidelines stipulate that in the absence of information needed to develop a relationship between chronic toxicity and the water quality parameters that affect it, the relationship developed for acute toxicity should be applied to chronic criteria. For nearly all current metals criteria, the hardness relationship for the chronic criterion was derived from acute toxicity tests. (2) The nearly universal practice for Water-Effect Ratio development is to apply the WER developed from acute tests to the chronic criterion. Alternatives are seldom feasible.

It is necessary to maintain some degree of logical consistency within the criteria program. EPA believes that its current approach for developing chronic criteria is technically sound and fully justified, and is currently the only feasible way to provide chronic exposure protection to aquatic life. EPA recognizes, however, that the time available for presenting the BLM to the SAB was not sufficient to allow an explanation of the criteria derivation procedure and the regulatory context in which the BLM would be used.

Because the high cost of chronic toxicity testing limits the availability of chronic data, the uncertainties inherent in chronic criteria are greater than those inherent in acute criteria. The acute-chronic extrapolation uncertainties are not the ones EPA ever intended to reduce using the BLM. Rather EPA is interested in the BLM's ability to reduce the uncertainties stemming from the site-to-site variability and the time variability of pH, hardness, alkalinity, and DOC.

Consequently, EPA views the question as being whether the BLM's handling of pH, hardness, alkalinity, and DOC is better than the current empirical acute hardness and WER approach. If the BLM is the better approach, EPA will use it to replace the current approach. Since the two approaches share most of the same acute-chronic extrapolation uncertainties, decoupling the acute and chronic criteria approaches would present the Agency with formidable difficulties in attempting to explain what it was doing and why. In addition, decoupling the acute and chronic criteria approaches would render the site-specific normalization procedures useless for the regulatory program, because in practice the criteria are never applied in a decoupled manner.

The Agency envisions that eventually a version of the BLM that is applicable to chronic toxicity will be developed for use in refining chronic WQC. The limited chronic data that are available suggest that the relationships of acute and chronic copper toxicity to hardness, alkalinity, pH, and DOC are similar (Meyer 1999). The Agency is aware of several research efforts that relate to chronic toxicity. An experimental and model development program for chronic toxicity for copper, via exposure to both food and water, is currently being developed for review by the International Copper Association (ICA). Efforts have also been initiated by the Photographic and Imaging Manufacturer's Association (PIMA) to develop a methodology for extending the BLM for silver to the analysis of chronic toxicity. In addition, an experimental program to investigate the mechanisms of chronic toxicity of silver to invertebrates has also been submitted for consideration by Kodak Canada and the National Sciences and Engineering Research Council of Canada (NSERC). (See also Response I-E for information on efforts to address dietary exposure issues.)

2. *Comment*
The model should presently be reserved for calculation of acute copper criteria for the protection of freshwater organisms excluding algae and macrophytes.

Agency Response
Although the model has not been validated using aquatic plant toxicity data, the available data suggest that macrophytes and algae are no more sensitive to copper

than invertebrates. These data include: (1) of more than 50 freshwater plant toxicity tests used in the 1998 draft copper criteria document (GLEC 1998), effects are seen at copper concentrations ranging from 1 µg/L to 8000 µg/L, with only five tests demonstrating effects below 10 µg/L; and (2) Genus Mean Acute Values (GMAVs) for the five most sensitive genera in the 1998 draft copper criteria document (GLEC 1998) range from 2.3 µg/L to 14.9 µg/L. Uncertainty remains regarding whether the BLM will adequately model copper toxicity to aquatic plants. A study currently planned by the University of Ghent should provide the necessary data to evaluate the applicability of the BLM to algae and macrophytes.

3. *Comment*
   The BLM should not be used in estuarine or marine applications until representative datasets have been used to validate the model's applicability for these waters.

   Agency Response
   The Agency agrees with this comment and will not recommend the use of the model for estuarine or marine applications until it has been appropriately validated per Response I-B.

4. *Comment*
   Caution should be used in estimating acute copper criteria when the calculations would be based solely upon predictions or measurements related to non-piscine biotic ligands (e.g., invertebrate respiratory structures). This is because there are less data currently available for the metal-ligand complex (e.g., binding site densities and conditional stability constants) in tissues of invertebrate species than for fish species. Additional data with sensitive species other than daphnids would help to eliminate this concern.

