Sediment Quality Obj.
Deadline: 11/28/06 5pm

CALIFORNIA CHAMBER of COMMERCE

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November 28, 2006

VIA ELECTRONIC MAIL AND U.S. MAIL

Song Her, Clerk to the Board
Executive Office
State Water Resources Control Board
P.O. Box 100
Sacramento, CA 95812-0100

Re: Public Workshop and CEQA Scoping Meeting -- Development of Sediment Quality Objectives for Enclosed Bays and Estuaries

Dear Ms. Her:

The California Chamber of Commerce's comments on the State Board's proposed sediment quality objectives ("SQOs") are attached to this cover letter, along with a technical memorandum prepared by our expert consultants.[1]

The Chamber's members include over 15,000 California businesses, including many parties that potentially will be impacted by the development and implementation of SQOs for California's bays and estuaries. Accordingly, the Chamber and its members have a very strong interest in encouraging reasonable and cost-effective approaches to managing impacted sediments. As you know, the State Board has recognized the Chamber's interest in this rulemaking by appointing it, pursuant to California Water Code Section 13394.6, to the Sediment Quality Objectives Advisory Committee ("Advisory Committee"). To facilitate the State Board's review, and without waiving any arguments, we have outlined our main comments below.

Overview

The SQO rulemaking presents the State Board with an important and challenging task. There are no SQOs in California, and few across the country. Given the magnitude of this rulemaking, it is critical that the State Board take the time to ensure that the SQOs are scientifically and legally defensible. To achieve these objectives, the State Board should develop SQOs that are consistent with the following principles:

The Chamber requests that the State Board place all of these materials in the Administrative Record for these proceedings.

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- *The SQOs should be based on sound science*. The State Board needs to ensure that the science underlying the SQOs is sound and correct. The State Board should not adopt vague, ambiguous and potentially grossly overbroad standards that are based on flawed science and unnecessary to protect the environment.

- *The SQO program should be transparent and understandable*. The public must be able to determine the meaning of the SQOs and how to achieve compliance. The State Board specifically must identify alternatives considered, proposed implementation measures, and costs of compliance. As currently drafted, the SQOs are preliminary in nature and lack transparency regarding many crucial aspects, such as when and how an exceedance of the SQOs will be determined, and what remediation actions are required.

- *The SQO program should use a tiered approach*. The State Board should adopt a tiered approach in which chemistry assessments are performed, followed by benthic community studies and toxicity assessments, if necessary. This tiered approach would allow the State Board to identify sediments containing chemicals at levels that might cause impacts, and then use benthic community analyses and toxicity studies to ascertain whether the chemicals appear to be causing an impact. This tiered approach is consistent with the multiple lines of evidence approach, and avoids unnecessarily performing costly toxicity studies at all sites.

- *The SQO program should comply with all legal requirements*. Not only must the SQOs be scientifically sound, they also must be legally defensible. The State Board therefore must comply with the legal requirements set forth herein and in the attached comments.

- *The SQO program should consider both environmental and economic impacts and balance them with the benefits of the program*. The State Board is required to engage in a balancing process when determining what SQOs and implementation measures are necessary and appropriate, taking into consideration a variety of factors including anticipated environmental benefits and economic considerations.

As set forth in the technical and legal issues set forth below and in the attached comments, the SQOs as proposed are not consistent with the above principles.

II. Technical Issues

The experts the Chamber has consulted have identified numerous technical deficiencies, ambiguities and inconsistencies in the State Board's analyses that make the proposed SQOs flawed.

- *The sediment chemistry prong of the evaluation is based on thresholds that are not scientifically supported*. The sediment chemistry prong of the State Board's proposal results in thresholds that do not reflect causal relationships between the specific pollutants and toxicity, ignore material contrary evidence, and rely on statistical artifice to drive the thresholds to arbitrarily low values.

- *The proposed SQO program does not address how the standards are to be applied when the lines of evidence and/or the data are inconsistent*. The State Board should specify at what point and under what guidelines the process will allow regulators and dischargers to take account of inconclusive lines of evidence, and determine whether the available data lead to consistent, scientifically defensible conclusions.

- *The Report does not make clear how to determine there is a failure to achieve the SQOs, or when action to address such non-compliance needs to be taken*.

- *Application of the matrices in the Report (Tables 3.7 - 3.9) leads to nonsensical results*. It is not logical to conclude, as the process does, that sediment is "likely impacted" by toxic pollutants when the benthic community is at the reference condition, or when there is an impact but there is no evidence that it is caused by the pollutants measured.

- *The proposed SQO program will impose unwarranted costs*. The Chamber is concerned that the SQOs will be an ineffective, costly and burdensome tool for regulating sediment quality. Unwarranted costs include those associated with requiring benthic community evaluations and toxicity tests for sediments proximate to each and every source subject to regulation; requiring a "reasonable potential analysis," which requires complicated modeling and may not be practical to routinely determine in any event; requiring sediments to attain relatively pristine levels (which is unrealistic); incorporating human health risk assessments into the SQOs, which will add tremendous expense to the overall assessment of a site; requiring costly follow-up studies, source control efforts, or even sediment remediation to abate sediment effects when the conclusions reached following the proposed framework are inconsistent and sediment effects are present at levels that pose no material risk; and requiring permittees to, at a minimum, monitor sediment quality at least once prior to issuance and re-issuance of a permit, which places the burden on the dischargers and incorrectly assumes a connection between the discharger and sediment quality.

III. Legal Issues

In addition to the SQOs' technical defects, the State Board's proposal appears to contravene a number of legal principles. As with the technical problems, the State Board should take the time necessary to ensure its approach can withstand legal scrutiny.

- *The SQO program should focus on toxic "hot spots*." Chapter 5.6 of the Porter-Cologne Act, which requires the State Board to establish SQOs, focuses on toxic "hot spots." The SQOs do not meet the Water Code requirement to focus on identifying actual toxic hot spots, because the State Board's proposal may result in sediment impairment as the norm -- not a condition limited to "hot spots."

- *The SQO program must be consistent with the "reasonableness" policies of the Water Code*. Water Code Section 13000 requires that activities and factors that may affect the quality of water be regulated to the highest water quality which is reasonable, considering all demands being made and to be made on the water and the total values involved, beneficial and detrimental, economic and social, tangible and intangible. The SQO program does not appear to meet the Water Code requirement of "reasonableness," which requires a substantive balancing of these factors. The State Board has not specified the costs associated with its proposal; but they appear to be significant. To justify such costs, the State Board must demonstrate that the SQOs will result in a significant and beneficial reduction in harm.

- *The Report does not explain how the program will comply with the requirements of Water Code Sections 13241 and 13242*. The State Board acknowledges it must comply with Sections 13241 and 13242 of the Water Code. However, the State Board's proposal does not comply with these requirements, especially the requirement that the SQOs be "reasonably achievable" under Section 13241, and include a clear program of implementation under Section 13242. It appears that major portions of bays and estuaries will be characterized as impaired under the State Board's proposal -- strong evidence that the standards are not reasonably achievable. A major defect in the State Board's proposal is its failure to establish a transparent, defined implementation framework.

- *Requiring a "reasonable potential analysis" (RPA) effectively treats the SQOs as water quality standards, which is improper and unlawful*. The State Board is proposing to require the Regional Boards to implement SQOs as receiving water limits in NPDES permits where the Board believes there is the "reasonable potential" that the discharge of pollutants may cause or contribute to an exceedance of an applicable SQO. Such a proposal is improper and unlawful because (1) application of an RPA requirement to SQOs is impractical; (2) there is no regulatory foundation for applying RPA to SQOs; (3) SQOs are not water quality standards; and (4) the State Board has not provided notice that SQOs would be treated as water quality standards.

- *The State Board's Report does not comply with CEQA*. The Report does not comply with the CEQA requirement to adequately analyze potential environmental effects of the program. The State Board itself recognizes that its Report is rather preliminary and that it does not address many of the more complex technical issues associated with the SQOs. The State Board will need to provide a thorough and comprehensive analysis of the entire SQO program before it can comply with CEQA's requirements.

- *The State Board has failed to analyze economic costs of the SQOs*. The Report does not meet the requirements of the Porter-Cologne Act, the California APA, and CEQA to analyze the economic impacts of the proposed SQO program.

- *The SQOs appear to be arbitrary and capricious and unsupported by substantial evidence*. Due to the technical and legal deficiencies described herein and in the enclosed comments, the SQOs appear to be arbitrary and capricious, and unsupported by substantial evidence.

We hope that our comments on the SQOs will help the State Board achieve its objective of developing defensible SQOs for the protection of California's enclosed bays and estuaries. Please do not hesitate to call me or Paul Singarella should you have any questions or if we can be of any further assistance. We look forward to continuing to serve on the Advisory Committee, and providing the State Board with our views on this important and precedential rulemaking.

Respectfully submitted,

Valerie Nera

Valerie Nera, Director
Agriculture, Resources & Privacy
California Chamber of Commerce

Attachments

cc: Paul N. Singarella, Esq., Latham & Watkins LLP
Patricia Guerrero, Esq., Latham & Watkins LLP

CALIFORNIA CHAMBER OF COMMERCE'S COMMENTS ON STATE WATER RESOURCES CONTROL BOARD'S

DEVELOPMENT OF SEDIMENT QUALITY OBJECTIVES FOR ENCLOSED BAYS AND ESTUARIES (AUGUST 17, 2006)

Submitted by: Date: November 28, 2006

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The California Chamber of Commerce appreciates the opportunity to submit comments regarding the State Water Resources Control Board's ("State Board") August 17, 2006 report entitled "CEQA Scoping Meeting Informational Document, Development of Sediment Quality Objectives for Enclosed Bays and Estuaries" ("Report"). The State Board proposes to provide an overview of the Report during its November 28, 2006 meeting, and to initiate the State Board's formal water quality planning process and a scoping process under the California Environmental Quality Act, Cal. Pub. Res. Code §§ 21000 et seq. ("CEQA"). The State Board intends to prepare and circulate a draft Substitute Environmental Document after the November 28th CEQA scoping meeting.

This letter contains our initial comments regarding the scope and content of the Report and the Substitute Environmental Document that the State Board must prepare pursuant to CEQA.[1] We have also attached a memorandum prepared by John Connolly, Elaine B. Darby and Jennifer Benaman at Quantitative Environmental Analysis, LLC ("QEA"), experts with whom we have consulted.[2]

The Chamber and its members have a particular interest in this matter, since we have concerns that the proposed SQOs contain significant error and would be an ineffective, costly and burdensome tool for regulating sediment quality. We hope our perspective will assist the State Board as it proceeds to adopt SQOs for enclosed bays and estuaries in California.

I. Overview Of Key Concerns

A. The State Board's Rulemaking Will Be Precedential

The State Board is faced with an important and challenging opportunity. There are no SQOs in California, and few across the country. Given the magnitude of the State Board's rulemaking, it is critical that the State Board take the time to ensure that the SQOs are scientifically and legally sound. This posture is tantamount to the early days of the California Porter-Cologne Water Quality Control Act ("Porter-Cologne Act"), when the State Board was required to develop water quality standards. The State Board is tasked with the equally important duty of developing standards for the underlying sediments. History instructs that it is

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1 These comments do not constitute an exhaustive list of our comments on the agency's CEQA process for the proposed sediment quality objectives ("SQOs"). We will expand on these comments and raise additional issues, as appropriate, at future administrative proceedings on this topic. We do not waive (and specifically reserve) our right and/or opportunity to make additional comments at future stages of this process.

2 The Chamber requests that its November 28, 2006 cover letter, these comments, the attached QEA Technical Memorandum and accompanying exhibits be placed in the Administrative Record for these proceedings. The exhibits are filed under separate cover and entitled "Technical Appendix to the California Chamber of Commerce's Comments on State Water Resources Control Board's Development of Sediment Quality Objectives for Enclosed Bays and Estuaries."

important to get the standards right. The components, structure, scope, implementation, costs and impact of the SQOs need to be both scientifically supportable and understandable.

B. SQOs Should Be Based On Good Science And Be Transparent

The State Board should learn from the state's experience with the Total Maximum Daily Load ("TMDL") program, where impairment has become the rule in the water column, and implementation plans are required for virtually every water body near human activity. The SQOs need not, and should not, be tantamount to a TMDL program for sediments. Rather, the SQOs should further the purposes of the underlying statute. Chapter 5.6 of the Porter-Cologne Act focuses on toxic "hot spots"; the State Board should tailor the SQOs specifically to facilitate the Chapter 5.6 program. As currently proposed, there is a risk that the SQOs needlessly will result in a vastly expanded program of sediment cleanups that are unjustified on the science, fail to effectively reduce risk, and cause more harm than good. Such a program is unwarranted by any reasonable assessment of potential impacts to the benthic community, human health or wildlife.

The State Board must ensure that the science underlying the SQOs is sound and correct to prevent California from adopting vague, ambiguous and potentially grossly overbroad standards that are unnecessary to protect the environment. The standards must be clear so that the public can determine their meaning and how to achieve compliance. At a minimum, the State Board closely must examine what implementation of the SQOs really will look like, what alternative approaches there are, how much sediment will fail to comply with the SQOs, and how much it will cost to return these sediments to compliance (which itself requires detailed articulation and specificity).

The SQOs are preliminary in nature and lack transparency regarding many crucial aspects, such as when and how a failure to achieve the SQOs will be determined. Based upon our evaluation of the State Board's preliminary environmental document, the Chamber is concerned that the State Board is proposing a process that will be very costly for regulators and dischargers, but that will not result in commensurate improvement in sediment quality or environmental benefit.

It is unclear how the proposed methods will be applied to California's enclosed bays and estuaries. There are ambiguities, inconsistencies and uncertainties that the State Board must address in order to adopt scientifically sound SQOs. For example, in establishing the thresholds to be used in the chemistry evaluation prong of the assessment, the State Board appears to be relying on the mere presence of chemicals at sites to conclude that those specific pollutants cause toxicity in sediments at those sites, even when empirical studies (discussed below) directly contradict this conclusion. For example, a study conducted in Newport Bay (Bay *et al.*, 2004) indicates that PCBs and DDT are not the cause of observed toxicity, even though these chemicals were detected in the sediments. However, the thresholds proposed by the State Board for these chemicals are based on the assumption that PCBs and DDT are the cause of toxic effects in benthic communities. In short, the State Board is proposing exceedingly low thresholds while ignoring evidence (such as the study discussed above) demonstrating that the compounds do not cause toxicity, and is merely relying on an association between the chemicals and the sediments to support its threshold values. As discussed further below, the State Board should consider all studies, including those indicating that the benthic community was not degraded when compounds such as DDT and PCBs were present at levels far higher than the State Board's proposed thresholds. Such evidence should cause the State Board to reconsider whether its exceedingly low threshold values make sense. We believe they do not.

C. The State Board Should Adopt A Tiered Assessment Approach For SQOs

The Report fails to define when and how a failure to attain the SQO will be determined. Although the State Board proposes a process with apparent flexibility in making station-level determinations, it appears that the results of the analyses may result in sediment impairment as the norm. For example, the process can lead to the conclusion that sediment is "likely impacted" by toxic pollutants even when the benthos is at the reference condition,[3] or the conclusion that sediments are "impacted" on some level where sediment concentrations are relatively low.[4] A site characterized with high toxicity and disturbance, but with minimal exposure, is categorized as "likely impacted" even in the case where no pollutants are detected in the sediments or where there is no evidence that the pollutants measured cause any observed impacts.[5] Rather than impairment being the norm, the State Board should incorporate a threshold analysis of sediment chemistry as a precursor to requiring the assessment of the benthic community, toxicity tests and complete site assessment. Toxic pollutants *attributable to particular sources* must be present in the sediments at levels known to cause impacts in bay and estuary environments to trigger further investigation. The State Board should adopt a tiered approach in which chemistry assessments are used to trigger benthic community studies, which are used to trigger toxicity assessment. If the sediment chemistry indicates that the chemicals attributable to the discharge(s) being evaluated are absent or are present at concentrations of no concern, benthic community evaluations and toxicity tests should not be required. Requiring benthic community evaluations and toxicity tests for the sediments proximate to each source subject to regulation will be very costly for regulators and dischargers, when the impact in many cases will not be due to chemicals attributable to the discharge(s) being evaluated.

Such a tiered approach should be accompanied by a mechanism for stepping back and determining whether the available data make sense. The current process fails to provide for this important evaluation. Characterization of a site requires thorough analyses and even then may yield conflicting results from chemical and biological measurements. As discussed further below, gross inconsistencies among the lines of evidence strongly suggest the potential for data quality issues or the dominant impact of factors other than the considered chemicals. Similarly, as also shown below, the current process in many cases leads to nonsensical results, such as a determination that a site can be "likely impacted" by toxic pollutants when the benthos is at the reference condition or when there is an impact but no evidence that it is caused by the pollutants measured. It is imperative that the State Board address these types of challenges to ensure that proper guidance is provided to those evaluating the data.

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3 QEA Technical Memorandum at 2.

