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December 2, 2009

Via Email

Dr. Thomas Armitage
U.S. Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Ave, N.W.
Mail Code 1400F
Washington, DC 20460

Re: Comments on SAB Ecological Processes and Effects Committee Draft Report

Dear Dr. Armitage:

The attached comments are submitted by Hall & Associates, Dr. Domenic Di Toro (University of Delaware), and Mr. Thomas Gallagher (HydroQual, Inc.) on behalf of the Pennsylvania Periphyton Coalition. Overall, we find that the detailed draft comments ("Draft") prepared by the Science Advisory Board Ecological Processes and Effects Committee ("Committee") on EPA's *Empirical Approaches for Nutrient Criteria Derivation* ("EPA Document") accurately characterize the numerous fundamental deficiencies in the EPA Document. We concur that these deficiencies must be addressed in order to develop scientifically defensible nutrient water quality criteria. To that end, the utility of the Draft would be greatly enhanced if the key Committee findings were consolidated and summarized as the Committee recommendations for developing nutrient criteria. In addition, while the detailed findings make explicit recommendations for developing nutrient criteria, the cover letter to Administrator Jackson and the Draft's Executive Summary present ambiguous language on the scientific acceptability of the EPA Document. The ambiguous language should be corrected to avoid misinterpretation of the Committee's findings. A clear and concise position would provide greater assistance to state regulatory agencies who will be the primary users of this document. Additional details on these concerns are provided below.

Key Report Findings

It is axiomatic that the most fundamental component in water quality criteria derivation is a clearly demonstrated cause and effect relationship between the pollutant of concern and

the unacceptable adverse impact caused by the pollutant. (Guidelines[1] at 5) Where multiple factors significantly influence the effect of the pollutant, these must be incorporated into criteria derivation. (Guidelines at 32, 44) The rational for these requirements is straight forward. Unless these criteria derivation components are properly established and considered, there is no assurance that the criteria will serve their intended purpose – to limit pollutants to the level necessary to protect beneficial uses. The Draft reflects these requirements of the Guidelines:

> "For criteria that meet EPA's stated goal of "protecting against environmental degradation by nutrients," the underlying causal models must be correct. Habitat condition is a crucial consideration in this regard (e.g., light [for example, canopy cover], hydrology, grazer abundance, velocity, sediment type) that is not adequately addressed in the Guidance. Thus, a major uncertainty inherent in the Guidance is accounting for factors that influence biological responses to nutrient inputs. Addressing this uncertainty requires adequately accounting for these factors in different types of water bodies". (Draft at 36-37, line 43) (Emphasis added);

We have identified what we believe are the key technical findings of the Committee on the deficiencies in the EPA Document that must be addressed to render scientifically defensible nutrient water quality criteria. This important listing should be attached to the cover letter so that there is no uncertainty on the need to address these fundamental considerations as the states proceed to develop nutrient water quality criteria. Moreover, these considerations necessarily apply to the evaluation of all evidence that may be incorporated into a "weight of evidence" analysis. Therefore, we ask the Committee to specifically note that any other information used in a weight of evidence approach to develop nutrient criteria must be assessed in light of these fundamental components.

Concerns with Cover Letter and Executive Summary

As noted throughout the Draft, EPA's empirical approach does not result in the necessary cause-effect relationships necessary to derive defensible criteria and provides no objective scientific means to ensure the criteria generated are either necessary or appropriate for their intended purpose. The cover letter to Administrator Jackson and the Executive Summary, however, use language that implies the statistical methods presented in the EPA Document "could" be used to derive nutrient criteria, but "improvements" are needed prior to implementation. These statements imply that the EPA Document can be fixed to address the Committee's basic concerns, but the detailed comments suggest otherwise. For example:

> "The Committee emphasizes that understanding the causative link between nutrient levels and impairment is necessary in order to assure that managing for particular nutrient levels will lead to desired outcomes". (Draft at 4, line 7) (Emphasis added)

[1] USEPA. 1985. Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses. PB85-227049.

