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Dominic Gregorio, Ph.D.
Ocean Unit Chief
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State Water Resources Control Board
P.O. Box 1977
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Dear Dr. Gregorio:

Attached you will find my review of the document entitled *Draft Staff Report, Water Quality Control Plan for Enclosed Bays and Estuaries, Part 1. Sediment Quality* (2007) and associated Appendices and Attachments. Reviewing these materials turned out to be a somewhat daunting task given the complexity, depth and breadth of information provided. At the same time, I am very impressed by the level and quality of work that has been done by Board staff and others to support the preparation of this document. Your agency received excellent input from a highly qualified technical team and an impressive scientific steering committee. I would also like to mention that Mr. Chris Beegan provided very timely responses to my requests for additional materials.

I hope that in the end I have captured the important points correctly and addressed the questions posed in a way that provides useful insights and constructive criticisms.

Please do not hesitate to contact me for clarification if any of my comments are not clear.

Sincerely,

Linda C. Schaffner

Linda C. Schaffner, Ph.D.

c: David Jenkins
Professor Emeritus
Civil and Environmental Engineering
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(email: flocdoc@pacbell.net)

General comments on the science and the process:

Taken as a whole, is the scientific portion of the proposed rule based upon sound scientific knowledge methods and practices?

I have reviewed the document entitled *Draft Staff Report, Water Quality Control Plan for Enclosed Bays and Estuaries, Part 1. Sediment Quality* (2007; hereafter Report), which was produced by the State Water Resources Control Board (hereafter Board), as well as the accompanying attachments.

The Report and supporting documents clearly outline the rationale and methodologies for developing approaches to address a Sediment Quality Objective (SQO) based on benthic invertebrates, toxicity tests and chemical data. The recommendations are based on the best available science and rigorous statistical testing, calibration and validation. Most of the scientific knowledge and methodologies on which the recommendations are based have been around for a decade or more and are well accepted by the scientific community. It is important to ensure that as better techniques and more data become available there are mechanisms in place that will allow for adaptive management and improvement in the approaches.

In reading the staff technical reports and proposed implementation language are there any additional scientific issues that are part of the scientific basis of the proposed rule not addressed in the specific questions below?

While I believe that I understand the general intent of the SGO, I find that the specific wording used to state the purpose is not clear and varies from one section to another in the documents I have been sent. For example:

Section 1.2 of the Report, states that the SQO "must provide adequate protection for the most sensitive aquatic organisms." This may be broadly interpreted to apply to individuals, species, populations or community-level sensitivity, or narrowly interpreted to apply only to individual species. Thus, I wondered if there is a precedent for interpretation.

In Appendix A of the Report, Section IV states "Pollutants in sediments shall not be present in quantities that, alone or in combination, are toxic to benthic communities in bays and estuaries of California." Here the emphasis is on benthic communities.

The "Plain English Summary" (Attachment 1) for the Report indicates that in this application the SQO is intended to "protect benthic invertebrates from community degradation and/or toxicity as a result of direct exposure to pollutants in sediments." I recommend changing community degradation to environmental degradation.

Section V of Appendix A states that the tools used to develop MLOEs are "intended to assess the condition of benthic communities relative to potential exposure to toxic pollutants in sediments." Here again the emphasis is on benthic communities.

Protecting "the most sensitive organisms"/individuals/species and protecting benthic communities are not necessarily the same thing. As noted by Gibson et al. (2000), "Individual macroinvertebrate species have sensitive life stages that respond to stress and integrate effects of short-term environmental variations, whereas community composition depends on long-term environmental conditions." From my reading of the report, I infer that the main intent of the Board is to ensure protection of benthic community integrity from environmental degradation. This should be clarified because the interpretation of the SQO is the basis for selecting LOEs, how thresholds are set for each LOE, and how MLOEs are weighted. I'm not certain that protecting benthic community integrity ensures that no sensitive species are adversely impacted unless you have that in mind when selecting LOEs, defining thresholds, and deciding how to weight MLOEs.