4 Id. at 5.

5 Id.

D. The SQO Program Should Be Based On Reasonableness And Consider Environmental And Economic Impacts

The goals and implementation measures of the State Board's approach need to be more clearly defined, consistent with the overarching goals of the Bay Protection and Toxic Cleanup Program ("Program") and the "reasonableness" policies of the California Water Code. The goal of the program can not realistically be to take all "impacted" sites to pristine, "unimpacted" conditions. The State Board's proposal could result in excessive monitoring and remediation by dischargers who may not have contributed to the impacted sediments. The State Board does not appear to have considered the economic and environmental impacts that may result from compliance with the SQOs. As the State Board moves forward with its proposal, it will be critical for the agency to perform the type of comprehensive analysis of these considerations that is required by law in order to make the SQOs scientifically and legally defensible. The Chamber hopes that its comments will assist the State Board to accomplish these objectives and improve the SQOs.

II. Regulatory Framework

A. California Porter-Cologne Water Quality Control Act

The Porter-Cologne Act establishes the framework pursuant to which the State Board and Regional Water Quality Control Boards ("Regional Boards") reasonably protect water quality in California. Cal. Water Code §§ 13000 et seq.[6]

The Porter-Cologne Act mandates that a balancing process be followed in regulating activities and factors that affect the state's water quality. According to the Legislature, such activities "shall be regulated to attain the highest water quality which is reasonable, considering all demands being made and to be made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible." Cal. Water Code § 13000 (emphasis added). The Porter-Cologne Act also recognizes that "it may be possible for the quality of water to be changed to some degree without unreasonably affecting beneficial uses." Cal. Water Code § 13241. The Act therefore identifies factors that the Boards must consider in determining what level of protection is reasonable, including economic considerations. Id.

The State Board and the Regional Boards are the state agencies with primary responsibility for the coordination and control of water quality, and must conform to and implement the Water Code in exercising their responsibilities. Cal. Water Code § 13001. The State Board discharges its duty to coordinate and control water quality by issuing a series of plans and policies, including plans for the adoption of SQOs. Cal. Water Code §§ 13392.6, 13393.

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[6] Division 7 of Chapter 1 of the Water Code consists of Water Code Sections 13000-14958, and is commonly referred to as the Porter-Cologne Water Quality Control Act.

B. Bay Protection And Toxic Cleanup Program

California Water Code, Division 7, Chapter 5.6 established a comprehensive program within the State Board to protect the existing and future beneficial uses of California's enclosed bays and estuaries. Cal. Water Code §§ 13390 et seq. The State Board and Regional Boards are required to (1) identify and characterize toxic "hot spots"; (2) plan for the cleanup or other appropriate remedial or mitigating actions at sites; and (3) amend water quality control plans and policies to incorporate strategies to prevent the creation of new toxic "hot spots" and the further pollution of existing toxic "hot spots." Cal. Water Code § 13392.

To accomplish these objectives focused on toxic "hot spots," the Bay Protection and Toxic Cleanup Program ("Program") requires the State Board to adopt SQOs pursuant to a workplan submitted as required by statute (Cal. Water Code § 13393(a)), and pursuant to the procedures established by the water quality law[7] for adopting or amending water quality control plans. Cal. Water Code § 13393(b).

The California Water Code defines "toxic hot spots" as locations in enclosed bays, estuaries, or the ocean where pollutants have accumulated in the water or sediment to levels that: (1) may pose a substantial present or potential hazard to aquatic life, wildlife, fisheries, or human health; (2) may adversely affect the beneficial uses of the bay, estuary, or ocean waters as defined in water quality control plans; or (3) exceed adopted water quality or sediment quality objectives. Cal. Water Code § 13391.5(e).

"Sediment quality objective" is defined under California law as the "level of a constituent in sediment which is established with an adequate margin of safety, for the reasonable protection of the beneficial uses of water or the prevention of nuisances." Cal. Water Code § 13391.5(d). The SQOs must be based on scientific information, including, but not limited to, chemical monitoring, bioassays, or established modeling procedures, and must provide adequate protection for the most sensitive aquatic organisms. Cal. Water Code § 13393(b). The State Board must base the SQOs on a health risk assessment if there is a potential for exposure of humans to pollutants through the food chain to edible fish, shellfish, or wildlife. Id.

C. CEQA Applies To The Development And Adoption Of SQOs

The State Board must comply with the requirements of CEQA and the California Administrative Procedure Act ("APA") when adopting a plan, policy or guideline. The State Board may be exempt from certain CEQA requirements, including the requirement to prepare an Environmental Impact Report ("EIR"), if it is acting pursuant to a "certified regulatory program" certified by the California Secretary of Resources. Even when this exemption applies, the State Board must produce a document that is functionally equivalent to an EIR.

Among other things, the "Substitute Environmental Documents" ("SEDs") that are prepared in lieu of EIRs must comply with CEQA's goals and policies; analyze alternatives; identify potentially significant adverse environmental impacts; consider cumulative impacts

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7 See Cal. Water Code §§ 13000-14958.

(which in this case include the environmental and economic impacts that may result from compliance with the SQOs); consult with other agencies with jurisdiction; provide public notice and allow public review; respond to comments on the draft environmental document; make findings as to how identified environmental impacts will be mitigated; and provide for monitoring of mitigation measures.

The Secretary of Resources has certified the State Board's Water Quality Control (Basin)/208 Planning Program as meeting the requirements for exemption from the need to prepare an EIR. Title 14, Cal. Code Regs., § 15251(g). To the extent that the State Board's adoption of a water quality control plan for sediment quality for enclosed bays and estuaries falls within this certification, a valid SED which considers environmental and economic impacts fulfills the requirements of CEQA for preparation of an environmental document.

In addition, when the State Board proposes to promulgate performance standards like those contained in the proposed SQOs, Section 21159 of the Public Resources Code applies. Section 21159 requires the State Board to consider the environmental and economic impacts of the reasonably foreseeable methods of compliance with adopted standards. The State Board's status as a certified regulatory agency does not exempt it from these requirements. Prior statements issued by the State Board's Office of Chief Counsel indicate that economic impacts will be considered when establishing a performance standard,[8] like the ones for contaminated sediments in enclosed bays and estuaries. Other California regulations likewise require consideration of economic effects as part of the rulemaking process. See, e.g., Cal. Gov't Code §§ 11340 et seq., i.e., the California APA.[9]

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8 See Exhibit 3, Memorandum from William R. Attwater, Chief Counsel, State Water Resources Control Board, to Regional Water Board Executive Officers (January 4, 1994) at 1, 3 (stating that Regional Boards are "under an affirmative duty to consider economics when adopting water quality objectives in water quality control plans," and also "are under an additional mandate to consider economics when adopting objectives" as a result of Public Resources Code § 21159); Exhibit 4, Memorandum from Sheila K. Vassey, Senior Staff Counsel Office of Chief Counsel, to TMDL Coordinator (October 27, 1999) at 26 ("CEQA also has specific provisions governing the Regional Water Boards' adoption of regulations, such as the regulatory provisions of basin plans that establish performance standards or treatment requirements. The Boards must do an environmental analysis of the reasonably foreseeable methods of compliance with these standards or requirements. They must consider economic factors in this analysis.") (citing Public Resources Code § 21159).

9 Section 11346.3 of the Government Code provides that "State agencies proposing to adopt, amend, or repeal any administrative regulation shall assess the potential for adverse economic impact on California business enterprises and individuals, avoiding the imposition of unnecessary or unreasonable regulations or reporting, recordkeeping, or compliance requirements."

III. Agency Proceedings

On August 17, 2006, the State Board released its CEQA Scoping Meeting Informational Document describing its proposed approach (the "Report"). The purpose of the Report is to present a summary of the progress and direction of the SQO program for the public in preparation for the CEQA Scoping Meeting, which will initiate the State Board's formal water quality planning process. The Report is preliminary in nature (as recognized by the State Board itself),[10] and will need to be substantially revised before the public can determine the scope of the State Board's proposal with the necessary level of clarity.

The Report establishes two "narrative" SQOs: (1) an "aquatic life" objective stating that "[p]ollutants in sediments shall not be present in quantities that, alone or in combination, are toxic to benthic communities in bays and estuaries of California"; and (2) a "human health" objective stating that "[p]ollutants shall not be present in sediments at levels that will bioaccumulate in aquatic life to levels that are harmful to human health." Id. at 41. To implement the aquatic life narrative objective, the Report relies on the application of "multiple lines of evidence" (i.e., benthic condition, sediment toxicity and chemistry) to assess the survivability of test organisms to the whole sediment. See id. at 42-50. The State Board proposes to integrate results from the multiple lines of evidence using a "logic system" to make station-level determinations regarding the likelihood of biological effects due to sediment contamination. To implement the human health objective, the Report proposes to use consumption rates and cancer risk factors used by OEHHA in establishing fish consumption rate risk advisories for bays and estuaries. Id. at 51.

The Report provides that the SQOs shall be implemented as receiving water limits where a Regional Board believes there is the "reasonable potential" that the discharge of toxic pollutants may cause or contribute to an exceedance of the SQOs. Id. at 52. The Report also contains provisions for monitoring of sediment levels by waste discharge permittees where the State or Regional Boards believe there is the "reasonable potential" that a discharge of toxic pollutants may accumulate in sediment "at levels that will cause, have the reasonable potential to cause, or contribute to an exceedance of applicable SQOs." Id. The State Board proposes to require permittees to, at a minimum, monitor sediment quality at least once prior to the issuance and re-issuance of a permit. Id. at 53.

If sediment fails to meet the narrative SQOs, the Report provides for the performance of "focused studies" consisting of the following three tasks: (1) confirmation and characterization of pollutant-related impacts; (2) pollutant(s) identification; and (3) source identification. Id. at 53.

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10 See Report at 36 ("it must be emphasized that this proposal is preliminary in nature"); id. at 4 ("Many of the more complex technical issues such as the selection and validation of test methods or derivation of thresholds are not discussed within this document. These issues will be summarized in the [draft SED] and described in detail within the program technical reports in preparation.").

The State Board states at the beginning of the Report that it decided not to specifically address the application of SQOs to sediment cleanup activities. Instead, the State Board states that Regional Boards "retain the discretion to apply the SQOs and supporting tools to cleanup activities, where appropriate." Id. at 6. Despite this initial statement, however, the Board states later in the Report that the Regional Boards shall impose cleanup obligations and management actions upon identifying sources of pollutant-related impacts. If a single discharger is found to be responsible for discharging the stressor pollutant, the Regional Board "shall require the discharger to take all necessary and appropriate steps to address exceedance of the SQO, including but not limited to reducing the pollutant loading into the sediment." Id. at 55. Similarly, if the Regional Board identifies multiple sources, the Board "shall require the sources to take all necessary and appropriate steps to address exceedance of the SQO." Id. The Report further provides that the Regional Board may adopt a TMDL to ensure attainment of the sediment standard, if appropriate. Id. These later statements appear to be inconsistent with a decision not to address the application of SQOs to sediment cleanup activities.

IV. Technical And Scientific Issues And Comments

The technical and scientific issues are discussed at length in the attached QEA Technical Memorandum. Each of the flaws and issues identified in the memorandum is of concern and renders the proposed SQOs scientifically unsound. Without waiving any objections, we are summarizing the key conceptual, overarching points of concern.

A. The State Board Improperly Concludes That Specific Pollutants Cause Toxicity In Sediments By Ignoring Directly Contradictory Evidence

The thresholds of toxicity reflected in the State Board's Report, for use in applying the sediment chemistry prong of the assessment, are alarmingly low. In many cases, it is not possible to determine exactly how the numbers were derived because of the preliminary nature of the environmental document the Board prepared.[11] Nonetheless, based upon the experience of our experts, it appears that the State Board could derive such exceedingly low values only by ignoring critical evidence that directly contradicts the State Board's conclusion that chemicals at these levels cause sediment toxicity. The numbers proposed by the State Board therefore appear to be erroneous and scientifically unjustified.

For example, the State Board appears to be relying on data from Newport Bay to support the DDT and PCB thresholds. However, the data relied upon shows that PCBs and DDT were merely present, or co-located, along with other compounds. Numerous studies, including the ones cited below, suggest that (1) other compounds or factors are likely responsible for any observed toxicity; (2) the benthic community is not impaired when exposed to levels that are considerably higher than the State Board's proposed thresholds; and (3) there is no "dose-response" relationship demonstrating that toxic effects in the relevant benthic populations increased with increasing levels of exposure to the compounds under investigation.

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[11] See Report at 4 ("Many of the more complex technical issues such as the selection and validation of test methods or *derivation of thresholds are not discussed* within this document.") (emphasis added).

As set forth in Exhibits 5-10, several recent studies suggest that DDT and PCBs are not likely a cause of toxicity in Newport Bay water and sediment. Bay *et al*. (2004) found evidence of acute toxicity in sediment from Newport Bay, but explicitly noted that variations in sediment toxicity were not correlated with concentrations of DDTs, PCBs, or PAHs.[12] The authors concluded that sediment toxicity seemed to be attributable to unmeasured organic compounds, such as organophosphate, carbamate, or pyrethroid pesticides.[13] Similarly, Lee *et al*. (2001) found that while toxicity related to urban storm-water runoff is present in Newport Bay, recent work has shown that the cause of the toxicity is not heavy metals or organochlorine compounds but rather organophosphate pesticides, such as diazinon and chlorpyrifos.[14] Lee and Taylor (2001) also suggest that pyrethroid pesticides should be investigated further as a potential source of toxicity in the Bay.[15] An extensive scientific literature review also was undertaken to evaluate the current state of knowledge about DDE (a metabolite of DDT) concentrations in the tissue of key wildlife species, trends in such DDE concentrations, and links between DDE tissue concentrations and reproductive success to evaluate potential chronic toxicity in sediment from Newport Bay.[16] The results of this literature review indicate that relevant wildlife populations are not currently exposed to levels of DDE in Newport Bay that are known to cause chronic toxicity, and that the expected continuing declines in DDE concentrations in the environment make it highly unlikely that DDE concentrations in wildlife tissue will increase from these nontoxic levels in the future.[17]

It is our understanding that the State Board nonetheless is using sediment chemistry data from Newport Bay -- where compounds other than DDT and PCBs are the cause of toxic effects -- to develop sediment thresholds used to conclude that DDT and PCBs cause toxicity. The State Board appears to be relying on data where the authors of the underlying scientific studies ascribed toxicity to other factors, and specifically found that the compounds for which the State Board has developed thresholds are not the cause of the toxicity.

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12 See Exhibit 8 (Bay *et al.*, *Newport Bay Sediment Toxicity Studies*) (June 2004) at i ("Variations in sediment toxicity were statistically correlated with the concentration of several metals, but not the concentration of DDTs, PCBs, or PAHs.").

13 Id. at ii ("Sediment toxicity to amphipods in the upper bay appears to be associated with unmeasured organic compounds, possibly organophosphorus or pyrethroid pesticides. The concentrations of PCBs, DDTs, and PAHs at this site were well below those expected to cause toxicity to amphipods.").

14 See Exhibit 9 (Lee *et al.*, *Synopsis of the Upper Newport Bay Watershed 1999-2000 Aquatic Life Toxicity Results with Particular Reference to Assessing the Water Quality Significance of OP Pesticide-Caused Aquatic Life Toxicity*) (March 2001) at 1.

15 See Exhibit 10 (Lee, G.F. and Taylor, S., *Results of Aquatic Toxicity Testing Conducted During 1997-2000 within the Upper Newport Bay Orange County, CA Watershed*, Report of G. Fred Lee & Associates, El Macero, CA) (2001) at 48-49.

16 See Exhibit 5 (DDT Analysis for the Newport Bay Watershed) at 4.

17 Id.

Moreover, there are several studies where relatively high levels of DDT and PCBs were present (well above the State Board's proposed thresholds), yet no toxicity was observed. For example, in a field study done with Rhepoxynius abronius ("R. abronius"), an amphipod, researchers found no toxicity in the Palos Verdes shelf sediments at DDT levels as high as 267 parts per million ("ppm") and at PCB levels as high as 31.8 ppm.[18] In a corresponding spiking study, the lowest observable effect concentration for causing toxicity to R. abronius was 9.69 ppm for DDT and 27.4 ppm for PCBs.[19] Another spiking study came to similar conclusions, finding no toxicity at DDE levels as high as 8.7 ppm.[20] A third study found no toxicity in sediments spiked with DDT to nearly twice this level, 16.5 ppm.[21] In addition, several studies have shown no correlation between toxicity and DDT[22] and between toxicity and PCBs,[23] thus indicating an apparent lack of a dose-response relationship.