"The Guidance needs to clearly indicate that the empirical stressor-response approach does not result in cause-effect relationships; it only indicates correlations that need to be explored further". (Draft at 39, line 38) (Emphasis added);

As noted in the Draft, to develop scientifically defensible criteria, cause and effect must be demonstrated, but none of the empirical stressor-response approaches demonstrate cause and effect. Rather, in addition to the empirical methods, some form of validated causal model must be developed to account for the significant habitat, physical, and chemical factors affecting designated use attainment. Such a model should be sufficient to derive scientifically defensible nutrient criteria for the specific ecological conditions present. To avoid confusion, the ambiguous language should be changed to leave no doubt that these six empirical approaches cannot be used as the basis to derive water quality criteria. It is critical that these changes be made in the cover letter and Executive Summary because some potential users will only read these sections before deciding on a course of action. Suggested changes to the cover letter to avoid such confusion are attached.

Other Concerns

- Conditional Probability Analysis

The Draft does not explicitly indicate that Conditional Probability Analysis (CPA) should not be used to derive nutrient water quality criteria. While the Committee expressed this conviction during its meeting on September 9 – 11, the Draft does not appear to specifically address this issue. For example, the Committee made the following statement:

"The use of non-parametric change point analysis and discontinuous regression analysis **must** be associated with biological significance and the designated uses to be protected by numeric nutrient criteria. ... However, although these methods may be able to identify and characterize breakpoints, such breakpoints may not necessarily have any biological significance, nor will they necessarily be related to designated uses that are to be protected by numeric nutrient criteria. Use of these methods **must** be associated with designated uses". (Draft at 22, line 6) (Emphasis in **bold**)

EPA's draft guidance expressly recommends the use of CPA where no impairment threshold has been set (The exact opposite of what the Committee recommended). (EPA Document at 52) None of the CPA examples presented in the EPA Document relate nutrient concentrations to recognized designated use impairments and no attempt is made to assess whether the change point identified was biologically significant or how such significance could be demonstrated. In addition, no effort is made to show the pollutant actually caused the response being evaluated. These fatal flaws are compounded by the fact that the methodology presented by EPA attempts to relate discrete instantaneous measurements of nutrient concentration to biological metrics

that do not respond to instantaneous concentrations. The analysis framework ignores all relevant physical factors that greatly influence whether nutrients will cause impairment. The presentations regarding actual application of this method confirm it was even applied to address "impairments" in severely habitat-altered receiving waters that clearly were not related to nutrients. As noted throughout the Draft, such an evaluation framework is not scientifically defensible and cannot be used for criteria derivation. The SAB cover letter needs to unequivocally reject such methods as scientifically indefensible.

- Downstream Impacts

Finally, we note that it is procedurally and technically inappropriate for the Draft criteria guidance to refer to consideration of "downstream impacts" as suggested in the cover letter. On a procedural basis, there is no charge question that addresses the consideration of downstream impacts with regard to nutrient criteria derivation. No information is provided in the EPA Document on the basis for or the need to consider downstream impacts. And, no analysis was provided to the Committee to show why such considerations are necessary or appropriate. In our view, downstream impacts are irrelevant to criteria derivation and, to our knowledge, have not been considered in setting water quality criteria. For example, consider copper – the marine criteria are much more restrictive than the freshwater requirements, and yet EPA approves both sets of criteria. If upstream loads cause adverse effects on downstream designated uses (e.g., violate the water quality criteria set for those waters), those effects must be addressed using individual wasteload allocations or through the TMDL process, considering the fate characteristics and confounding factors that influence the cause-effect relationship. However, the criteria established for the downstream waters are intended to protect the designated uses of the downstream waters. The criteria for the upstream waters must protect the designated uses of the upstream waters "with only a small possibility of considerable overprotection or underprotection". [2] There is no legal, regulatory or scientific basis presented to this panel or the public that requires upstream criteria to be amended to reflect downstream ecosystem needs.