   Agency Response
   The Agency agrees that additional data for invertebrates would be beneficial. The Agency has been working with WERF to construct a research plan that includes additional validation of the BLM for daphnids. See Response II-B-1 for a more detailed description of these research efforts.

   There are no resources available for new tests with invertebrates other than daphnids. Nevertheless, in developing national criteria EPA will evaluate the ability of the model to adequately normalize all available toxicity data for sensitive invertebrates.

   EPA appreciates the comment's invocation to use caution in applying criteria. EPA recognizes that uncertainties remain.

D. Site-specific Silver Criteria

Comment
The Committee is less confident in the accuracy of silver acute toxicity predictions than for copper and we do not recommend that this approach be incorporated into the silver

criteria document used to derive CMC at this time. ...The approach does appear to have merit as a complementary method to the existing WER approach for site specific modifications of WQC, but should be used with caution. The Committee recognizes that the WER approach also has limitations, namely that it utilizes a limited number of species and does not properly account for temporal variations in water quality. Thus, EPEC supports the continued development of the BLM. Parallel use of the model and WER approaches initially would be useful to provide additional validation of the BLM relative to empirical WERs.

Agency Response
The Agency agrees. EPA has been working cooperatively with interest groups to obtain additional data and analysis.

E. Dietary Exposure

Comment
The Committee emphasizes that a fundamental assumption of the BLM is that toxicity is driven by exposure to dissolved metal alone, rather than combined toxic effects from dissolved and dietary exposures. While this may be largely true for acute effects, understanding of dietary exposure (via uptake of metal-DOC complexes or bioaccumulated metals in aquatic prey species) may be necessary to predict chronic effects for particular metals.

Agency Response
Independent of the BLM, a fundamental premise of all of the relevant metals criteria is that toxicity is driven by exposure to dissolved metal. Consequently, this is a metals criteria issue in general and not a BLM issue per se. EPA thus interprets the comment as a reminder that there are other bioavailability issues that the BLM, in its current form, does not address.

Although EPA did not approach BLM development with the intention of linking it to a resolution of the dietary exposure issue, EPA believes that the mechanistic insight provided by the model might be somewhat helpful in addressing the dietary issue. At a minimum, it is believed that chemical speciation will be an important consideration in gaining an improved understanding and resolving outstanding dietary issues.

The Agency agrees that the importance of the dietary route of exposure in the chronic toxicity of metals is uncertain. In response to this concern, the Agency's National Health Exposure and Effects Research Laboratory (NHEERL) in Duluth, Minnesota conducted a workshop, "Effects of Dietary Metal Uptake by Fish and Other Aquatic Organisms", on March 1-2, 2000. Workshop goals were to: (1) describe our current understanding of risk from dietary metal exposure; and (2) discuss the experimental data that are needed to complete our understanding of this pathway. Additionally, the Agency is funding studies currently underway at NHEERL in Duluth and at the University of Delaware. The objective of the NHEERL study is to evaluate the risk to fish posed by mixtures of metals under combined exposure in both water and diet, while the University of Delaware study

seeks to determine the relative importance of dietary exposure versus water exposure. (See also Response I-C-1 for information on chronic toxicity research.)

F. Implementation Guidance

Comment
The model's use in regulatory contexts should be guided by the Agency to ensure that any forthcoming applications are supported by and conform with the current state of validation. Development of specific guidance by the Agency on the model's use, with flexibility to allow expanded applications in the future, would be helpful in this regard.

Agency Response
The Agency agrees with this comment and is currently developing implementation guidance to be published with the BLM.

II. Outstanding Validation Needs

A. Chronic and Sub-Acute Toxicity

Comment
The model does not account for chronic or sub-acute toxicity, although this may be incorporated through future research. For metals that have a small acute-to-chronic ratio (ACR), such as copper with an ACR of 2x, the model may predict chronic toxicity with simple adjustments in model parameters. For other metals with moderate to large ACRs, and where the mode of toxicity appears to be different for acute and chronic effects, there is some doubt as to the applicability of the model. Furthermore, there is a need to evaluate acute toxicity contributed by non-dissolved metal species, and acute mechanisms of action not directly related to impairment of physiological function at the gill surface. Other methods may be required to adequately address other mechanisms of metal toxicity. These could include mechanisms of toxicity unrelated to the gill; or toxicity linked to chronic uptake at the gill at concentrations lower than those that affect the gill itself (e.g., damage to dermal surfaces such as fin erosion, internal effects to the liver, gut epithelia, reproductive processes, or energetics that have implications for populations).