The Chamber understands the State Board has indicated that the chemical concentration thresholds under the chemistry prong of the multiple lines of evidence will not be over-weighted, but rather evaluated along with the other lines of evidence. However, the existence of such contradictory data noted above should cause the State Board to carefully evaluate whether its thresholds are scientifically supportable, particularly given the State Board's own recognition of the limited utility of this line of evidence.[24] The State Board can not selectively cull data to support its conclusion, while ignoring an abundance of data that directly contradicts its position. As discussed in the QEA Technical Memorandum, the thresholds utilized in the State Board's

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18 EVS Consultants, P. Chapman and M. Murdoch, *Southern California Damage Assessment Surface Water Injury: Sediment* (Table E.1).

19 Id.

20 Bay, S.D. Greenstein, J. Brown, and A. Jirik, *Investigation of Toxicity in Palos Verdes Sediments* (1994).

21 Exhibit 11 (D.W. McLeese and C.D. Metcalfe, *Toxicities of Eight Organochlorine Compounds in Sediment and Seawater to Cragon septemspinosa*, 25 Bull. Environm. Contam. Toxicol. 921-928) (1980).

22 See, e.g., Exhibit 12 (R. Sapudar *et al.*, *Sediment Chemistry and Toxicity in the Vicinity of the Los Angeles and Long Beach Harbors*, Draft Final Report) (Nov. 1994) at 66, 68 (finding a "lack of significant toxicity to amphipods relative to sediment total DDT concentrations in the Los Angeles/Long Beach study"); Exhibit 13 (Russell Fairey *et al.*, *Chemistry, Toxicity and Benthic Community Conditions in Sediments of the San Diego Bay Region*, Final Report) (Sept. 1996) ("Fairey Report") at 127.

23 Fairey Report at 127.

24 See Report at 16 ("[S]ediment quality indicators based on pollutant concentrations in sediment have only limited utility when used by sediment managers unless bolstered by effects data such as toxicity and benthic community disturbance…."); id. at 15 ("Water quality is routinely assessed based on a single line of evidence (LOE), chemical-specific concentration-based thresholds developed from toxicological studies…. Sediment, however, is a more complex matrix that makes establishment of an objective based on chemical concentration alone problematic.").

PMAX and CCS formulations do not conclusively relate cause to effect and have the potential for predicting thresholds much lower than actual toxic levels. See QEA Technical Memorandum at 14-15. In light of these facts, the Chamber respectfully requests that the State Board:

- Identify to what extent it is relying on data from Newport Bay;
- Identify to what extent it is using chemistry data from certain water bodies to demonstrate the toxicity of certain compounds where studies of the same water bodies ascribed toxicity to factors other than those compounds;
- Identify to what extent, in developing thresholds for specific compounds, the State Board is using studies in which the authors found that those compounds were not the cause of toxicity;
- Identify to what extent it is relying on data where the benthic community was not impacted adversely when exposed to levels higher than those reflected in the State Board's thresholds;
- Identify to what extent it is relying on data that failed to demonstrate a dose-response relationship with respect to the compounds for which the State Board has developed thresholds;[25]
- Search for studies in bays and estuaries where the benthic community was not degraded when exposed to levels higher than those reflected in the State Board's thresholds;
- Inform the public whether it is relying on any analyses performed by Donald MacDonald, and if so, which analyses.[26]

B. The State Board's Proposed Approach Fails To Provide A Mechanism For Evaluating Whether The Available Data Make Sense And Are Consistent

An important and missing step in the State Board's approach is evaluating whether the available data lead to consistent, scientifically sound conclusions. For example, there are instances when indicators of benthic health are contradictory and the balance between chemical

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25 Whereas water quality standards are developed based on dose-response information, the SQOs are not supported by such information or a clear understanding regarding toxicity. The State Board appears to rely on an association between pollutants and observed toxic effects, ignoring evidence that no dose-response relationship exists.

26 MacDonald proposed a consensus-based sediment effect concentration as a means of reconciling sediment quality guidelines developed from various empirically-based methods which were shown to vary by as much as two orders of magnitude. QEA Technical Memorandum at 15.

toxicity and community disturbance is unclear. As set forth in the QEA Technical Memorandum, such contradictions can be seen from the investigation of sites in San Francisco Bay by Hunt *et al*. (2001). This study found conflicting chemical and biological lines of evidence. This detailed study indicates that characterization of a site requires thorough analyses and even then may yield gross inconsistencies among the lines of evidence, which strongly suggests the potential for data quality issues or the dominant impact of factors other than the considered chemicals. QEA Technical Memorandum at 3-4. The Report fails to delineate at what point and under what guidelines the process will account for such inconclusive lines of evidence.

In addition, the State Board appears to be applying a Logistic Regression Modeling ("LRM") approach where the data provide a poor fit for evaluating PCB-contaminated sediments. The State Board appears to have relied on data from Field *et al*. (1999),[27] or adopted an approach similar to that by Field.[28] However, the Field study concluded that "PCBs tended to fit poorly with the model." QEA Technical Memorandum at 11. As a result, the applicability of the LRM approach to evaluate PCB-contaminated sediments is questionable. Id. The State Board should provide further discussion and analyses supporting the use of this model for PCBs in the SQO evaluation. The State Board should explain to what extent its analysis differs from Field's, and how the State Board has overcome (if it did) the poor fit in the data that precludes its use in evaluating PCB-contaminated sediments.

These examples and others set forth in QEA's Technical Memorandum demonstrate that at some point in the evaluation process, there must be a step to evaluate whether the overall data are consistent and supportable prior to applying the prescribed methods.

C. The Lack Of Transparency Regarding The State Board's Proposed Implementation Measures Renders The SQOs Defective

There are significant ambiguities and uncertainties in the State Board's proposed process. For example, there is no well-defined implementation plan. The Report is not clear on when and how a nonattainment of the SQO will be determined, and how remediation of the site will be accomplished.

Section 2 of the Report provides an overview of the issues involved in developing and implementing SQOs in California's enclosed bays and estuaries. However, this part of the Report is conceptual in nature. The public must look to Section 3 for a description of the technical details regarding how to assess sediment toxicity and exposure to toxic pollutants in sediment. Section 3 of the Report falls short in linking the results of the State Board's proposed analyses to whether the narrative SQOs are being achieved. It is unclear whether a finding of

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27 See Report at 23 ("The Logistic Regression Modeling (LRM) approach is based on statistical analysis of matching chemistry and biological effects for amphipod toxicity (Field *et al*., 1999).").

28 The State Board appears to have used different numbers than those in Field's study. See QEA Technical Memorandum at 9-11.

nonattainment is triggered after putting the available data through the tests and equations outlined in Section 3, which would then initiate the focused studies to determine the pollutant(s) causing the impact and source identification pursuant to Section 3(VII). If a site is "possibly impacted," does that mean that the SQOs are not attained? Does it depend on the site or waterbody? Do the focused studies aid in determining compliance or are they implemented after nonattainment has been established? None of these crucial questions is addressed in the Report, presenting a significant weakness in the proposed approach. QEA Technical Memorandum at 4-5.

The State Board's Report does not address how a discharge would potentially be controlled using the findings of the evaluation set forth in Section 3. It is assumed that this control would occur through the NPDES permitting process, but no clear steps are identified to indicate exactly how a discharge permit may be evaluated and changed when an SQO is exceeded. Id. at 5.

In addition, the State Board's ultimate "goal" for the sediment quality is not clearly defined. Is the target to make all "impacted" systems "unimpacted"? Such a goal would be unrealistic and costly (in addition to being legally invalid as discussed below). The Report should contain guidance on how to set realistic goals once a failure to achieve an SQO is determined. The Report should specify how to determine what level of reduction in permitted discharges (if any) would be necessary to accomplish the program's goals, and how dischargers are expected to evaluate the effect of reductions in water-based concentrations on the sediment quality. Id. at 5-6.

With respect to the approach for evaluating human health impacts, the Report is virtually silent. Id. at 1-2. The State Board refers to various California Environmental Protection Agency and U.S. EPA human health risk assessment policies as a way to assess impacts to human health, but more clarification should be provided as to when the state would expect such a full risk assessment to be performed. It is unrealistic to assume such costly analyses would be performed for every discharge into bay or estuarine waters of California. Id.

These issues potentially could impact regulators and dischargers considerably through the cost and management of detailed monitoring plans, focused studies, and operational modifications loosely prescribed by the SQO process and driven through the NPDES permitting process.

D. Application Of The State Board's Proposed Approach For Assessing Benthic Community Protection Leads To Illogical Results

The State Board's proposed process leads to the conclusion that sediments are impaired when such a conclusion is illogical in many cases. For example, when the multiple lines of evidence are integrated and a site is found to be "possibly impacted," that is supposed to indicate that sediment contamination is present at the site and may be causing significant adverse direct impacts to aquatic life, but these impacts may be moderate or variable in nature. Report at 29. However, based upon the State Board's proposed framework, a site can be characterized as "possibly impacted" even though sediment contamination at the site is considered low from both a toxicity and exposure standpoint. Report, Table 3.9. Similarly, a site is categorized as "likely impacted" when there is high toxicity and high disturbance, but minimal exposure. Id. The designation is supposed to indicate confidence that sediment contamination is present at the site causing significant adverse direct impacts to aquatic life, yet it applies even if no pollutants are detected in the sediment. QEA Technical Memorandum at 7. It also is illogical to conclude, as the process does, that sediment is "likely impacted" by toxic pollutants when the benthos is at the reference condition. Id. at 2. When application of the State Board's proposed process leads to such illogical conclusions, it should be evaluated and modified to correct such scientifically unsound results.

E. Applying The State Board's Proposed SQOs Will Result In Significant Costs That Are Not Warranted By Commensurate Environmental Benefits

Several aspects of the State Board's proposed approach result in significant costs, including, but not limited to, the following:

- Performing costly toxicity tests in all cases, which can be avoided if the State Board adopts a tiered approach in which chemistry assessments are performed, followed by benthic community studies and toxicity assessments, if necessary. Such additional tests would be performed ***only*** if chemicals attributable to the discharge are present at levels of potential concern ***and*** the benthic community data in the impacted area show impairment relative to the reference condition. QEA Technical Memorandum at 2-3.

- Converting all "impacted" systems to "unimpacted," if that is the goal of the State Board's approach (which would be problematic from both a legal and technical perspective). Id. at 5-6.

- Performing EPA-level risk assessments to assess human health impacts. Id. at 2.

- Performing a "reasonable potential analysis" and requiring dischargers to prove or disprove whether contamination is related to their permitted discharge. Id. at 5.

- Implementing the procedure for assessing benthic community condition, which is costly and complex and thus should be performed only if the chemical data indicate the presence of discharge-related chemicals at levels of potential concern. Id. at 3.

- Requiring permittees to, at a minimum, monitor sediment quality at least once prior to the issuance or re-issuance of a permit. Id. at 14-15.

Taken as a whole, the State Board's proposed approach in many cases will result in costly follow-up studies, source control efforts, or even sediment remediation to abate sediment effects present at levels that essentially pose no risk, with the likely result of little or no progress toward the desired SQO. Given that the studies alone will cost many tens to hundreds of thousands of dollars, and the existence of hundreds of thousands of potentially affected dischargers, costs to the regulated community for these studies alone, which in and of themselves will result in no cleanup or environmental improvement, will easily be hundreds of millions of dollars. Moreover, given the absence of any discussion regarding costs of implementation, the Chamber is concerned that there are additional significant costs associated with the State Board's proposal.

V. Legal Issues

A. The SQOs Should Be Applied In A Manner That Furthers The Purpose Of The Bay Protection And Toxic Cleanup Program Of Identifying Actual Toxic "Hot Spots"

As set forth in the Regulatory Framework section above, the Bay Protection and Toxic Cleanup Program ("Program") is designed to focus on toxic "hot spots."

In creating the Program, the California Legislature intended that a plan be prepared for remedial action at toxic "hot spots" (Water Code Section 13390), and required the development of cleanup plans that are distinct from Water Quality Control Plans. Chapter 5.6 requires the formulation of a water quality control plan for enclosed bays and estuaries (Section 13391) and toxic hot spot cleanup plans (Section 13394). The Water Code further states that the State Board and Regional Boards shall "(1) identify and characterize toxic hot spots..., (2) plan for the cleanup or other appropriate remedial or mitigating actions at the sites, and (3) amend water quality control plans and policies to incorporate strategies to prevent the creation of new toxic hot spots and the further pollution of existing hot spots." Cal. Water Code § 13392.

The Section of the Water Code requiring the development of a workplan for adoption of SQOs likewise underscores the Legislature's emphasis on addressing toxic "hot spots." See Water Code § 13392.6 (requiring the State Board to "adopt and submit to the Legislature a workplan for the adoption of sediment quality objectives *for toxic pollutants that have been identified in known or suspected toxic hot spots* and for toxic pollutants that have been identified by the state board or a regional board as a pollutant of concern. The workplan shall include *priorities and a schedule for development and adoption of sediment quality objectives*, identification of additional resource needs, and identification of staff or funding needs.") (emphasis added).

The SQOs should be designed to further the fundamental goal of the Program of which they are a part. To that end, the State Board should utilize the SQOs to positively identify actual toxic "hot spots" -- i.e., sites where scientifically defensible evidence demonstrates the presence of significant adverse impacts to aquatic life or human health, and sound evidence establishes that specific pollutants in the sediment are the cause of the observed adverse effects on benthic organisms. Without this necessary linkage, the State Board violates its statutory mandate to reasonably protect the beneficial uses of California bays and estuaries, and fails to advance the legislative purpose of the Program.

As currently drafted, the SQOs fail to accomplish the above objectives. Rather than focusing on sites that are known to have the highest magnitude of identifiable, concrete impacts and making sediment management decisions targeted at those sites, the State Board appears to be

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proposing a scheme where sediment impairment is the norm. Although the State Board's proposed framework identifies six categories of station-level impacts, the data and tools available for interpreting the multiple lines of evidence do not appear to support the varying levels of distinction the agency proposes to make. Despite the apparent flexibility embodied in the proposed framework, the default endpoint for the analysis is often an illogical determination that sediments are contaminated (albeit to varying degrees).[29]

The agency creates the appearance of being able to make finely-tuned determinations and distinctions that will trigger management actions, when such a detailed analysis and methodology is not scientifically supportable. The State Board should instead adopt an approach that identifies toxic "hot spots" and considers the pathways by which risks exist, receptors for those risks (sediment-dwelling organisms, wildlife or humans), the spatial extent of the contamination, the regulatory goals of the Program, and costs of different sediment management decisions. Utilizing such an approach will better allow the State Board to provide a meaningful interpretation of ecological significance and to make sound management decisions designed to provide the appropriate degree of ecological and human health protection consistent with the regulatory context.

The Report's mandate that permittees monitor sediment quality at least once prior to issuance and re-issuance of a permit also deviates from the objective of focusing on toxic "hot spots." The requirement places unreasonable and misplaced burdens on the dischargers to establish to the State and Regional Boards' satisfaction that the SQOs are being met, with no real guidance on how this is to be done even assuming it were legally defensible to shift the burden in this manner (which the Chamber does not concede). The fact that the State Board oversimplifies matters by assuming a connection between the discharger and sediment quality, and failing to consider real confounding factors such as temporal and spatial variability, multiple dischargers, etc., compounds the flaws in the State Board's proposed approach. It is unreasonable to develop a program on the assumption that a link exists between contaminated sediment and point source discharges, and to require dischargers to prove that no such link exists. The State Board should focus on measures designed to address real impacts at identified toxic "hot spots," rather than effectively requiring dischargers to demonstrate that pristine conditions exist before permits can be issued or reissued. Before any action is taken, a scientifically validated link must be established between a discharge and the identified sediment problem. Even if point sources are identified as significant contributors, existing regulatory mechanisms should be evaluated as the first means to reduce loads. The goal should be to develop a practical and feasible methodology to identify sites where point sources are actually contributing to a sediment problem. Once these sites are identified, agency efforts could be targeted toward reductions that would help attain the beneficial uses, taking into consideration existing regulatory mechanisms.

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29 See Section IV(D), supra.

B. The Protectiveness Of The SQOs Must Be Consistent With The "Reasonableness" Policies Of Division 7

Water Code Section 13393(b) requires the State Board to provide "adequate" protection for the most sensitive aquatic organisms. "Adequate" protection must be determined in a manner consistent with Water Code Sections 13000 and 13001 of Chapter 1 of Division 7.

Water Code Section 13000 requires that activities and factors that may affect the quality of water be regulated to the highest water quality which is reasonable by considering all demands being made and to be made on the water and the total values involved, beneficial and detrimental, economic and social, tangible and intangible. The enactment of Section 13000 finds its roots in a study by the State Board, commissioned by the Legislature. See Study Panel, California State Water Resources Control Board, Recommended Changes in Water Quality Control: Final Report of the Study Panel to the California State Water Resources Control Board (March 1969) (recommended changes to the legislation contained in the report were adopted) (hereinafter, the "Study Panel Report").

The Study Panel Report stated: "The recommended language (section 13000, paragraph 2) recognizes that efforts made toward accomplishing the ideal of clean water must accelerate but that economic progress and development is essential, not, however, at the sacrifice of the environment." Study Panel Report at 7. Porter-Cologne is premised upon striking a proper balance among competing objectives, as stated in the Study Panel Report:

> The regional boards must balance environmental characteristics, past, present and future beneficial uses, and economic considerations (both the cost of providing treatment facilities and the economic value of development) in establishing plans to achieve the highest water quality which is reasonable.