By recommending the selection of Alternative 2 in Section 5.6 the Board is adopting a relatively conservative (protective) approach to providing a binary interpretation of the condition categories. Adopting this alternative should provide adequate protection for the sensitive components the benthic community. This could certainly be evaluated using the datasets in hand.

Specific Questions:

1. The exposure-receptor relationship selected for protection. Are benthic invertebrates important, ecologically relevant receptors to protect from direct exposure to toxic pollutants in sediments within bays and estuaries of California?

The Board has clearly stated in Section 5.3.2 of the Report the rationale for protecting benthic invertebrates. While benthic invertebrates will never qualify as charismatic megafauna, they are integral and important parts of estuarine and coastal ecosystems in terms of food webs and key ecosystem services that directly benefit humans. They are used in most, if not all, major monitoring programs at the Federal and State levels. Some potential limitations of using benthic invertebrates (infauna) for monitoring and assessment programs have been outlined by Gibson et al. (2000). These are discussed below, however, none relate to the ecological relevance of this group.

2. Approach to assess the exposure-receptor relationship. Are multiple lines of evidence appropriate to assess the potential risk to benthic invertebrates from toxic pollutants in sediments within bays and estuaries of California?

The complexity of estuarine and coastal ecosystems makes it challenging to develop methods to assess impairment. The use of multiple lines of evidence (MLOEs) has become more or less mandatory and is widely employed worldwide (e.g. http://www.clw.csiro.au/cecr/documents/Fact_Sheet_Sediment_Quality_Assessment.pdf).

In the Report, the Board recommends the use of multiple lines of evidence for decision-making. The benefits of using MLOEs are clearly stated in Section 5.5. The LOEs are sediment

chemistry, sediment toxicity and benthic community indicators. The rationale for selecting each LOE is provided in the Report and associated Appendices. These are the most widely employed LOEs (e.g. sediment triad) for assessing environmental impairment, so their selection here is not surprising. Effective application of the MLOEs to decision-making depends on the thresholds for each component of the individual LOEs and how the LOEs are integrated. These issues are discussed below.

3. Individual lines of evidence.

a. Are the proposed sediment toxicity indicators appropriate for assessing both the potential risk of exposure from toxic pollutants and the biological effects in benthic invertebrates within bays and estuaries of California?

In addition to the Report, I reviewed the document by Bay et al. (2007), which was included as Attachment 5. The methods used to select the recommended toxicity tests are robust and well described. Both acute and sublethal tests are included, which will serve to increase confidence in the test data. Test results are averaged to create a LOE for integration with the other major LOEs.

I am less certain about the provision that allows for additional toxicity tests as described in Appendix A, Section V. F. Isn't it likely that this option would be employed only when the initial tests show toxicity? If the tests already recommended for this LOE are considered the most sensitive and reliable, why allow additional tests to be added?

b. Are the proposed sediment chemistry indicators appropriate for assessing the potential risk of exposure from toxic pollutants to benthic invertebrates within bays and estuaries of California?

Section 5.5.3.2 of the Report, Section V. H of Appendix A, Attachment 6 and the Ritter et al (2007) document that was sent under separate cover by Chris Beegan at my request, describe the methods and approach for using sediment chemistry indicators. I find the wording of the baseline and alternatives in Section 5.5.3.2 of the Report to be somewhat fuzzy relative to the wording in Section V. H of Appendix A which clearly states that "sediment chemistry exposure will be assessed using the two following methods: [CSI and CA LRM]." The CSI is a new method, which provides a means to define chemical indicators based on benthic community effects while the CA LRM is based on toxicity tests. The information provided suggests that the methodology is robust, and the idea of using benthic community data as a means of developing a sediment chemistry indicator has it's appeal, but, I urge caution in the application of this indicator until it has been peer-reviewed by experts. Such a detailed review is beyond the scope of this broader review. I support the use of chemical indicators as a LOE and I do not have a problem with averaging more than one indicator for use in the MLOE decision framework.

c. Are the benthic community indicators appropriate for assessing biological effects through benthic community condition within bays and estuaries of California?