Agency Response
The Agency acknowledges that these are interesting areas of possible research, however see Responses I-C-1, I-E, and II-C-3.

It is most important to note that the BLM is not limited to gill-mediated effects. The model is calibrated and validated with lethality data. Consequently, it should be able to correctly normalize effects data where the processes affecting bioavailability parallel those processes included in the model. Because the Agency is interested in the BLM primarily as a regulatory tool, rather than as a heuristic tool for elucidating a variety of

possible processes, we judge its usefulness on whether it can normalize for water quality differences more reliably than the current empirical hardness approach.

B. Broad Taxonomic Applicability

1. *Comment*
We recommend that additional testing be performed with a wider range of organisms (freshwater and marine, vertebrate and invertebrate, pelagic and benthic, representing multiple functional groups) and that additional studies be undertaken to compare water-effect ratios with predicted toxicity values generated by the BLM (i.e., model verification with independent data sets).

Agency Response
At present, the Agency is focusing on applying the BLM to freshwater criteria, and therefore is focusing on efforts to validate the model for freshwater organisms. As discussed in Response I-C-3, the Agency will not recommend the use of the BLM for marine applications until it has been appropriately validated, and research in this area is a long-term goal. To advance the validation of the copper BLM for a wider variety of freshwater organisms on a more short-term basis, EPA has provided input to WERF's research program. On-going WERF research includes: (1) development and subsequent validation of the copper BLM using several WER datasets that include toxicity test results for invertebrates (e.g., *Daphnia magna*, *Ceriodaphnia dubia* and perhaps others as they are identified and as resources permit); and (2) evaluation of the model using the relatively limited toxicity/chemistry datasets that are available in the copper criteria document for other sensitive species. If these two efforts are successful, then validation of the copper BLM will be sufficient to support the use of the BLM in the Agency's criteria program. A third WERF research task that will begin soon involves *D. magna* toxicity testing with systematically varied water quality parameters. Due to the extended time period required to complete these tests and refine the BLM based on results, EPA may release the first version of the model before this task is complete. The Agency intends to update the model on an ongoing basis as additional information becomes available.

As has been previously noted, because the copper criterion is the first one to attempt incorporation of the BLM approach, EPA is intending to provide somewhat more supporting evidence than called for by its criteria derivation procedures.

2. *Comment*
We recommend that a sensitivity analysis be performed with the model to identify those variables to which the model is most sensitive.

Agency Response
The Agency agrees that a sensitivity analysis should be performed and is intending to do so. Results of the analysis will be made available to users and will aid the Agency in developing implementation guidance for the model.

C. Mechanistic and Kinetic Understanding

1. *Comment*
The model relies upon equilibrium assumptions, yet the importance of kinetic exchanges of metal between ligands in the micro-environment near the gill membrane is unknown. Better understanding of the relationship between biotic ligand metal concentration and expressed toxicity will help to improve the model's predictiveness.

Agency Response
The Agency agrees that a better understanding of metal interactions at the biotic ligand might help to improve the effectiveness of the model. Although we know that the chemistry of the gill micro-environment is different from that of the ambient water, these effects have not been incorporated into the model since the data that would be necessary to formulate these processes do not exist. With the current approach of expressing metal accumulation as a function of ambient water chemistry the gill binding constants should be viewed as lumped parameters that include chemical interactions with the biotic ligand and the effects of changing chemistry within the gill micro-environment. Current development efforts are targeted at testing and improving the ability of the BLM to predict toxicity since ultimately, the utility of the model will be evaluated on its ability to predict effects rather than accumulation.

The Agency believes that the absence of these micro-scale considerations in the current model should not be viewed as a limitation of the BLM when it is compared to the current empirical hardness adjustment. Further, to the degree that these considerations may be significant, their absence from the model is reflected in the current ability of the BLM to predict measured LC50s.