Id. at 13.

Water Code Section 13001 states that the State Board must conform to and implement the policies of Chapter One when exercising any power in Division 7. Since SQOs are required under Division 7, the Section 13001 policies apply.

The State Board therefore must address the balancing test under Water Code Section 13000 and explain how it is to be met in connection with the development and adoption of the proposed SQOs. To avoid running afoul of the principles of Porter-Cologne as reflected in Section 13000 and the Study Panel Report, this balancing test should focus on, among other relevant considerations, sediment quality, benthic community protection, socio-economics, and the feasibility of such protection. The costs associated with the SQOs are among the chief factors that the State Board must evaluate. To appropriately analyze this factor, the State Board must weigh all anticipated costs of its proposal against a realistic assessment of expected risk reduction benefits. The State Board must be able to demonstrate that the costs of the program are justified by a significant and beneficial reduction in harm from contaminated sediments.

C. The State Board Must Explain How It Plans To Comply With Water Code Sections 13240 Through 13247

The State Board acknowledges that it is required to comply with the statutory requirements of Water Code Sections 13240-13247 in adopting SQOs.[30] Report at 4.

Water Code Section 13241 recognizes that in exercising judgment to ensure the reasonable protection of beneficial uses, "it may be possible for the quality of water to be changed to some degree without unreasonably affecting beneficial uses." The California Supreme Court recently recognized the importance of Section 13241 where state law, rather than the federal Clean Water Act, governs (as in this case).[31] Section 13241 describes factors to be considered in establishing water quality objectives:

> (a) Past, present, and probable future beneficial uses of water.
>
> (b) Environmental characteristics of the hydrographic unit under consideration, including the quality of water available thereto.
>
> (c) Water quality conditions that ***could reasonably be achieved*** through the coordinated control of all factors which affect water quality in the area.
>
> (d) Economic considerations.
>
> (e) The need for developing housing within the region.
>
> (f) The need to develop and use recycled water.

Water Code Section 13242 requires the State Board to specify a program of implementation with respect to water quality objectives. At a minimum, the implementation program shall include (1) a description of the nature of actions that are necessary to achieve the objectives, including recommendations for appropriate action by any entity; (2) a schedule for the actions to be taken; and (3) a description of surveillance to be undertaken to determine compliance with objectives. Cal. Water Code § 13242.

To satisfy Water Code Section 13393, the State Board must interpret the statutory factors under Section 13241 with respect to sediment, and the water associated with it, and specify implementation measures for SQOs pursuant to Section 13242. The "program of

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30 These provisions, which relate to water quality control plans, are cross-referenced in the SQOs statute. Specifically, Water Code Section 13393(b) requires the State Board to adopt SQOs pursuant to procedures established in Division 7 for adopting or amending water quality control plans. These procedures are specified at Sections 13240-13247 of the Water Code.

31 See City of Burbank v. State Water Resources Control Bd., 35 Cal. 4th 613, 625-27 (2005).

implementation" is essential to inform the regulated community as to whether the SQOs are reasonably achievable, as required under Water Code Section 13241.

Notably, the State Board has indicated that "additional information and implementation guidance should be provided to provide greater understanding and consistency" with respect to the SQOs (as opposed to water quality objectives). Report at 4. In other words, the State Board suggests that it has a heightened duty under Water Code Sections 13241 and 13242 when adopting SQOs. However, the State Board fails to comply with provisions that the Board itself has recognized to be critical to the regulated community. Nowhere else in the Report does the State Board mention Water Code Sections 13241 or 13242. The State Board merely refers the public to Section 3(I)(B) of the Report, which provides only a cursory overview of the components of the proposed SQOs,[32] rather than any indication of how the State Board proposes to comply with Sections 13241 and 13242. The Report should be revised to address these relevant statutory requirements and to indicate how they will be satisfied. Until the State Board does so, it is not possible to complete our comments on the Report.

For example, it appears that the State Board likely will not be able to establish that the SQOs are reasonably achievable, as required by Water Code Section 13241. As discussed above (Section V(A)), the Board's proposed framework appears to lead to the conclusion that the vast majority of sediments are impacted. Given this pre-ordained conclusion, it appears that most major waterbodies will be determined to have underlying sediments that fail to achieve the SQOs. This is inconsistent with a legislative framework that is based on addressing toxic sediment "hot spots," not all sediments. Similarly, the State Board has not demonstrated that it can meet the requirements of Section 13242. There is no well-defined implementation plan; the State Board has failed to clarify when and how a nonattainment of the SQO will be determined, and how remediation of the site will be accomplished.

D. The SQOs Violate California Water Code Section 13267

Water Code Section 13267 requires that the type of sampling and monitoring requirements set forth in the current proposal, including the costs of the proposed program, bear a reasonable relationship to the benefits to be obtained. The State Board's program requires vast sampling and analysis; yet, the State Board has not demonstrated that the costs and the need for this program bear a reasonable relationship to any concrete environmental benefits. The current proposal therefore violates Water Code Section 13267.

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32 See Report at 37 ("This Plan includes: 1. Narrative SQOs for the protection of aquatic life and human health; 2. Identification of the beneficial uses that these objectives are intended to protect; 3. A program of implementation that contains: a. Specific indicators, tools and implementation provisions to determine if the sediment quality at a station or multiple stations meets the narrative objectives; [and] b. Monitoring, stressor identification and corrective action guidance.").

E. The SQOs Are Arbitrary And Capricious And Unsupported By Substantial Evidence To The Extent That They Are Not Technically Feasible Or Scientifically Defensible, Or Are Otherwise Substantively Defective

The State Board is authorized to adopt SQOs based only on sound scientific evidence.[33] The State Board is required to adequately consider all relevant factors and demonstrate a rational connection between those factors, the choice made, and the purposes of the Porter-Cologne Act.[34] Under California law, the State Board's action will be considered "arbitrary, capricious and unreasonable" if it is without support in the evidence,[35] or is contrary to the uncontradicted evidence presented.[36] The term substantial evidence means that the evidence must be "reasonable in nature, credible, and of solid value."[37] Evidence which is "based on surmise, speculation, conjecture, and guess" does "not constitute substantial evidence."[38]

As discussed in these comments, the State Board's proposed SQOs suffer from a number of significant technical and legal defects, many of which would render the proposed program arbitrary and capricious. To withstand challenge, the SQOs must be based on sound science, comply with all legal requirements, and achieve a reasonable balance among environmental and economic considerations.

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33 Cal. Water Code § 13393(b) ("The sediment quality objectives shall be based on scientific information, including, but not limited to, chemical monitoring, bioassays, or established modeling procedures, and shall provide adequate protection for the most sensitive aquatic organisms. The state board shall base the sediment quality objectives on a health risk assessment if there is a potential for exposure of humans to pollutants through the food chain to edible fish, shellfish, or wildlife.").

34 See, e.g., California Hotel & Motel Ass'n v. Industrial Welfare Comm'n, 25 Cal. 3d 200, 212 (1979); Baltimore Gas & Elec. Co. v. Natural Res. Def. Council, 462 U.S. 87, 105 (1983) (holding that agency must demonstrate "a rational connection between the facts found and the choice made").

35 Rogers v. Retirement Bd. of San Francisco City Employees' Ret. Sys., 109 Cal. App. 2d 751, 757 (1952) ("Of course, if the local board makes findings totally unsupported by the evidence, it has acted in excess of and in abuse of its discretion, and its decision will be set aside.").

36 See, e.g., Naughton v. Retirement Bd. of San Francisco, 43 Cal. App. 2d 254, 260 (1941) (where the uncontradicted evidence showed that a police officer's preexisting heart disease was aggravated by the performance of his duties, retirement board acted arbitrarily and clearly abused discretion in denying a pension based on such disability; board's decision "must be based on something more than mere conjecture").

37 Martino v. City of Orinda, 80 Cal. App. 4th 329, 336 (2000).

38 Bracken v. W.C.A.B., 214 Cal. App. 3d 246, 257 (1989).

F. The Requirement For A "Reasonable Potential Analysis" Is Improper And Unlawful

As set forth above, the State Board is proposing that the SQOs "shall be implemented as receiving water limits in NPDES permits where the Regional Water Board believes there is the *reasonable potential* that the discharge of toxic or priority pollutants may cause or contribute to an exceedance of an applicable SQO or SQOs." Report at 52 (emphasis added).[39] This so-called "reasonable potential" analysis (or "RPA") is an element of federal, not state, law. It is intended to determine whether and for what pollutants water quality-based effluent limits are required. When "reasonable potential" exists, regulations at 40 C.F.R. § 122.44(d) require a water quality-based effluent limit for the pollutant(s) of concern in NPDES permits. The water quality-based effluent limits may be narrative requirements to implement BMPs or, where necessary, may be numeric pollutant effluent limitations.

Requiring the Regional Board to perform a reasonable potential analysis effectively treats SQOs as water quality standards.[40] However, treating SQOs as water quality standards is unfounded, impractical and inappropriate. Furthermore, there is no regulatory basis for applying a reasonable potential analysis to SQOs.

1. Applying Water Quality Standard Procedures To SQOs Is Impractical And Inappropriate

The State Board's effort to apply a reasonable potential analysis to SQOs is unwarranted given the absence of precedent for such an approach, and the fact that no scientific basis exists to extend this concept to sediments. Conventional statistical approaches used in the water program (which have their independent limitations) would not work for evaluating sediment problems. The cumulative nature of sediment problems is very different from the episodic focus of the water quality standards programs.

Water quality standard procedures, such as a reasonable potential analysis, also are difficult to translate into NPDES permits for SQOs due to the unpredictability of multiple discharges. In performing a reasonable potential analysis, the permitting authority must "use procedures which account for existing controls on point and nonpoint sources of pollution, the variability of the pollutant or pollutant parameter in the effluent, the sensitivity of the species to toxicity testing (when evaluating whole effluent toxicity), and where appropriate, the dilution of

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39 See also id. ("Where the State Water Board or Regional Water Boards believe there is a *reasonable potential* that toxic or priority pollutants discharged by a Permittee may accumulate in sediments at levels that will cause, have the reasonable potential to cause, or contribute to an exceedance of applicable SQOs, sediment quality monitoring shall be required.") (emphasis added).

40 See 40 C.F.R. § 122.44(d)(1)(i) (NPDES permits must achieve Clean Water Act water quality standards; limitations must control all pollutants where there has been a determination that the discharge "will cause, have the reasonable potential to cause, or contribute to an excursion above any State *water quality standard*.") (emphasis added).

the effluent in the receiving water."[41] Reaching a determination that any particular discharge has a reasonable potential to contribute to an exceedance of water quality standards is difficult in the SQO context because of the lack of understanding regarding factors contributing to pollutant concentrations. Implementing the SQOs as receiving water limits in NPDES permits is based on the assumption that the sediment quality is directly connected to a permitted discharge on a pollutant basis, even though many other factors are involved in benthic community assessment.[42]

Water quality standard procedures (including reasonable potential analysis) are technically impractical and inappropriate in setting SQOs. Further, such an effort would be very costly and time-consuming.[43]

2. There Is No Regulatory Foundation For Applying A Reasonable Potential Analysis To SQOs

Notably, there in nothing in the Porter-Cologne Act that requires Regional Boards to conduct a reasonable potential analysis as to whether discharges may cause or contribute to exceedances of SQOs.

The authorizing statute for SQOs in Porter-Cologne does not mention a reasonable potential analysis.[44] Prior to the enactment of Bill AB 1104 in 1999, there was no reasonable potential analysis in Porter-Cologne. Currently, the reasonable potential analysis concept is found in Porter-Cologne in only two sections: one regulating POTWs and one regulating on-site treatment plants.[45] "It is a well recognized principle of statutory construction that when the Legislature has carefully employed a term in one place and has excluded it in another, it should not be implied where excluded." People v. Bland, 28 Cal. 4th 313, 337 (2002).

The California Code of Regulations provides for reasonable potential analysis in both the California Ocean Plan ("Ocean Plan") and the Policy for Implementation of Toxic Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California ("SIP").[46] While the Ocean Plan contains a reasonable potential analysis,[47] the plan does not apply to discharges to enclosed bays and estuaries.[48] Moreover, the reasonable potential analysis is merely designed to determine whether a water quality-based effluent limitation is required, and requires the Regional Board to identify the applicable water quality objective as the starting point of its

41 40 C.F.R. § 122.44(d)(1)(ii).

42 QEA Technical Memorandum at 5.

43 Id.

44 Cal. Water Code § 13393.

45 Cal. Water Code §§ 13263.6 and 13291, respectively.

46 See 23 Cal. Code Regs., § 3005 (Ocean Plan); §§ 2914, 2914.5 (SIP).

47 California Ocean Plan (2005) at 13, Appendix VI.

48 Id. at 2.

analysis.[49] Similarly, the SIP, which is applicable to enclosed bays and estuaries, "is a tool to be used . . . to ensure achievement of water quality standards.[50] Like the Ocean Plan, the SIP conceives of reasonable potential analysis as a tool to determine if a water quality-based effluent limitation is required in the discharger's permit.[51]

None of these regulatory tools envisions the use of reasonable potential analysis for sediment. It is therefore improper for the State Board to attempt to use reasonable potential analysis in connection with SQOs.

3. SQOs Are Not Water Quality Standards

The whole notion of applying reasonable potential analysis to SQOs seems to assume that the SQOs are not just sediment objectives, but also serve as Clean Water Act water quality standards, which is not the case. Pursuant to Section 303 of the federal Clean Water Act, state water quality standards must "consist of the designated uses of the navigable waters involved and the water quality criteria for such waters based upon such uses." 33 U.S.C. § 1313(c)(2)(A). Section 303 of the Clean Water Act requires that state authorities periodically review water quality standards and secure the EPA's approval of any revisions in the standards. If the EPA recommends changes to the standards and the state fails to comply with that recommendation, the Act authorizes the EPA to promulgate water quality standards for the state. 33 U.S.C. § 1313(c). Upon approval by EPA, the state standard becomes "the water quality standard for the applicable waters of that State." 33 U.S.C. § 1313(c)(3).[52]

The need to prepare a Section 303(d) list of impaired waterbodies, and to adopt TMDLs, applies to Clean Water Act standards. Pursuant to Section 303(d):

> Each State shall identify those waters within its boundaries for which the effluent limitations . . . are not stringent enough *to implement any water quality standard* applicable to such waters.

33 U.S.C. § 1313(d)(1)(A) (emphasis added). Similarly, with respect to TMDLs, Section 303(d) provides:

> Each State shall establish for the water identified [on the Section 303(d) list of impaired waterbodies], and in accordance with the priority ranking, the total maximum daily load…. Such

49 Id., Appendix VI.

50 SIP at 1 (emphasis added).

51 Id.

52 Under the California Water Code, the state uses the term "water quality objectives" rather than "water quality standards," and defines that term as "the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area." Cal. Water Code § 13050(h).

> load shall be established at a level *necessary to implement the applicable water quality standards* with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality.

33 U.S.C. § 1313(d)(1)(C) (emphasis added). Thus, whether or not something qualifies as a water quality standard has real impacts.

Based upon the above provisions, it is clear that SQOs do not constitute water quality standards. California law is similarly clear on this point. Section 13393 of the Water Code expressly requires that the State Board adopt "sediment quality objectives" and makes a distinction between water quality objectives and sediment quality objectives for the purpose of providing protection to sensitive aquatic organisms. The State Board in its "Consolidated Toxic Hot Spots Cleanup Plan Volume I: Policy, Toxic Hot Spot List And Findings (June 1999)," likewise draws a clear distinction between sediment and water objectives when providing guidance regarding what constitutes a "candidate" toxic hot spot:

> A site meeting any one or more of the following conditions is considered to be a "candidate" toxic hot spot.
>
> 1. The site exceeds *water* ***or*** *sediment quality objectives* for toxic pollutants that are contained in appropriate water quality control plans *or exceeds water quality criteria* promulgated by the U.S. Environmental Protection Agency (U.S. EPA).

Id. at 11-12 (emphasis added).

4. The State Board Has Not Complied With Its Notice Obligations

If the State Board intends to apply the SQOs as Clean Water Act standards, or utilize federal tools such as the reasonable potential analysis to interpret them, it must make its intent clear to the public so that interested parties can comment on the State Board's proposed actions. The need to accurately inform the public is critical because treating the SQOs as Clean Water Act standards has significant consequences. For example, if SQOs are not water quality standards, then the failure to achieve them would not necessarily implicate NPDES or even TMDL requirements.