Summary

Given the findings by the Committee regarding the need for scientifically defensible causal models that directly relate nutrients to use impairments and appropriately account for significant physical and biological factors affecting designated uses, it is apparent that the approaches presented in the EPA Document are wholly inadequate and cannot be used to derive water quality criteria for nutrients. The cover letter and the Executive Summary should explicitly note that the suggested, stand-alone methods are (1) not scientifically defensible and (2) any approach to scientifically defensible nutrient criteria must be based on:

[2] USEPA. 1985. Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses. PB85-227049. at 5

- A properly documented underlying causal model which incorporates all significant confounding factors, and

- Response variables that are clearly related to designated-use impairment thresholds.

Sincerely,

John C. Hall

Enclosures

cc: Dr. Domenic Di Toro
Mr. Thomas Gallagher
Pennsylvania Periphyton Coalition

SAB Ecological Processes and Effects Committee 12/3/09 Draft
Review of Empirical Approaches for Nutrient Criteria Derivation

KEY FINDINGS

General Observation on Current Use of Guidance

- The Committee finds that improvements in the Guidance are needed prior to implementation to enable development of technically defensible criteria and to make the document more useful to state and tribal water quality scientists and resource managers. (at 2)
- Large uncertainties in the stressor-response relationship and the fact that causation is neither directly addressed nor documented indicate that the stressor-response approach using empirical data cannot be used in isolation to develop technically defensible water quality criteria that will "protect against environmental degradation by nutrients." (at 37; see also 22)
- A clear framework for statistical model selection is needed. This framework should include: 1) an assessment of whether analysis indicate that the stressor-response approach is appropriate; 2) selection criteria to establish models of cause/effect and direct/indirect relationships between stressors and responses; 3) consideration of model relevance to known mechanisms and existing conditions; 4) establish of biological relevance; and 5) ability to predict probability of meeting designated use categories. (at 30; exec sum at xiv)

A. Cause and Effect Demonstration Necessary

- [T]he final document should clearly state that statistical associations may not be biologically relevant and do not prove cause and effect. (at 2) Without a mechanistic understanding and a clear causative link between nutrient levels and impairment, there is no assurance that managing for particular nutrient levels will lead to the desired outcome. (at 4); The Guidance needs to clearly indicate that the empirical stressor-response approach does not result in cause-effect relationships; it only indicates correlations that need to be explored further. (at 39)

B. Biological Significance/Use Impairment Threshold Relationship

- The use of non-parametric change point analysis and discontinuous regression analysis must be associated with biological significance and the designated uses to be protected by numeric nutrient criteria. … However, although these methods may be able to identify and characterize breakpoints, such breakpoints may not necessarily have any biological significance, nor will they necessarily be related to designated uses that are to be protected by numeric nutrient criteria. Use of these methods must be associated with designated uses. (at 22)
- The Committee emphasizes the importance of choosing the biological endpoints (i.e., response variables) that respond specifically to nutrients. We note that responses of benthic indices can be related to many types of stress. We question why periphyton would not be a better receptor to measure. (at 15)

C. Consideration of Factors Influencing Nutrient Dynamics/Impairment Metric

- The examples provided in the Guidance generally do not demonstrate a strong nutrient stressor linkage to beneficial use impairment. The stream examples show very weak correlations that have high levels of uncertainty, and lump data from distinctly different ecosystems where multiple factors in addition to nutrients will contribute to biotic responses. (at 14,15)
- In order to be scientifically defensible, empirical methods must take into consideration the influence of other variables. …The statistical methods in the Guidance require careful consideration of confounding

variables before being used as predictive tools. … Without such information, nutrient criteria developed using bivariate methods may be highly inaccurate. (at 22)