As noted by Gibson et al. (2000), "Individual macroinvertebrate species have sensitive life stages that respond to stress and integrate effects of short-term environmental variations, whereas community composition depends on long-term environmental conditions." The community level benthic indicators being averaged for this LOE should be protective of sensitive benthic species, as a component of benthic community integrity, for two reasons. First, some of the indicators explicitly include estimates of species sensitivity as metrics and second, the overall thresholds (for combining MLOEs) for defining impacted versus non-impacted conditions are relatively conservative (protective).

There are some limitations to using macrobenthos as indicators, but these are primarily methodological. Gibson et al (2000) have listed the following:

- Relatively few state and federal programs have the necessary in-house taxonomic expertise to support extensive monitoring.
- Current methods can distinguish severely impaired sites from those that are minimally impaired. However, it can be difficult to discriminate between slightly or moderately impaired areas, particularly in estuaries (due to their natural spatial and temporal variability). (note: this concern is probably not relevant given 1) multiple condition thresholds have been adopted for each LOE and 2) the specific method being used to integrate the MLOEs)
- The condition of benthic habitats can vary over relatively small scales. Therefore, if too few samples are collected from a specified area, the ambient heterogeneity to be expected may be missed, potentially leading to incorrect conclusions regarding the biological and water quality conditions in the area;
- The cost and effort to sort, count and identify benthic invertebrate samples can be significant, requiring tradeoffs between expenses and the desired level of confidence indecisions based upon the collected data.

Many of these concerns can be addressed by stipulating sampling protocols, methodologies for processing samples, steps that need to be taken to ensure proper taxonomic identifications and general QA/QC guidelines. There is only limited discussion of sampling designs, levels of replication needed or specific field methodologies in Appendix A. Perhaps this is beyond the intended scope of the documents being reviewed.

4. Integration Framework. Is the integration framework appropriate for determining if a station meets the narrative objective?

As stated in Section 5.5.5, multiple approaches for integrating MLOEs have been developed. At present, no single method has been accepted as best for interpreting MLOE. The approach recommended in the report is a transparent, logic-based framework for integrating MLOE to make a station level determination of the likelihood of biological effects due to sediment. This system was developed in consultation with a stakeholder advisory committee and an independent scientific steering committee. The logic-based MLOE assessment framework developed allows for an ordinal classification of sites and a definitive conclusion regarding sediment quality at a site.

Based on the results presented in Table 5.13 there is evidence that the framework is at least as effective as best professional judgment, and probably more consistent. However, the number of experts used to make this comparison seems relatively small given the high variability among their assessments. I did not have access to the Bay et al (in press) paper during this review for reference on the details of the BPJ study relating to MLOE/triad results. Why is it that BPJ works so well for evaluating benthic community condition and less so for evaluating the MLOE data?

5. Is the implementation of the narrative SQO appropriate, given the limitations of the individual tools and potential uncertainty associated with sediment quality assessment?

The individual tools have been used together and individually to assess sediment quality and benthic community impairment for more than a decade. What is new here is the development of numerical thresholds for each LOE and a defined logic-based approach for weighting the LOEs to reach a decision about the status of a site. The rationale for setting thresholds has been given in detail in the Report or the supporting documents. As far as I can ascertain, the thresholds are based on consideration of large datasets and data that has undergone rigorous QA/QC. There is appropriate characterization of the variance structure in each dataset. As I understand what has been presented in the Report, the overall approach is robust, reliable and defensible. It allows for a clear definition of conditions that will protect benthic communities and component species from habitat degradation and/or toxicity as a result of direct exposure to pollutants in sediments and using the best available data and methodologies.

Reference:

Gibson, G.R., M.L. Bowman, J. Gerritsen, and B.D. Snyder. 2000. Estuarine and Coastal Waters: Bioassessment and Biocriteria Technical Guidance. EPA 822-B-00-024. U.S. Environmental Protection Agency, Office of Water, Washington, DC.