Thus, the State Board would violate the public's due process rights and fail to comply with the requisite notice requirements if the agency does not provide clear notice to the public regarding its intent to apply federal concepts to the SQOs. See generally Stauffer Chemical Co. v. Air Res. Bd., 128 Cal. App. 3d 789, 794 (1982) ("principles of fairness" require a public hearing prior to agency action); California Ass'n of Nursing Homes, Sanitariums, Rest Homes and Homes for the Aged, Inc. v. Williams, 4 Cal. App. 3d 800, 807 (1970) (holding that minimum procedural requirements require "the agency to publish and mail notice of its proposed action, to provide interested persons an opportunity for hearing and to give consideration to all relevant matter presented to it").

Courts routinely hold that notice is inadequate where it fails to inform the public of the actual scope of the agency's proposed action, or is otherwise defective. See, e.g., Horn v. County of Ventura, 24 Cal. 3d 605, 617-18 (1979) (notice provided by county regulations was inadequate to apprise concerned landowners of governmental actions affecting their property interests and violated purchaser's due process rights); Mortgage Investors Corp. of Ohio v. Gober, 220 F. 3d 1375, 1380 (Fed. Cir. 2000) (notice inadequate when information withheld is so central to decisional process that its nondisclosure is tantamount to refusing to describe the subject or issues in rulemaking proceeding); Wagner Elec. Corp. v. Volpe, 466 F. 2d 1013, 1019-20 (3d Cir. 1972) (notice inadequate where only "some knowledgeable" manufacturers would grasp link between subject notice identified and final rule).

Because the regulated community can not determine when and under what circumstances sediments pass or fail the SQOs, the State Board has not provided reasonable notice of the SQOs' scope and sphere of application. The State Board's failure to provide sufficient information regarding the nature of the SQOs, their breadth, required implementation measures and associated costs makes the SQOs unlawfully vague, ambiguous and potentially overbroad.

VI. The Report Does Not Adequately Analyze The Potential Environmental Effects Of The Proposed SQOs And Implementation Measures

CEQA requires the State Board to (1) include a description of the proposed activity, including a characterization of existing baseline conditions;[53] (2) analyze alternatives to the proposed activity;[54] and (3) include a discussion of any significant or potentially significant adverse effects on the environment as well as mitigation measures proposed to avoid or reduce such effects.[55]

The Chamber is unable to fully comment on the State Board's compliance with CEQA's mandates because of the preliminary nature of the State Board's Report. Although Section 2 provides an overview of major policy-related issues, Section 3 falls short in providing the requisite detail regarding the actual nature and scope of the proposed SQOs and their proposed implementation. Accordingly, the regulated community lacks sufficient information as to what the SQOs are going to look like and how they will be implemented. Despite the lack of transparency on these points, our preliminary review suggests that the State Board's proposed approach has significant implementation and compliance costs, yet its suitability and effectiveness as the foundation for sediment regulation are questionable.

For example, the State Board mandates the performance of problematic and costly toxicity tests for all sediments. This imposes costly and unreasonable burdens on the regulated community, without commensurate environmental benefit. Such costs could be avoided if the State Board were to adopt a tiered approach. If the sediment chemistry indicates that the chemicals attributable to the discharge(s) being evaluated are absent (or present at concentrations

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53 See, e.g., CEQA Guidelines § 15252(a).

54 Id.

55 See, e.g., CEQA Guidelines § 15252(b).

of no concern), then toxicity tests should not be required; impacts of non-pollutant related stressors, such as prop wash or invasive benthic species should be investigated. A tiered approach in which a chemistry assessment is used to trigger a benthic invertebrate community assessment, which in turn is used to trigger toxicity tests, makes more sense from an economical and ecological perspective. Such an approach, which is consistent with the multiple lines of evidence approach, would avoid the need to prepare prohibitively expensive toxicity tests for every impacted location, when the impact may not be due to chemicals attributable to the discharge(s) being evaluated. See QEA Technical Memorandum at 2-3.

Similarly, the proposed "reasonable potential analysis" discussed above imposes costly requirements on dischargers that are not environmentally warranted. The State Board appears to assume that the sediment quality is directly connected to a permitted discharge on a pollutant basis, even though the multiple lines of evidence do not support this and instead indicate that many other facts are involved in benthic community assessment. The State Board then requires dischargers to prove that the contamination is not related to their discharge. In regions of multiple discharges, it is unclear whether the State Board will require gradient analyses to be performed to determine the source(s) of contamination. In any event, performing the "reasonable potential analyses" will be extremely costly for both discharges and regulators. See id. at 5. There also are significant problems arising from the lack of transparency regarding proposed implementation measures. It is unclear what the State Board's goal is if it is determined that an SQO is not achieved, or how far down the spectrum from "likely impacted" to "unimpacted" one must go. If the goal is to attain relatively pristine levels, i.e., to take all "impacted" systems to "unimpacted," this would be unrealistic and costly (in addition to being legally impermissible). The State Board should include guidance in its Report on how to set realistic, cost-effective and legally defensible goals once it is determined that an SQO is not attained.

In addition, under Section 21159 of the Public Resources Code, when the State Board adopts a performance standard, it must prepare an analysis of the reasonably foreseeable environmental impacts arising from the reasonably foreseeable methods of compliance with the standard, as well as an analysis of economic and technical considerations arising from the reasonably foreseeable methods of compliance with the standard. Does the State Board consider the proposed SQOs to be performance standards subject to Section 21159? The Report makes no mention of Section 21159. What steps does the State Board intend to take to comply with Section 21159, including its requirement to consider both the environmental and economic impacts that may result from compliance with the SQOs?

VII. The State Board Has Failed to Analyze The Economic Impacts Of The Proposed SQOs

As described above, the State Board is required to analyze the economic impacts associated with the proposed SQOs. This requirement derives from several sources, including provisions of the Porter-Cologne Act, the California APA, CEQA and guidance issued by the State Board. As noted above, our review indicates that numerous potential economic impacts may result from the proposed SQOs. Although the SQOs have been in development for many years, and have potentially enormous economic implications, the Report does not give any indication that any economic analysis has yet been performed.

The requirement to perform an economic analysis is not a perfunctory exercise. It is embedded in the first section of the Porter-Cologne Act, which states "activities and factors which may affect the quality of the waters of the state shall be regulated to attain the highest water quality which is reasonable, considering all demands being made and to be made on those waters and the total values involved, beneficial and detrimental, *economic* and social, tangible and intangible."[56] The legislative history of Porter-Cologne emphasizes that "[t]he regional boards must balance environmental characteristics, past, present, and future beneficial uses, and economic considerations (both the cost of providing treatment facilities and the economic value of development)."[57] The State Board has acknowledged that the state agencies "cannot fulfill this duty [to consider economic impacts] simply by responding to economic information supplied by the regulated community."[58] The State Board has an affirmative duty to consider economic objectives when adopting SQOs, and it should ensure that the costs of compliance with the SQOs are justified by significant reductions in risk to the environment.

VIII. Conclusion

In closing, we look forward to working with the State Board constructively, as it proceeds over the next year to develop SQOs for the State of California. We recognize the importance of this initiative, and trust that our comments on the Report will be of assistance to the State Board as it proceeds.

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56 Cal. Water Code § 13000 (emphasis added).

57 Study Panel Report, at 13.

58 Exhibit 3 (January 4, 1994 State Board Memo) at 4.

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Quantitative Environmental Analysis, LLC

MEMORANDUM

TO:	Paul Singarella, Latham & Watkins Patricia Guerrero, Latham & Watkins	**DATE:**	November 28, 2006
FROM:	Elaine B. Darby, P.E. Jennifer Benaman, Ph.D. John Connolly, Ph.D., P.E., DEE	**RE:**	Review of the Development of Sediment Quality Objectives for Enclosed Bays and Estuaries
CC:	Files	**JOB#:**	GENfra:111

Pursuant to your request, Quantitative Environmental Analysis, LLC (QEA) has reviewed the State of California State Water Resources Control Board's *CEQA Scoping Meeting Informational Document, Development of Sediment Quality Objectives* (SQOs) *for Enclosed Bays and Estuaries* (SWRCB 2006). The first two sections of the document present the background and purpose of the California SQO development; discuss the issues relevant to developing and implementing SQOs with recommended alternatives; outline the technical details of the draft plan for evaluating a water body in relation to the narrative SQO; and provide some discussion on the implementation of the SQO, if the water body is found not to comply with the SQO. Section 3 presents a preliminary draft Plan which proposes a process for assessing sediment quality within a regulatory framework. Within this section, the State Water Board staff presents the SQOs and technical tools that will be likely supported when the draft Plan is adopted. Although there is discussion of the issues involved in applying SQOs and recommendations to addressing these issues, as well as a presentation of technical methods behind evaluating compliance or non-compliance with the SQOs; in general, it is unclear exactly how the proposed methods will be applied to California's enclosed bays and estuaries. The purpose of this memo is to outline the major concerns we have with the SWRCB scoping document and in particular, highlight the potential ambiguities and uncertainties within the proposed process.

Issues Related to Site Assessment:

Issue 1: The SQO document purports to address the development and evaluation of SQOs in relation to benthic communities and human health, however very little, if any, details are provided on the human health aspect of the plan. In addition, it is not clear the extent to

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which the human health component of the SQO evaluation will be applied within each waterbody.

The proposed SQO is said to address both benthic communities and human health. To that end, some discussion of the consideration of human health impacts is provided in Section 2. However, Section 3 is relatively silent on the approach for evaluating human health impacts. Section 3.VI refers to the California Environmental Protection Agency's and the U.S. EPA's Human Health Risk Assessment Policies as a way to assess the human health impacts. However these types of risk assessment-based analyses are costly and definitely not routine in every waterbody. More clarification should be given as to when the state would expect a full risk assessment be performed. It is unrealistic to assume that an EPA-level risk assessment would be performed for every discharge into bay or estuarine waters of California.

Issue 2: The procedure for benthic community protection (Section 3.V) over-reaches by requiring sediment triad studies in all cases.

As stated on page 1 of the document: "SQOs would provide a mechanism to differentiate sediments impacted by toxic pollutants from those that are not." Thus, there is a threshold issue here with regard to impact. Toxic pollutants **attributable to particular sources** must be present in the sediments at levels known to cause impacts in some bay and estuary environments for there to be any reason to investigate whether the particular sources might be causing negative impacts to the benthic community. The procedure laid out in Section 3.V seems to put the cart before the horse. Full sediment triad studies must be performed regardless of the sediment chemistry. If the sediment chemistry indicates that the chemicals attributable to the discharge(s) being evaluated are absent or present at concentrations of no concern, then benthic community evaluations and toxicity tests should not be required. Requiring benthic community evaluations and toxicity tests for the sediments proximate to each and every source subject to regulation will be very costly for regulators and dischargers, when the impact may not be due to chemicals attributable to the discharge(s) being evaluated. Although it is plausible that unknown chemicals may be impacting the benthic community, this seems to be an issue that is beyond the scope of the permitting process and perhaps should be dealt with as a separate investigative study.

Moreover, it seems that once it has been determined that toxic pollutants attributable to the sources being evaluated are present in the local sediments at levels that have some reasonable potential of causing a negative impact to the benthic community, the next step should be to look for evidence of impacts, i.e., evidence that the benthic community differs from that expected. After that conclusion is drawn, it is warranted to assess whether or not toxic pollutants are responsible for the impact (i.e., implementation of the analysis in Section 3.V). This sequence is supported by the discussion on page 16, which states that benthic community condition is a good indicator of sediment quality; whereas pollutant concentrations have "limited utility" and toxicity tests are "problematic". For this reason, it seems illogical to conclude, as the process does, that sediment is "Likely Impacted" by toxic pollutants when the benthos is at the reference condition. To the extent that spatial variability of the benthic community makes it difficult to judge whether toxic pollutants are causing an impact (i.e., the benthic indices associated with sediments from

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reference sites cover a wide range), consideration should be given to the idea that control of discharges through NPDES permits is unlikely to provide a measurable benefit to the benthic community; the structure of the community appears to be regulated by other factors (e.g., salinity variations, sediment deposition and erosion variations and exotic species).

The Board should consider a tiered approach in which chemistry assessments are used to trigger benthic community studies, which are used to trigger toxicity assessment. Such an approach is consistent with the Multiple Lines of Evidence approach. In fact, this type of approach mirrors the ideas underlying the Sediment Triad. The Triad idea was conceived as a means to discern whether chemicals found to be present in sediments are causing ecological effects. The Triad was developed to determine 1) the existence and extent of benthic ecosystem degradation and 2) the cause(s) of that degradation, including specifically chemical contamination. (Chapman et al. 1997). In 2005, Chapman and Anderson, recommended a decision-making framework for sediment contamination which calls for starting with chemical hazard assessment, then adding toxicity tests, followed by incorporating environmental evaluations (Chapman and Anderson, 2005). The Sediment Management Standards adopted in 1991 in Washington State applies the Triad approach in a tiered procedure defining the initial designation based on applicable chemical concentration criteria (Washington Administrative Code Chapter 173-204). This tiered approach: find sediments containing chemicals at levels that might cause impacts and use benthic community analyses and toxicity studies to ascertain whether the chemicals appear to be causing an impact, matches current practices and international trends (Chapman and Anderson 2005).

Issue 3: The procedure to assess benthic community condition is costly, complex, and uncertain; and application and integration of community data is ill-defined within the SWRCB scoping document.

Considerable expertise and substantial data sets are necessary to calculate meaningful values for the four indices that form the basis for the benthic community conditions assessment. For example, the Relative Benthic Index (RBI) requires sufficient data to compute meaningful probability distributions of six parameter values and expertise to define regionally appropriate positive and negative indicator species and threshold index values coincident with real effects (rather than natural variability). Yet, no guidance is given on the number of stations, habitat types or the appropriate spatial scale for collection of data for assessing benthic condition.

No methods are provided to guide conversion of the resulting indices to response categories. Moreover, it is unclear how to integrate the response categories because of the problem of interpreting a median value for 4 responses (Section 3.G.2). For example, if one of the responses is "Reference", one is "Low Disturbance" and two are "Moderate Disturbance", what is the median response category?

Issue 4: The process does not take account of data inconsistencies that might exist and be evident in cross-station comparisons.

An important and missing step in the SQO is evaluating if the available data make sense. At what point and under what guidelines will the process be allowed to step back from inconclusive lines of evidence? For example, Hunt et al. (2001) investigated sites in San Francisco Bay using sediment quality triad, toxicity identification evaluations, and gradient studies. This study found conflicting chemical and biological lines of evidence. Table 1 below is an excerpt of Hunt's (2001) analysis showing chemical and biological measurements along gradients at three sites:

Table 1. Chemical and biological measurements along gradients at three sites in San Francisco Bay (excerpted from Table 6 of Hunt et al. 2001).

Partial Table	**Peyton Slough (Site 1)**			**Mission Creek (Site 8)**			**Islais Creek (Site 10)**		
	Upper	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**
Mean ERM Quotient	2.3	0.4	0.3	3.9	1	0.3	1.2	0.6	0.6
Biological endpoints									
Relative benthic index	0.36	0.51	0.34	0	0.34	0.65	0.22	0.25	0.43
% Amphipod survival	69	59	14	19	58	80	0	81	49
% Normal larvae	1	0	81	11	98	94	8	45	76

As the mean effects range median (ERM) quotients dropped down gradient, the % amphipod survival rate actually decreased in Peyton Slough, increased in Mission Creek and initially increased then decreased in Islais Creek down gradient. The relative benthic index followed the same trend as the % amphipod survival rate only in Mission Creek. This detailed study indicates that characterization of a site requires thorough analyses and even then may yield conflicting results from chemical and biological measurements. Gross inconsistencies among the lines of evidence strongly suggest the potential for data quality issues or the dominant impact of factors other than the considered chemicals. Addressing these types of challenges in the SQO document is imperative to ensure that proper guidance is provided by the Board to those that will be evaluating the data.

Issues Related to Implementation of SQOs:

Issue 5: The level of impact assigned on the basis of chemical concentration and severity of effects is not clearly linked to the assessment of whether the proposed narrative SQOs are met.

Section 2 of the document provides a solid overview of the issues involved with developing and implementing SQOs in California's enclosed bays and estuaries. This section also presents the Board's proposed alternative to deal with each issue. However, most of what is discussed in Section 2 is conceptual. Section 3 is the true "test" of the proposed Plan with a description of the narrative SQOs for aquatic life and human health (Sections 3.IV.A and 3.IV.B) and technical details on how to assess sediment toxicity and exposure to toxic pollutants in sediment (Section 3.V). But, Section 3 falls short of linking the final conclusions drawn from any analyses following the methods in Section 3.V back to whether the narrative SQOs are being

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complied with. In other words, how does one determine if sediments "fail to meet narrative SQOs in accordance with Section V and VI," which would then initiate focused studies to determine the pollutant(s) causing the impact and source identification (see p. 53, 3.VII.C. Focused Studies)? If one finds, after putting the available information on a site through the equations and tests outlined in Section 3.V that a site is "Possibly Impacted", would this trigger non-compliance with the SQOs? Would the trigger vary from site to site or among waterbodies? In addition, it is not clear what would actually trigger the further evaluations outlined in Section V.II.C. Do these studies aid in determining whether the SQOs are met or are they implemented after an exceedance has been determined? These important questions are not addressed in the document and present a significant weakness in the proposed approach.