- For criteria that meet EPA's stated goal of "protecting against environmental degradation by nutrients," the underlying causal models must be correct. Habitat condition is a crucial consideration in this regard (e.g., light [for example, canopy cover], hydrology, grazer abundance, velocity, sediment type) that is not adequately addressed in the Guidance. Thus, a major uncertainty inherent in the Guidance is accounting for factors that influence biological responses to nutrient inputs. Addressing this uncertainty requires adequately accounting for these factors in different types of water bodies. (at 36,37) Numeric nutrient criteria developed and implemented without consideration of site specific conditions can lead to management actions that may have negative social and economic and unintended environmental consequences without additional environmental protection. (at 37)

D. Stream Considerations

- Single variable stressor-response relationships (e.g., those derived using the simple linear regression approach discussed in the Guidance) that explain a substantial amount of variation are likely to be uncommon for most aquatic ecosystems (in particular, streams). (at 10); As previously discussed, relationships for streams may be more complex than for lakes and must account for multiple stressors/conditions and/or stream 'types' or conditions, and then be applied appropriately. (at 23)

F. Loading Versus Concentration Approach

- A basic conceptual problem concerning selection of nutrient concentrations as stressor variables (as illustrated in the Guidance) is that nutrient concentrations directly control only point-in-time, point-in-space kinetics, not peak or standing stock plant biomass. Plant biomass is driven by nutrient supply rates (i.e., nutrient mass loads). Ambient nutrient concentrations are not necessarily good surrogates for nutrient mass loads. Relationships between nutrient mass loads and ambient nutrient concentrations are highly system-specific and depend on many factors including inflows, hydrology, bathymetry, sediment-water exchanges and chemical-biological processes. Consequently, there may be many systems for which nutrient concentrations will not be appropriate stressor variables. For such systems it may be more appropriate, and scientifically defensible, to use site-specific mechanistic models incorporating loading to determine the nutrient controls required to attain designated uses. (at 11)

G. Data Requirements

- The document should better address data requirements, including data acquisition and data quality. Without providing guidelines on data requirements, the potential for applying techniques to inappropriate or inadequate datasets is great. (at 8)

H. Weight of Evidence Approach

- The Guidance should contain a quantitatively based "weight-of-evidence" (WoE) framework using multiple methods and then combining them into figures and tables for visualization. Multiple statistical methods on one dataset do not equate to a reasonable WoE that significantly reduces uncertainty. Rather, the WoE should involve different assessment methods (e.g., different datasets, different biological endpoints, measures of habitat, etc.). This premise has been embraced by other EPA programs and the scientific community. (at 16,17); The Guidance can be used to develop nutrient criteria in a tiered weight of evidence assessment using appropriately modified EPA approved procedures together with other approaches that address causation. (at 37)

DATE TO BE INSERTED

The Honorable Lisa P. Jackson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Subject: SAB Review of Empirical Approaches for Nutrient Criteria Derivation

Dear Administrator Jackson:

EPA's Office of Water (OW) requested that the Science Advisory Board (SAB) review the Agency's draft guidance document titled *Empirical Approaches for Nutrient Criteria Derivation* ("Guidance"). The Guidance is one of a series of technical documents developed by OW to describe approaches and methods for developing numeric criteria for nutrients. The Guidance specifically focuses on empirical approaches for determining stressor-response relationships to derive numeric nutrient criteria. In response to the Agency's advisory request, the Science Advisory Board Ecological Processes and Effects Committee, augmented with additional experts, met on September 9 – 11, 2009 to conduct a peer review of the Guidance. OW requested that the SAB: 1) comment on the technical merit of the methods and approaches described in the Guidance; 2) suggest approaches that might be considered to improve the Guidance; and 3) offer suggestions to improve the utility of the Guidance for state and tribal water quality scientists and resource managers. The enclosed advisory report provides the advice and recommendations of the Committee.