2. *Comment*
Distinguishing relative differences in binding affinity and toxicity mitigation among hardness cations (e.g., Na, Ca, Mg) will provide further improvements to the model.

Agency Response
The Agency agrees with this comment. The unique role that each of these cations plays in determining metal bioavailability needs to be addressed. The BLM has been formulated to consider each of the cations separately rather than considering them as a lumped hardness measurement. Ongoing work as part of the WERF project for the copper BLM should help to address this concern. Current plans include measurement of the specific binding of these cations (Ca, Mg and Na) with DOM and their differential ability to mitigate acute copper toxicity to *D. magna*.

3. *Comment*
There are also outstanding questions regarding the applicability of the model to other "biotic ligands" besides the fish gill (i.e., for non-piscine taxa of water column-dwelling organisms), particularly invertebrates and marine species, which may require

collection of binding site density and conditional stability constant information specific to other taxa.

Agency Response
The Agency agrees that collection of binding site density and conditional stability constant information for invertebrates would be helpful. However, the Agency believes that complete mechanistic understanding and direct measurements of, for example, binding site densities, are not essential to have in developing a useful model. The Agency will consider the model usable if it makes predictions that are reasonably accurate based on empirical data.

Direct measurement of metal accumulation at the biotic ligand in invertebrates is difficult for a variety of reasons. While it is straightforward to excise the gills of fish and measure metal content, it would be difficult to make similar measurements on the respiratory surfaces of most invertebrates due to their small size. Measurements of total body accumulation have recently been made, but adsorption of metal on the carapace of organisms such as *Daphnia* and high internal concentration of copper in some organisms prevents the use of whole body accumulation as a surrogate for accumulation at the biotic ligand. Recent work with *Lumbriculus*, which lacks a carapace, has shown that whole body accumulation can be a suitable surrogate for accumulation at the biotic ligand and can be used in a BLM framework to predict toxicity (Boese et al. 1999). While we think that these advances will help to reinforce the mechanistic underpinning of the modeling framework, the utility of the model will be determined by its ability to predict toxic effects and not by its ability to predict accumulation.

4. *Comment*
In addition to assumptions of molecular equilibrium at the gill interface, some data (e.g., pertaining to diluter cycling and toxicant delivery time; Ma et al., 1999) also raise questions of the predictability of the model under non-equilibrium water quality conditions, such as would be expected under dynamic field conditions (e.g., mixing zones, stream confluences).

Agency Response
EPA does not view this as a problem specific to the BLM model, but rather a problem general to toxicity tests. The non-equilibrium problem exists quite independently of the BLM and the intended regulatory uses of the BLM. Merely because the current empirical hardness regression is too crude to provide any insight into the non-equilibrium problem does not mean that the problem does not exist when the empirical hardness regression is used.

Although the BLM offers a more rigorous framework on which to build an understanding of the problem, there does not appear to be any feasible alternative approach that can more reliably be used at this time for setting criteria in non-equilibrium conditions. The Agency will continue to apply the best available science as further development takes place.

D. DOC Complexing

1. *Comment*
Distinguishing the events and kinetics of dissolved organic carbon (DOC) complexing with divalent cations and biological uptake will contribute greatly to interpretations of model predictions. DOC is not a uniform constituent... The BLM, however, only allows DOC to be specified as percent humic acid, with the remainder of DOC modeled as fulvic acid... However, the percent of DOC present as humic acid will vary with system type.

Agency Response
The Agency agrees with this recommendation. The question of whether dissolved organic matter (DOM) samples from diverse sources have different capacities for mitigating the toxicity of copper will be addressed as part of the ongoing WERF project for the copper BLM. The results from this work will help to determine if the existing characterization of DOM as a mixture of humic and fulvic acid in the BLM is adequate to describe the variability of natural organic matter. Testing will also be performed to consider the kinetics of Cu-DOC interactions for alternative DOM sources and to insure that the experimental design reflects this consideration as well.

2. *Comment*
In addition, Dahm (1981) demonstrated that there is a distinct, two-phase depletion of organic material introduced into surface water systems: phase 1 involves physical complexing with cations on the order of hours, and phase 2 involves biological (microbial) uptake and metabolism on the order of several days. Yet, the model does not take microbial uptake and decomposition into account.