Issue 6: Guidelines on how Regional Water Boards will determine "reasonable potential that the discharge of toxic or priority pollutants may cause or contribute to an exceedance of an applicable SQO or SQOs" are not listed, but are necessary to determine the process in which the connection between dischargers and SQO exceedances will be made.

Section 3.VII.A states that the SQOs shall be implemented as receiving water limits in NPDES (National Pollutant Discharge Elimination System) permits where the Regional Water Board believes there is the reasonable potential that the discharge of toxic or priority pollutants may cause or contribute to an exceedance of an applicable SQO or SQOs. This indicates that the sediment quality is directly connected to a permitted discharge on a pollutant basis, even though the multiple lines of evidence (MLOE) indicate that many other factors are involved in benthic community assessment. In regions of multiple discharges, will gradient analyses be required to determine source of contaminant? How do dischargers prove that the contamination is or is not related to their permitted discharge, especially if the contaminated sediment is located some distance from the discharge? The analyses proving "reasonable potential" will be extremely involved and costly for dischargers and regulators. Modeling is typically used to determine reasonable potential when developing water quality-based effluent limits. Whereas relatively simple models are adequate for most water quality-based permitting, the modeling necessary to relate a discharge to sediment toxic pollutant concentrations is complicated by the numerous processes involved in sediment transport, contaminant sorption and speciation and physical and chemical interactions between the sediment and the water column. This is especially true in bays and estuaries because of the complex hydrodynamics, the influence of winds and variations in salinity. Thus, it may not be practical to routinely determine reasonable potential.

Issue 7: There is no indication of how the permitted dischargers will be controlled using the results of the SQO process. In addition, tying the SQO exceedances to NPDES permits indicates the ability to mediate sediment quality and, in turn, the SQO result through changes in discharge contaminant levels.

The proposed Plan does not address how a discharger would potentially be controlled using the findings of the SQO evaluation spelled out in Section 3. It is assumed that this control would occur through the NPDES permitting process, but no clear steps are given to indicate exactly

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how a discharge permit may be evaluated and changed when an SQO is not achieved. The state's Continuing Planning Process (CPP) provides guidance as to how to implement changes in NPDES permits and Basin Plans in order to work towards attaining a water quality standard, but no mention of SQOs or the like is given in the current CPP. Does the Regional Board assume that the state's CPP will be amended to include consideration of the SQOs, as well? If so, a proposed approach for this type of amendment should be addressed in the current SQO plan.

In addition, the ultimate "goal" for the sediment quality is not clearly defined. For example, in the wasteload allocation portion of the Total Maximum Daily Load (TMDL) process, the NPDES permits are evaluated in relation to non-point sources and suggested % reductions for the dischargers are spelled out in the TMDL document. In the case of TMDLs, the goal is relatively clear: attainment of the water quality standard. Modeling is usually required to show that the proposed % reductions will attain the water quality standard. If the water quality standard is narrative, there is typically an attempt to link the narrative standard through modeling, to some quantitative end-point. However, in the case of an exceedance of an SQO, what is the goal? Will the target be to move from "Likely Impacted" to "Possibly Impacted" or will the target be to move to "Likely Unimpacted" or "Unimpacted" levels? If the goal is to attain relatively pristine levels, or in other words, take all "Impacted" systems to "Unimpacted", this would be unrealistic and costly to many. Guidance on how to set realistic goals once an exceedance is determined should be spelled out in the document.

Finally, if this goal is to be attained, what level of reduction in the permitted discharge is necessary to achieve it, if any? Will modeling be required in order to ensure there is an accurate link between the SQO exceedance and the discharge? As mentioned in other comments within this memo, there are instances where sediment concentrations can be relatively low, but the process enumerated in Section 3 still results in the sediment being "Impacted" on some level. If that is the case, what is the process for the dischargers? If the chemicals they are discharging are found at low concentrations in the sediments, it would seem prudent to then focus on other causes for the "Impacted" conclusion than on the dischargers. But, if additional control of the dischargers is warranted, how can they evaluate 10%, 20% or 30% reductions in water based concentrations effect on the sediment quality? Will there be target values specifically driven by sediment-based chemical thresholds and will the final decisions regarding the discharge load reductions be supported by modeling? The current SQO document is relatively silent on these issues and consequently, raises many questions for stakeholders that may be impacted if non-compliance with an SQO is determined within their system.

Issues Related to Application of Methods for Assessing Benthic Community Protection:

Issue 8: The station assessment for benthic community protection presented in Tables 3.9 and 3.10 inexplicably concludes that sediments are "Possibly Impacted" by toxic pollutants when pollutant levels and the sediment toxicity are both low but the benthic community is moderately disturbed.

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“Possibly Impacted” sediments are linked back to “sediment contamination present at the site may be causing significant adverse direct impacts to aquatic life, but these impacts may be moderate or variable in nature (Section 3.I.3, p. 49).” However, based on the matrix integrations of Tables 3.7 and 3.8 into Table 3.9, sediments with a low potential for Chemical Mediated Effects as a result of low toxicity and low exposure (Table 3.8) but with moderate or high Severity of Effect due to moderate or high disturbance (Table 3.7) will be designated as “Possibly Impacted”, even though sediment contamination at the site is considered low from both toxicity and exposure. Likewise, a site characterized with high toxicity, high disturbance but minimal exposure is categorized “Likely Impacted”. This categorization would be designated even if no pollutants were detected in the sediments. While there is an impact, there is no evidence that it is by the pollutants measured.

The “Inconclusive” category is designed for sites where there is extreme disagreement among the LOE; however, this designation is only applied when high toxicity is present without corroborating evidence of chemical exposure and benthic disturbance. These conditions show that the conclusions can be inconsistent and may result in costly follow-up studies, source control efforts, or even sediment remediation to abate sediment contamination present at levels that are essentially posing no risk, with the likely result of little or no progress toward the desired SQO.

Issue 9: The procedure for benthic community protection (Section 3.V) includes steps that are ill-defined.

Section 3.V.F.4 (p. 44) states: “The average value of all test responses shall be used to determine the final toxicity category”. In addition, Section 3.V.H.6 (p. 47) states: “The average value of both approaches shall be used to determine the final chemical category”. In the first case, it is unclear if the “values” mentioned refer to the percentages presented in Table 3.4 or to the resulting categories (i.e., low, moderate, and high). If it refers to the percentage values, how reasonable is it to combine such numbers among different tests? If it refers to the resulting categories, it is unclear how an “average” can be taken among the resulting categories. In the second case, the averaging is in relation to toxic pollutants in sediments. Again, it is unclear if the intent is to average the numerical results of Equation 1 and Equation 2, which would be problematic, given that Equation 1 is a weighted category and Equation 2 is a probability. Or, as before, if the intent of the word “average” is meant for the resulting categories (minimal, low, moderate, and high exposures), how is it proposed that this “average” would occur? As a result, it is important for the proposed approach to provide more clarification on how multiple test results will be combined to determine both the final assessment of sediment toxicity and the assessment of exposure to toxic pollutants.

Issue 10: There is no documentation of the basis for the coefficient values assigned to the logistic model used to relate sediment toxic pollutant concentrations to toxicity.

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The California Pmax approach is based on the following logistic regression model (LRM; Equation 2, p. 46):

$$p = e^{B0 + B1(x)}/(1 + e^{B0 + B1(x)})$$

Where:

p	=	probability of observing a toxic effect
$B0$	=	intercept parameter
$B1$	=	slope parameter
x	=	concentration of the chemical

Parameter values are listed in Table 3.6 (p. 47). The maximum probability (Pmax) obtained from the individual chemical results is used to represent the chemical mixture present in a sample. The exposure categories are determined based on Pmax values:

Minimal exposure:	< 0.32
Low exposure:	0.33 – 0.49
Moderate exposure:	0.50 – 0.66
High exposure:	> 0.67

If the probabilities in Equation 2 are based on *x* being equal to chemical concentration, the probability increases rapidly for all chemicals over very small (generally less than 1 ppm or 1 ppb) concentration ranges. However, review of the original research from which this equation was developed indicates that *x* in Equation 2 can be concentration or log of concentration (Field et al. 1999). If the model is based on *x* representing the log of the chemical concentration, the model yields significantly different results as shown in Figure 1.

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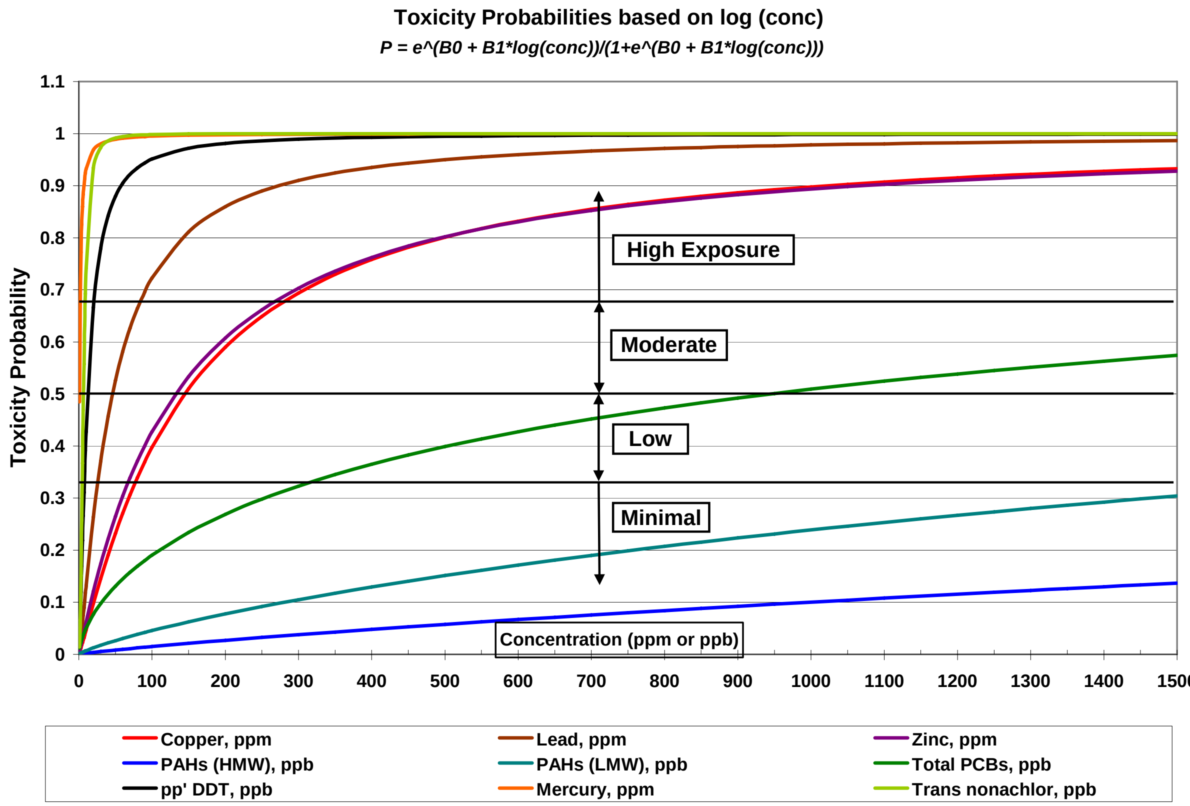

Figure 1. Results of Equation 2, using *x* = log(concentration).

By using the log of the concentration, the ranges between low to high exposure seem more realistic, although for some chemicals, such as PAHs and DDTs, still somewhat questionable. The development of California LRM models and the Pmax approach followed the methods described in Field et al. (2002). In this paper, Field states: "The model parameters (slope, intercept) define the shape of relationship between the chemical concentration (log10) and probability of a toxic result." In a previous paper, Field et al. (1999) state: "In general, using log(concentration) as the independent variable, rather than concentration, resulted in higher chi-square values; thus only the results for models using log(concentration) are presented." Because of the very different results in applying Equation 2, the independent variable, *x*, should be rigorously confirmed as concentration or log of concentration for each constituent.

The coefficients shown in Table 3.6 differ from those presented in both Field et al. (1999) and Field et al. (2002). If the log of concentration is used as the independent variable, small changes in the coefficients can result in large changes in chemical concentration "cut offs". For example, Field et al. (1999) gives coefficients for lead of an intercept (*B0*) at -4.35 and slope (*B1*) at 1.91. Using these coefficients the lead concentration at which there is a 50% probability the samples are toxic is 191 ppm (dry weight), with 95% confidence intervals of 146 to 249 ppm around this value. In Field et al. (2002), when the study is refined and updated, the coefficients for lead were

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given at *B0* = -5.45 and *B1* = 2.77. Using these values the 50% probability comes out to 94 ppm, with confidence intervals of 84 to 104 ppm. Using Table 3.6 from the SQO document (for lead, *B0* = -4.7228 and *B1* = 2.8404) and assuming that the independent variable is the log of lead concentration, the 50% probability value is less than 50 ppm (see Figure 2). Given the potential for such differing results, explanation should be given as to how the coefficients shown in Table 3.6 were derived in order to compare the final results to the original work performed by Field et al. (1999, 2002) and understand their impact within California waters. Also, given the varying results from the different studies, the approach should acknowledge that the LRM method is a screening level assessment and the threshold values that are determined from this approach should be considered as estimates or indicators, but not "hard and fast" levels of low to high contamination. The table below lists the logistic regression coefficients for various metals and organic compounds from Field's original and subsequent works in 1999 and 2002 compared to the coefficients proposed in the 2006 CEQA Scoping Meeting Informational Document.

Table 2. Logistic Model Regression Coefficients

	Field 1999		**Field 2002**		**Draft Calif. SQO 2006**	
Intercept & Slope Values	*B0*	*B1*	*B0*	*B1*	*B0*	*B1*
Cadmium (mg/kg)	n/a	n/a	-0.34	2.51	0.2894	3.1764
Copper (mg/kg)	n/a	n/a	-5.79	2.93	-5.5931	2.5885
Lead (mg/kg)	-4.25	1.91	-5.45	2.77	-4.7228	2.8404
Mercury (mg/kg)	-0.06	2.03	0.8	2.55	-0.0618	2.6837
Zinc (mg/kg)	-7.15	2.75	-7.98	3.44	-5.1337	2.4205
HMW, PAH (ug/kg)	n/a	n/a	**	**	-8.1922	1.9995
LMW, PAH (ug/kg)	n/a	n/a	**	**	-6.8071	1.8827
Chlordane, alpha (ug/kg)	n/a	n/a	n/a	n/a	-3.408	4.4570
Dieldrin (ug/kg)	n/a	n/a	-1.17	2.56	-1.8344	2.5890
Trans nonachlor (ug/kg)	n/a	n/a	n/a	n/a	-4.2590	5.3435
PCBs, total (ug/kg)	-2.78	1.01	-3.46	1.35	-4.4144	1.4837
pp' DDT (ug/kg)	n/a	n/a	-1.77	1.68	-3.5531	3.2621

*Note: ** 22 individual PAH compounds listed in Field 2002*

Using the coefficients listed above and selected concentrations, a quick comparison shows considerable variation in "p" values between the CEQA values and Field's work.

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Table 3. Variability in predicted probability of a toxic effect *p = e^(bo + b1*log(x))/(1+e^(bo +b1*log(x))*				
	CONC	***1999***	***2002***	***2006***
PCB (ug/kg)	35	0.23	0.20	0.11
pp' DDT (ug/kg)	0.08		0.03	0.0008
Lead (mg/kg)	3.5	0.04	0.02	0.04
Mercury (mg/kg)	0.25	0.22	0.32	0.16

Issue 11: The use of the proposed LRM is problematic for PCBs.

Field et al. (1999) states that total PCBs "provided poorer fits with the logistic model based on chi-square analyses…" In addition, the study presents the results for various metals and chemicals, but indicates that PCBs tended to fit poorly with the model and the results for PCBs were relatively sensitive to the endpoints chosen in the toxicity tests. For example, a comparison of 10, 50 and 90% effects levels for each amphipod species suggests that *A. abdita* is more sensitive to the effects of sediment-associated contaminants than *R. abronius*, especially for PCBs, fluoranthene, and phenanthrene (Field et al. 1999). For each of these compounds, there was almost an order of magnitude difference between the 50% effects level for different amphipod survival rates. Field et al. (1999) also state that in cases where observed toxicity may be caused by other contaminants, a data screening process was applied to filter out samples for a particular chemical when the concentration was less than or equal to the mean concentration of nontoxic samples in the same study. However, for PCBs and fluoranthene, this screening process did not effectively eliminate high variability at low concentrations, and the resultant models did not provide as good a fit as the other models based on screened data. In 2002, Field et al. published logistic regression models based on an expanded data set. In this study, total PCB concentration was calculated for each sediment sample represented in the database. If concentrations of Aroclors or congeners were reported, these values were summed to determine the total PCB concentration. If fewer than 20 congeners were reported, the sum was multiplied by a factor of 2. An improved fit for PCBs was noted; however, the issue of differences in toxicity endpoints was not addressed. As a result, the applicability of the LRM approach to evaluate PCB contaminated sediments is questionable. Further discussion and analyses should be provided supporting the use of this model for PCBs in the SQO evaluation.