Nutrients (nitrogen and phosphorus) are a major cause of water quality impairment in the Nation's waters, and the SAB recognizes the importance of EPA's efforts to develop technically defensible numeric nutrient criteria. The stressor-response approach is a legitimate, scientifically based tool for assisting in the development of defensible numeric nutrient criteria, but only if the approach is appropriately applied in conjunction with other more robust methods. EPA's draft Guidance provides a primer on a limited set of statistical methods that are intended to serve as the basis for deriving nutrient criteria based on assumed stressor-response relationships. However, in its present form, the Guidance does not present a complete or balanced view of using the statistical methods to assist in developing criteria. Improvements in the Guidance are needed prior to implementation to enable development of technically defensible criteria and to make the document more useful to state and tribal water quality scientists and resource managers. The attachment summarizes the key scientific deficiencies and uncertainties with use of the proposed methods to derive scientifically defensible and appropriately protective nutrient criteria for a range of environmental settings.

In general, we find that the scope and intended use of the Guidance must be more clearly identified and the procedures need to be expanded to ensure critical factors that

Comment [b1]: Suggest deletion as confusing – EPA has published numerous guidance documents that require a cause and effect demonstration be made in regulating nutrients. This is the first guidance document that intentionally abandoned that necessary component. Is the Committee commending EPA for developing these methods for criteria derivation?

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Comment [b2]: Suggest deleting/rewording this sentence given the numerous fundamental deficiencies cited in the Draft. Please do not confuse the public on whether these methods, by themselves, can show cause and effect or produce scientifically defensible instream standards that are likely to remedy adverse impacts from nutrients. As these methods, by their nature, cannot prove cause and effect, and numerous critical factors are ignored by the statistical procedures, pressing forward with these simplistic approaches is not reasonable or scientifically defensible.

Deleted: We encourage the Agency to continue this important work.

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Comment [b3]: This sentence was confusing. The methods cannot ever be used by themselves to generate nutrient criteria, as noted by the Committee's comments. These methods can only support other scientifically defensible methods.

Comment [b4]: Use of the word "should" implies that the existing approach is acceptable, just not as good as it could be. That tone does not reflect the fundamental deficiencies identified by the Committee.

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influence selection of appropriate numeric nutrient criteria are fully considered. The empirical stressor-response framework described in the Guidance has profound, unresolved uncertainties associated with estimated stressor-response relationships that would need to be resolved if this approach were used as a "stand alone" method because statistical associations do not prove cause-and-effect. To be scientifically defensible, the stressor-response approach should only be considered for use with other available methodologies in the context of a tiered approach where uncertainties in different approaches are recognized, and weight of evidence is used to establish the likelihood of causal relationships between nutrients and their effects for criteria derivation. In this regard, we recommend that EPA more clearly articulate how this particular guidance fits within the Agency's decision-making and regulatory processes and, specifically, how it relates to and complements EPA's other nutrient criteria approaches, technical guidance manuals, and documents that are intended to establish such causal relationships.

Deleted: is one possible approach for deriving numeric nutrient criteria, but the uncertainty

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Comment [b5]: "Suggesting" a change means the regulatory agency is free to ignore the advice. In addition, criteria are not based on a "likelihood" of relationship, they must be based on demonstrated relationships per the 1985 Guidelines.

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Comment [b6]: No such guidance exists and no information was presented to the Committee on how downstream waters dictate upstream criteria.

The SAB has provided many recommendations to ensure that scientifically defensible criteria are developed where such empirical methods are employed and strongly recommends that they be incorporated into the final document. These recommendations focus on revising the document to address: cause-and-effect; the utility and limitations of the statistical methods and approaches in the document; the supporting analyses and data needed to correctly identify predictive relationships; the need for more guidance and examples to describe when and how to use various methods and approaches; linkages among designated uses and stressors; and the need for a more specific and descriptive framework outlining the steps in the criteria development process. Finally, the SAB strongly recommends that EPA invest in providing the technical support and training needed to make the approaches and methods in the final Guidance more useful to state and tribal water resource managers.

Deleted: The SAB also recognizes that methods in the Guidance do not address downstream impacts of excess nutrients, and suggests ways in which these could be addressed.

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Thank you for the opportunity to review this important guidance document. The SAB looks forward to receiving the Agency's response to this advisory report and stands ready to provide additional advice as EPA continues to develop nutrient criteria guidance.

Sincerely,