Agency Response
The Agency feels that, by taking measurements of DOC in the receiving water body and the effluent, users will be able to adequately characterize organic material as it is modified by microbial processes.

With regard to the comment's concern about phase 2 microbial metabolic influences on organic matter, it should be noted that most regulatory interest involves substantial discharges, usually sewage treatment plant effluents, entering small headwater streams. In these types of situations, rapid downstream dilution of the discharged copper ordinarily renders the far downstream concentrations (that is, concentrations occurring several days travel time from the discharge) of little interest to state pollution control agencies. Consequently, even if the model had the capability to predict changes in DOC characteristics, such a capability would probably not be routinely exercised.

Optimum use of the Agency's limited resources require that it develop tools to efficiently handle the most common regulatory problems. Consequently, in the near term, some of the issues involving downstream changes in DOC might remain

unresolved. Nevertheless, the WERF research is pursuing information on the effectiveness of different forms of DOC (see previous response).

E. Applicability to Multiple Metals and Water Chemistry Conditions

1. *Comment*
There is a need to validate the applicability of the model to other metals besides copper, and further work is needed to understand and resolve the larger uncertainties associated with silver toxicity relative to copper. It may be important to incorporate additional environmental ligands, such as suspended particulates, that are known to sorb divalent cations.

Agency Response
The Agency agrees that further validation is needed for metals and intends to apply the procedures listed in Response I-B in making determinations about the inclusion of the BLM in nationally recommended criteria for any of the applicable metals.

Although EPA has no immediate plans for the BLM to replace the current empirical approach to suspended particulates, it believes that the BLM framework is ideally suited for simulating the adsorption of metals on suspended particles. Recently, the University of Delaware performed studies that were related to the partitioning of copper to particulate material in natural water settings. Additionally, Lofts and Tipping (1998) proposed an assemblage model for the binding of cations to natural particulate matter. Their model might eventually lead to reliable mechanistic predictions of metal partitioning to particles suspended in the water column. During the next year BLM developers plan to further analyze these data and model in the process of developing a fate and transport model for copper. The results of these analyses should be directly suitable for use in conjunction with the BLM for copper and BLM investigators are planning to include these effects.

2. *Comment*
The model should be tested under a broader range of water chemistry (e.g., pH, Ca, Mg, DOC) conditions, including a range of sources of DOC (e.g., from different waters, from interstitial versus overlying water, from allochthonous versus autochthonous sources, etc.), and conditions where several water chemistry parameters are varied simultaneously.

Agency Response
The Agency agrees with this recommendation and is coordinating with WERF on these efforts for copper. (See also Responses II-B-1, II-C-2 and II-D-1.)

EPA intends to test the model under at least as broad a range of conditions as it tested the empirical approach which it will replace. EPA nevertheless recognizes that the range of natural conditions that it could test is substantially greater than the range of conditions that are usually of interest for regulatory purposes. Because EPA is interested in the BLM as a regulatory tool, its primary concern is that the model work

better than the current empirical hardness normalization in the majority of regulatory situations.

3. *Comment*
   Seasonal and diurnal shifts in water chemistry parameters such as pH and temperature will influence metals bioavailability, thus complicating efforts to obtain representative samples of site water for toxicity tests and to determine which water chemistry data should be used to parameterize the BLM. ...The Committee recommends, therefore, that further consideration be given to how water chemistry conditions are characterized for use in the BLM.

   Agency Response
   The Agency agrees that these are important concerns and is currently conducting analyses to determine how to address them in the implementation guidance that will accompany the BLM. EPA believes that the result will be a substantial improvement over the way water chemistry is handled by the current empirical hardness normalization.

F. Use of BLM-based WQC in Sediment Guidelines

Comment
The Committee concluded that because the chemistry of interstitial water is not the same as the chemistry in the water column, it would be inappropriate to substitute the BLM-adjusted water column criterion for the water quality criterion in the ESG equation without additional validation experiments.

Agency Response
This comment will be addressed in the Agency's response to the SAB's companion document (EPA-SAB-EPEC-00-005).

References Cited

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