Issue 12: The two proposed methods for assessing exposure to toxic pollutants in sediment can result in inconsistent exposure categorization.

Section 3.V.H (p. 45) of the SQO document states that two methods shall be employed to categorize the risk of exposure to toxic pollutants: the regionally derived north and south Chemical Category Score (CCS) method developed from chemistry and community response data, and the California Pmax approach derived by logistic regression that relates the probability

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of toxicity to the concentration of chemical mixtures (discussed above). The weighted CCS method is based on the individual chemical concentrations and a set of weighting factors for each of the chemicals. The predicted benthic effect category for each chemical is determined by comparing the chemical concentration to a series of three thresholds that define four effect categories. Each constituent's predicted effect level is then multiplied by its respective weighting factor to produce a benthic impact score. These scores are then summed across all constituents in the sample and divided by the sum of weighting factors, producing the mean weighted benthic category score. The mean weighted CCS (Equation 1, p. 46):

$$\text{Mean weighted CCS} = \Sigma(w \times cat)/\Sigma w$$

Where:

w = weighting factor for a constituent
cat = predicted chemical impact category.

Weighting factors are listed in Table 3.5 (p.46). Exposure levels are categorized by the mean weighted CCS value:

Minimal exposure:	< 1.68
Low exposure:	1.69 – 2.33
Moderate exposure:	2.34 – 2.99
High exposure:	> 2.99

We have assumed that the variable "*cat*" in Equation 1 corresponds to an ordinal number (1, 2, 3, and 4). For clarity, the numeric values (1, 2, 3, and 4) should be explicitly listed for each of the associated effect categories as determined from the threshold values listed in Table 3.5 (p. 46). In addition, high exposure should be shown as greater than 2.99 and not overlapping moderate exposure with the current greater than or equal to 2.99.

Table 4 compares the results of Weighted CCS Equation (Equation 1) with any conclusions that would be drawn from the LRM equation (Equation 2), using chemical concentrations for individual compounds, selected within threshold ranges from Table 3.5 (p. 46). For example, a concentration of 3.5 ppm for lead would yield a minimal exposure with a mean weighted CCS value of 1; whereas the LRM based on concentration, results in categorization of high exposure. And, the result of the LRM based on the log of lead concentration would place this concentration into a minimal exposure category. Conflicting results are also seen for PAHs (high molecular weights [MW]) at a concentration of 1000 ppb. The CCS equation would place this concentration into a high exposure category, while the use of the LRM equation would either place it in high or low exposure, depending on whether the concentration is transformed (log) or untransformed in the equation. When evaluating chemical mixtures, the differing results are even more pronounced, with few results between Equation 1 and Equation 2 agreeing.

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Table 4. Comparison of categories for reasonable chemical concentrations using Equation 1 and Equation 2.

			Equation 1 Results Weighted CCS		**Equation 2 Results California Pmax Based on p = f{log (x)}**	
Chemical Concentrations			***CCS***	***Category***	***Pmax***	***Category***
PCBs	35	ppb	4.00	High	0.11	Minimal
DDEs	0.75	ppb	2.00	Low	n/a	n/a
DDTs	0.08	ppb	2.00	Low	0.001	Minimal
Mercury	0.25	ppm	2.00	Low	0.16	Minimal
Cadmium	0.2	ppm	2.00	Low	0.13	Minimal
Copper	40	ppm	2.00	Low	0.20	Minimal
Lead	3.5	ppm	1.00	Minimal	0.04	Minimal
Zinc	90	ppm	1.00	Minimal	0.40	Low
PAHs, high MW	1000	ppb	3.00	High	0.10	Minimal
PAHs, low MW	150	ppb	1.00	Minimal	0.06	Minimal
Chlordane, alpha	1	ppb	3.00	High	0.03	Minimal
Chlordane, gamma	0.15	ppb	2.00	Low	n/a	n/a
DDDs	5	ppb	2.00	Low	n/a	n/a
Mixtures*						
PCB+DDE			2.95	Moderate	n/a	n/a
PCB+DDT			3.04	High	0.11	Minimal
PCB+Hg			2.56	Moderate	0.16	Minimal
PCB+DDE+DDT			2.66	Moderate	0.11	Minimal
PCB+DDE+DDT+Hg			1.90	Low	n/a	n/a
PCB+Cadmium			2.99	Moderate	0.13	Minimal

Notes:
Using the concentrations annotated for each individual chemical in Table 1.
n/a designation indicates p value for one or more of the compounds is not listed in Table 3.6 (p. 47) and therefore can not be determined.

An additional issue arises in evaluating samples which contain compounds that do not have coefficients listed for the logistic regression model, such as DDE. How should the Pmax value be determined when all of the compounds in the sample are not listed in Table 3.6?

It should also be noted that a single chemical sample will never give a moderate exposure level under the mean weighted CCS as the value will either be 1, 2, 3, or 4 and the moderate exposure level is between 2.33 and 2.99.

Issue 13: Empirically derived thresholds, such as those used in Pmax and CCS formulations, do not conclusively relate cause to effect and have the potential for predicting thresholds much lower than actual toxic levels.

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Thresholds utilized in Pmax and CCS formulations were developed from screened databases for individual chemicals from samples that often contained multiple contaminants. For example, in the development of the empirically derived thresholds, a toxic sediment high in metal concentrations and low in PCB concentration will be used in PCB model development as a positive toxic sample as long as the PCB concentration is above the mean PCB concentration for the survey without consideration of the possible causal effect of the metal. MacDonald et al. (2000) studied the differences between theoretical and empirical approaches for creating SQGs, specifically for PCBs and proposed a consensus based sediment effect concentration (SEC) as a means of reconciling SQGs, developed from various empirically based methods which were shown to vary by as much as two orders of magnitude. Theoretical approaches attempt to quantify causal effects for contaminants by addressing bioavailability, covariance, chemical interactions and ecological adaptations. Fuchsman et al. (2006) contend that cause-effects benchmarks instead of empirically derived thresholds are needed specifically for benthic invertebrates to support both predictive ecological risk assessments and retrospective evaluations of the causes of observed sediment toxicity. Fuchsman et al. (2006) question MacDonald's assertion that consensus based SECs incorporate causal effects and contend that cause-effect benchmarks based on equilibrium partitioning assessment are critical and provide an improved framework for understanding cause-effect relationships for risks to invertebrates from PCB exposure. Without direct cause-effect determinations, empirically derived thresholds based evaluations such as Pmax and CCS may result in predicting lower concentration thresholds for effects than actually exist in the environment.

Conclusions

The process set forth in the draft Plan attempts to integrate MLOE into a prescriptive process categorizing sediment quality. While technical issues exist in applying equations, identifying categories and determining averages amongst methods, these issues can mostly be resolved with additional information and guidelines. The greatest flaws in the proposed Plan are: 1) failure to incorporate a threshold analysis of sediment chemistry as a precursor to requiring the assessment of the benthic community and the conduct of toxicity tests implementation and complete site assessment; 2) use of relationships between pollutant concentrations and impact that have no cause-effect basis; 3) lack of consideration of the technical impediments to the use of SQOs to manage sources; 4) failure to clearly define when and how non-compliance with the SQO will be determined; and 5) the lack of detail on the means and methods to comply with stated requirements to conduct human health risk assessments as part of the SQO process. These issues could potentially impact regulators and dischargers considerably through the cost and management of detailed monitoring plans, focused studies, and operational modifications loosely prescribed by the SQO process and driven through the NPDES permitting process. The requirement of permittees to, at a minimum, monitor sediment quality at least once prior to issuance and re-issuance of a permit (Section VII.B.6) places the burden on the dischargers and assumes a connection between the discharger and sediment quality. This process could result in excessive monitoring and remediation by dischargers who may or may not have contributed to

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the impacted sediments. Additionally, incorporating human health risk assessments into the SQO will add tremendous expense to the overall assessment of a site.

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PROFESSIONAL HISTORY	QEA, LLC, Managing Engineer, 2006 to present The University of Texas at Austin, Graduate Research Assistant, Environmental and Water Resources, 2005 – 2006 The University of Texas at Austin, Outreach Program Coordinator, 2004 Angelina College, Instructor of Chemistry and Engineering, 1993 – 2003 Dow Chemical, U.S.A. Senior Production/Senior Research Engineer, 1982 – 1988
EDUCATION	The University of Texas at Austin, M.S., Environmental and Water Resources Engineering, 2006 Texas A & M University, M.E., Chemical Engineering, 1985 The University of Texas at Austin, B.S., Chemical Engineering, 1981
REGISTRATION	Professional Engineer, State of Texas (Lic. No. 61702)

EXPERIENCE SUMMARY

Ms. Darby's experience is in water and sediment quality in natural systems. Her recent graduate research in Environmental and Water Resources Engineering at The University of Texas at Austin focused on treatment and re-use of co-produced waters from oil and gas exploration and production. Her studies also included water quality modeling, utilizing GIS in water resources, water pollution chemistry, groundwater contaminant fate and transport, and water resources planning and management.

A primary focus since joining QEA has been to identify potential changes in diel dissolved oxygen conditions under varying flow regimes for Texas streams. This research supports modified river management along the lower Colorado River to meet future water demands. Additionally, Ms. Darby has developed expertise in sediment quality assessment and emerging state level regulations. This includes research into methodologies and practices for evaluating sediment toxicity and benthic community disturbances.

Before coming to QEA, Ms. Darby worked with Dow Chemical, U.S.A. as a Senior Engineer in research and production, where she received a patent for a new process for producing high purity epoxy resins.

MAJOR PROJECTS

Water Quality/Water Resources

LCRA-SAWS Diel Dissolved Oxygen White Paper Project

Client: Lower Colorado River Authority, San Antonio Water System

Review and analyses of research and modeling efforts for the Colorado River below Austin on diel dissolved oxygen. QEA, LLC, 2006, "Lower Colorado River Diel Dissolved Oxygen White Paper." Final Report; Austin, TX; Prepared for Lower Colorado River Authority and San Antonio Water System, November 2006.

Natural Eutrophication/Reservoir Aging

Client: Texas Water Conservation Association, Nutrient Criteria Committee

Investigation of natural eutrophication occurrence and related data analyses of eutrophication measures in selected Texas reservoirs.

Contaminated Sediments Assessment and Management

Analyses of Methodologies and Practices Utilized by State Regulatory Agencies for Sediment Assessment
Client: General Electric Company
Review of current recommended methodologies and practices for sediment quality assessment as directed by state level regulations and guidelines.

Comparisons of Logistic Regression Models, Empirically Derived Thresholds, and Theoretical Modeling Approaches for Defining Sediment Toxicity
Client: General Electric Company
Detailed study of the variances and predictability of models and thresholds on sediment toxicity.

Impact of Remedial Options Pilot Study Operations on Re-suspension of Contaminants
Client: Aluminum Company of America
In-depth study of sediment and water quality data collected during remedial options pilot study to identify contributions to re-suspension of contaminants to the water column as a function of in-stream operations.

PROFESSIONAL ACTIVITIES

Affiliations

American Institute of Chemical Engineers
Texas Water Conservation Association

Invited Participation in Technical Workshops

ATEEC Fellows Institute on Environmental Technology. Ten-day NSF Advanced Technology workshop at University of Northern Iowa. Cedar Rapids, IA. June, 1998.

PUBLICATIONS

Economic and Engineering Assessment of a Surfactant Modified Zeolite/Vapor Phase Biofilter Process for Treating Produced Water. Darby, E.B., *Masters Thesis*. The University of Texas, Environmental and Water Resources Engineering. May 2006.

Pilot Scale Test of a Produced Water Treatment System for Organic Compounds. Sullivan, E., L. Katz, K. Kinney, S. Kwon, L. Chen, E. Darby, R. Bowman, C. Altare, 13th Annual International Petroleum Environmental Conference. San Antonio, TX. *Published in Proceedings*. October 17-20, 2006.

PRESENTATIONS

Assessment of a Surfactant Modified Zeolite/Vapor Phase Biofilter Process for Treating Produced Water. Darby, E.B., Proceedings of the Texas Section-ASCE Fall 2006 Meeting, San Antonio, TX, October 11-14, 2006.

New Opportunities for Re-Use of Produced Water – Water Quality and Permitting Issues. Darby, E.B., Presented at Annual Meeting of the Geological Society of America. Salt Lake City, UT. October 16, 2005.

JOHN P. CONNOLLY, Ph.D., P.E., DEE

CONTACT INFORMATION

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PROFESSIONAL HISTORY

Quantitative Environmental Analysis, LLC, President and Senior Managing Engineer, February 1998 to present
USEPA Science Advisory Board, 2005 to present
HydroQual, Inc., Principal Engineer, 1993 to January 1998
HydroQual, Inc., Consultant, 1980 to 1993
Manhattan College, Professor, 1992 to 1994
Manhattan College, Associate Professor, 1986 to 1992
Manhattan College, Assistant Professor, 1980 to 1986
U.S. Environmental Protection Agency, Environmental Scientist, 1978 to 1980
Manhattan College, Research Engineer, 1975 to 1977

EDUCATION

The University of Texas at Austin, Ph.D., 1980
Manhattan College, M.E., Environmental Engineering, 1975
Manhattan College, B.E., Civil Engineering, 1973

REGISTRATION

Professional Engineer, State of Texas (License No. 92122)
Professional Engineer, State of New York (License No. 59428)

EXPERIENCE SUMMARY

Dr. Connolly has worked on more than 35 projects in the areas of contaminant transport and bioaccumulation. These studies have involved field sampling, fine-grained sediment transport analysis, chemical fate and food web bioaccumulation modeling and remedial design activities. They have generally been directed to exposure assessment and risk assessment problems related to surface water and groundwater contamination problems for the purposes of evaluation of remedial options, remedy design or wasteload allocation. Dr. Connolly has participated in negotiations with regulatory agencies to craft consent decrees governing contaminated sediment sites.

Dr. Connolly has considerable experience in the areas of ecosystem processes. His work in this area has focused on eutrophication resulting from nutrient releases and the associate cycling of carbon and nutrients in the environment. This work has typically involved the development and application of models to evaluate pollutant loadings and the effectiveness of various pollution control strategies.

Dr. Connolly is frequently invited to participate in government and industry sponsored workshops. He is a member of the USEPA Science Advisory Board. He has worked throughout the U.S., in Latin America, and in Europe. He has served as an expert witness for industry and government agencies and has provided testimony before the U.S. Congress and the New York State Assembly. He is also a member of the Manhattan College Council of Engineering Affairs.

TESTIMONY

Subcommittee on Water Resources and Environment of the U.S. House of Representatives Transportation and Infrastructure Committee Hearing on Strategies to Address Contaminated Sediments.
Expert testimony given on 7/19/01 regarding the approaches used by USEPA to address contaminated sediments.

Maine Peoples' Alliance and Natural Resources Defense Council, Inc. vs. HoltraChem Manufacturing Company, LLC and Mallinckrodt, Inc.
For defendant Mallinckrodt; expert witness testimony at deposition on 7/3/01 and at trial on 3/12/02 regarding mercury bioavailability in the Penobscot River Estuary.

United States of America vs. Montrose Chemical Corporation of California, et al.

For plaintiff Unites States of America; expert witness testimony at deposition from 7/13 to 7/17/98 and 4/6/00 and at trial 10/19/00 regarding the transfer of DDT and PCBs from contaminated sediment in coastal waters off Los Angeles to fish, birds and sea lions.

Kalamazoo River Study Group vs. Rockwell International, et al.

For defendant Eaton Corporation; fact witness testimony at deposition on 7/22/97, expert testimony at deposition on 1/26/98 and trial testimony on 8/17 and 8/21/98, 1/19/01 and 2/5 and 2/6/01 regarding technical analyses conducted to evaluate the PCB contributions from Eaton's Battle Creek and Marshall facilities to the Kalamazoo River.

New York State Assembly Standing Committee on Environmental Conservation Public Hearing on PCB Contamination in the Hudson River.

Expert testimony given on 3/19/97 on behalf of the General Electric Company regarding the sources of PCBs observed in Hudson River fish.

Alcoa and Northwest Alloys, Inc. vs. Accident & Casualty Insurance Company, et al.

For plaintiff Alcoa; expert witness testimony at deposition on 2/28 and 3/1/96 regarding the nature, extent and expansion of sediment contamination at Alcoa facilities in Massena, New York and Point Comfort, Texas.

MAJOR PROJECTS

Contaminated Sediments Assessment and Management

Peer Review of Contaminated Sediment Remediation Guidance for Hazardous Waste Sites

Client: USEPA

One of three national experts tasked with reviewing the draft guidance document which has been developed to provide technical and policy guidance to project managers and management teams making remedy decisions for contaminated sediment sites.

Source Allocation for Mercury in the Penobscot River Estuary

Client: Mallinckrodt, Inc.

Principal investigator for evaluation of the relative contributions of sediment and water column mercury to mercury found in resident biota. This study involved data analysis and development of a conceptual modeling explaining the probable reasons of the apparent lack of impact of elevated sediment mercury concentrations on biota mercury levels. The work was used to provide litigation support through expert testimony. Subsequent to litigation, work has focused on development of a detailed investigation plan, interaction with a court-mandated Study Panel, technical support for the client's legal team and oversight of planned field work.

Source Allocation for Mercury in the Peconic River

Client: Brookhaven National Laboratory

Principal investigator for investigations to determine the sources of methyl mercury in the fish of the Peconic River. This study involved the design of sampling programs and interpretation of data to determine the relative contributions of background sources and various sediment deposits throughout the river to methyl mercury in the water and fish. This work was conducted to satisfy a diverse group of stakeholders with differing positions on appropriate remediation. It led to a revision of the contemplated remedial action and a convergence of opinion on the best approach for the river.

Investigation of Mercury in Lavaca Bay

Client: Alcoa

Principal investigator for the evaluation of mercury sources and prediction of the impacts of remedial actions and storm events on mercury levels in sediment and biota. The project involves data analysis and the development of linked hydrodynamic, sediment transport, mercury fate and bioaccumulation models. A primary goal is the evaluation of the impact of hurricanes and other rare storms on buried mercury.

Remediation of the Hudson River PCBs Site

Client: General Electric Company

Principal investigator for various aspects of remedial design (RD), including the design and execution of an extensive pre-design sediment sampling program involving the collection of more than six thousand sediment cores, management of the RD database, determination of the dredging prisms, design and execution of the baseline and construction monitoring programs and support of the design of dredging and processing of dredged sediment. This project included the development of sophisticated data entry, data processing and data display systems that were used by the GE design team. Additional activities included direct participation in consent decree negotiations.

Analysis of the Fate of PCBs in the Hudson River

Client: General Electric Company

Principal investigator for extensive data analysis and modeling studies of the dynamics of PCBs in the Hudson River. This study involved field sampling, data analysis and the development of linked hydrodynamic, physical/chemical, sediment transport and food chain models for the purpose of predicting the effects of alternative remediation plans.

Analysis of the Fate of PCBs in the Grasse River

Client: Alcoa

Principal investigator for the determination of the impacts of contaminated sediments and point sources to PCB contamination in resident fish. Efforts include the design of field sampling programs, estimation of PCB fluxes between water and sediment, including the importance of areas of elevated concentrations and the transport and bioaccumulation in the food web. Goal is to provide a technical basis for examination of remedial options.

Assessment of Contribution of PCBs to the Kalamazoo River from Eaton Corporation

Client: Eaton Corporation

Principal investigator for the analysis of data and development of models to evaluate whether either or both of two Eaton facilities contributed measurable quantities of PCBs to the Kalamazoo River. The project involved the compilation and analysis of historical data, design and execution of a sampling program and the development of models to predict the transport of sediment and PCBs through the Kalamazoo River.

Analysis of the Fate of PCBs in the Housatonic River

Client: General Electric Company

Technical advisor for extensive data analysis and modeling studies directed to determining the appropriate remedial solution for the contaminated sediments. This study involves data analysis and the development of linked hydrodynamic, sediment transport, PCB fate and PCB bioaccumulation models. An important aspect of this project is the evaluation of the role of river flooding in PCB fate and impact of flood plain soils.

Modeling of Heavy Metal and Organic Contaminant Fate in the Pawtuxet River to Support a RCRA Facility Investigation

Client: Ciba-Geigy Corporation

Principal investigator for determination of target chemicals by qualitative risk analysis, design of a sampling program and development of a model to evaluate temporal and spatial concentration reductions resulting from remedial action alternatives including excavation and groundwater treatment.

Analysis of DDE and PCB Transfer Pathways in the Southern California Bight Ecosystem

Client: National Oceanic and Atmospheric Administration

Principal investigator for the analysis of data and development of food chain models to study the relationship between sediment contamination and levels of DDE and PCBs in fish, mammals, and birds. The purpose of this work was to establish probable sources of contamination in support of a Natural Resource Damages Assessment.

Contaminated Groundwater Assessment and Management

Evaluation of Solvent Plume Migration and Fate at the MW Manufacturing Site, Valley Township of Pennsylvania

Client: Lucent Technologies

Principal investigator for the development and application of flow and transport models to be used to predict the movement and decay of a VOC plume composed of PCE, TCE, 1,2-DCE and vinyl chloride. The goal of the project is to estimate whether the plume has achieved a steady-state configuration in response to a non-aqueous phase source and to project discharge rates to a local stream.

Modeling of Groundwater Remediation Using Vertical Groundwater Circulation Technology

Client: SBP Technologies

Principal investigator for the development of a strategy to model the treatment efficiency of *in-situ* vertical groundwater circulation technology. Work included the evaluation of circulation, nutrient dynamics and PAH biodegradation and volatilization. The goal was to develop a modeling framework that could be used to design sampling strategies and evaluate treatment efficiency.

Water Quality/Eutrophication Assessment

Assessment of the Environmental Fate and Impact of ICE-B-GON on Lake Wingra, Wisconsin

Client: Chevron Research Company

Principal investigator for the laboratory determination of the degradation and oxygen utilization kinetics of the de-icing chemical, ICE-B-GON and projection of the effect of the use of this chemical on the dissolved oxygen of receiving waters using Lake Wingra as a case study.

Mathematical Modeling of Water Quality in Lake Erie

Client U.S. Environmental Protection Agency, Grosse Ile, Michigan

Project Engineer in charge of data analysis development and calibration of an eutrophication model including multiple algal species and zooplankton, and projections of the effects of reduction in point and non-point nutrient loadings on pollution indicators; lake phytoplankton, nutrient, and dissolved oxygen levels.

Analysis of Heavy Metals, Ammonia and Cyanide in the Genesee River

Client: Eastman Kodak Corporation

Project Engineer in charge of data analysis, mathematical model development and assessment of the relative impact of the Kodak treatment plant effluent on water quality in the River.

Analysis of the Fate of Toxic Chemicals in Estuaries

Client: U.S. Environmental Protection Agency, Gulf Breeze, Florida

Project Manager in charge of development of a mathematical model describing the transport and degradation of toxic chemicals in estuarine environments.

Development of Version 4.0 of the Water Analysis Simulation Program (WASP)

Client: U.S. Environmental Research Laboratory, Athens, Georgia

The purpose of this project was to modify the USEPA water quality model WASP (3.2) to provide a single modeling framework for use in all types of surface water problems including conventional and toxic pollutants under steady-state or time-variable conditions. Responsibilities included the development of the kinetic routines for the toxic chemical component of the model from those used in EXAMS II, TOXIWASP and WASTOX, integration of the WASTOX steady-state solution into WASP and providing technical assistance on all other components of model development.

Total Maximum Daily Load (TMDL) Investigations

San Francisco Bay PCBs

Client: General Electric Company

Principal investigator for the review and critique of a draft TMDL document issued by the San Francisco Bay Regional Water Quality Control Board. This study involved the analysis of data and modeling to provide the Board with the information necessary to correct deficiencies in the draft document with regard to natural recovery and the need for, and effectiveness of, available source control options and to develop an effective implementation strategy. It included the development of presentation materials and a face-to-face meeting with the authors of the document.

Coosa River PCBs

Client: General Electric Company

Principal investigator for the review and critique of a draft TMDL document issued by the State of Georgia. This study involved the analysis of data to provide the State with the information necessary to correct deficiencies in the draft document with regard to natural recovery and the need for, and effectiveness of, available source control options and to develop an effective implementation strategy. It included the development of presentation materials and a face-to-face meeting with the State and with EPA Region 4.

Ecological Risk/Natural Resource Damage Assessments

Development of Water Quality Criteria for Wildlife

Client: U. S. Environmental Protection Agency

Principal investigator for the development of methodologies to determine water concentrations protective of aquatic feeding wildlife. Defined methods to relate laboratory toxicity estimates to wildlife species. Efforts included compilation and analysis of toxicity data, development of models to permit extrapolation of laboratory toxicity data to field animals and development of models of the relationship between water column contaminant concentrations and effects in wildlife. Initial work focused on dieldrin and DDT.

Modeling PCBs in the Aquatic Biota of Green Bay

Client: U.S. Environmental Protection Agency

Principal investigator for the development and application of a model of PCBs in the food web of Green Bay. This work is part of the Green Bay Mass Balance Study for the U.S. Environmental Protection Agency. The purpose of these studies was to evaluate the impacts of potential remediation alternatives.

Analysis of PCBs and Metals Contamination in the Biota of New Bedford Harbor, Massachusetts

Client: U.S. Environmental Protection Agency, Region I, Battelle Ocean Sciences

Project manager in charge of developing a mathematical model of the contamination of the lobster and winter flounder and their food chains in New Bedford Harbor and Buzzards Bay. Responsible for linking this model with a hydrodynamic-contaminant fate model developed by Battelle Northwest to project the response of the biota to various remedial action alternatives. This work was part of an EPA Superfund project in New Bedford Harbor.

Analysis of PCBs in the Hudson River Striped Bass and its Food Chain

Client: Hudson River Foundation, New York, NY

Project manager in charge of the development of a mathematical model describing the accumulation of PCBs in the striped bass food chain.

Analysis of Kepone Accumulation in the Striped Bass Food Web of the James River Estuary

Client: U.S. Environmental Protection Agency, Gulf Breeze, Florida

Project manager in charge of the development and application of a mathematical model describing the accumulation of the pesticide Kepone in the striped bass food chain. Projected the response of the food chain to declining exposure concentrations.

Pathogen Fate and Transport

Development of a Framework for Predicting the Fate of Genetically Engineered Microorganisms in Surface Water Systems

Client: U.S. Environmental Protection Agency, Environmental Research Laboratory, Gulf Breeze, Florida

Principal investigator for the development of a model of the population dynamics of bacteria, phytoplankton and zooplankton in surface waters and application of this model to predicting the risk associated with the introduction of genetically engineered bacteria to these environments. Population dynamics models were developed for the Delaware River and Mirror Lake.

Modeling Fate and Transport of Pathogenic Organisms in Mamala Bay, Hawaii

Client: Mamala Bay Study Commission

Principal investigator for review of historical data, design of a sampling program and development and calibration of a mathematical model of pathogen fate in Mamala Bay. Goal is to determine pathogen sources and level of control necessary to meet water quality goals.

Evaluation of Cryptosporidium Sources and Fate in Milwaukee, Wisconsin

Client: Sara Lee Corporation

Principal investigator for the evaluation of the likely contribution of various potential sources to the Cryptosporidium responsible for a disease outbreak in the city of Milwaukee.

Hydraulic Engineering

Hydraulic Analysis of the Fairfield, New Jersey Sewer System

Client: Lee Purcell Associates, Inc.

Project engineer in charge of determining the capacity and flow characteristics of an in-place sewer system. Developed a gradually varied flow analysis for this purpose.

HONORS

Diplomate Environmental Engineer by Eminence, American Academy of Environmental Engineers, 2002
Manhattan College Environmental Engineering Alumni Club Service Award, 1994

PROFESSIONAL ACTIVITIES

Affiliations

American Academy of Environmental Engineers
Sigma Xi - The National Scientific Research Society
Society of Environmental Toxicology and Chemistry
American Society of Limnology and Oceanography
Water Environment Federation

Committees and Advisory Boards

2005	USEPA Science Advisory Board
1997	USEPA Technical Qualifications Board to review promotion application
1991-96	New York Water Environment Association Outstanding Paper Award Committee
1990-95	DuPont Technical Advisory Board for Evaluation of HMPA Releases at their Spurance Plant in Richmond, VA
1990	USEPA Exploratory Research Review Panel

Invited Participation in Technical Workshops

Addressing Uncertainty and Managing Risk at Contaminated Sediment Sites. St. Louis, MO October 26-28, 2004 – Steering Committee Member.

SERDP/ESTCP Contaminated Sediments Workshop. Arlington, VA August 10-11, 2004.

Stability of Chemicals in Sediments. San Diego, CA April 8-10, 2003 – Steering Committee Member.

Sediment Stability Workshop. New Orleans, LA, January 22-24, 2002 – Steering Committee Member.

U.S. EPA Forum on Contaminated Sediments. Alexandria, VA, May 30-June 1, 2001.

National Research Council Workshop on Bioavailability. Washington, D.C., November 12, 1998.

SETAC Pellston Workshop: Re-evaluation of the State of the Science for Water Quality Criteria Development. Fairmont Hot Springs, MT, June 25-30, 1998.

National Academy of Sciences National Symposium on Contaminated Sediments. Washington, D.C., May 27-29, 1998.

SETAC Pellston Workshop: Reassessment of Metals Criteria for Aquatic Life Protection. Pensacola, FL, February 10-14, 1996.

California EPA Workshop on Critical Issues in Assessing Ecological Risk. Asilomar, CA, January 23-25, 1995.

USEPA Workshop on Taura Syndrome. Gulf Breeze, FL, August 2-3, 1994.

USEPA Workshop on Modeling Uncertainty. Buffalo, NY, February 3-5, 1991.

USEPA Workshop on Sediment Quality Criteria. Grosse Ile, MI, March 29-30, 1990.

Industry Sponsored Workshop on the Environmental Impacts of the Deicer Calcium-Magnesium-Acetate. Albany, NY, February 27, 1990.

USEPA Workshop on Biotechnology Risk Assessment. Breckenridge, CO, January 11-15, 1988.

SETAC Workshop on Risk Assessment. Breckenridge, CO, August 17-21, 1987.

PRESENTATIONS

Challenges to Monitoring and Assessing Natural Recovery. Third International Conference on Remediation of Contaminated Sediments, New Orleans, LA, January 27, 2005.

Monitoring to Support the Dredging Remedy on the Upper Hudson River. Third International Conference on Remediation of Contaminated Sediments, New Orleans, LA, January 26, 2005.

Adaptive Management as a Measured Response to the Uncertainty Problem. Addressing Uncertainty and Managing Risk at Contaminated Sediment Sites, St. Louis, MO, October 27, 2004

Optimal Use of Conceptual and Mathematical Models at Contaminated Sediment Sites. Addressing Uncertainty and Managing Risk at Contaminated Sediment Sites, St. Louis, MO, October 27, 2004

Sampling of Sediment and Water in the Upper Hudson River to Support the USEPA Dredging Remedy. Hudson River Environmental Society Conference, RPI, Troy, NY, October 5, 2004

Nature and Causes of Non-Particle Related Contaminant Releases in Large River Systems. Workshop on Environmental Stability of Chemicals in Sediments, San Diego, CA, April 10, 2003

Management of Contaminated Sediments. NSF US/Italy Workshop on Sediments, Arlington, VA, December 10, 2002

Use of Sound Science to Develop a Defensible Site Model. U.S. EPA Forum on Managing Contaminated Sediments, Alexandria, VA, May 31, 2001.

A Quantitative Framework for Evaluating Contaminated Sediment Sites. SETAC 20th Annual Meeting, Philadelphia, PA, November 14-18, 1999.

Prediction of Natural Recovery and the Impacts of Active Remediation in the Upper Hudson River. SETAC 20th Annual Meeting, Philadelphia, PA, November 14-18, 1999.

Evaluation of Remedial Alternatives for Contaminated Sediments: A Coherent Decision-Making Approach. National Research Council, National Symposium on Contaminated Sediments, Washington, D.C., May 28, 1998.

Applications of Models to the Risk Assessment Problem. Chesapeake Biological Laboratory, Solomans, MD, November 1, 1996.

Use of Food Web Models to Evaluate Bioaccumulation Data. National Sediment Bioaccumulation Conference, Bethesda, MD, September 11, 1996.

Assessment and Remediation of Contaminated Sediments at MGP Sites. Electric Power Research Institute, Monterey, CA, August 28, 1996.

Modeling the Environmental Fate and Transport of Metals. 26th Pellston Workshop: Reassessment of Metals Criteria for Aquatic Life Protection, Pensacola, FL, February 11, 1996.

Toxicologically Based Ecological Risk Assessment. California EPA Workshop on Critical Issues in Assessing Ecological Risk, Asilomar, CA, January 24, 1995.

Data Requirements for the Development and Use of Water Quality Models. USEPA Conference on Quality Assurance in Environmental Decision Making, IBM T.J. Watson Research Center, Yorktown Heights, NY, November 2, 1994.

Mathematical Modeling of the Bioaccumulation of Hydrophobic Organics. National Biological Survey, Columbia, MO, August 25, 1994.

A Model-Based Evaluation of PCB Bioaccumulation in Green Bay Walleye and Brown Trout. International Association for Great Lakes Research 36th Conference on Great Lakes Research, De Pere, WI, June 7, 1993.

Bioaccumulation Modeling of Micropollutants in the Field. International Workshop on Mechanisms of Uptake and Accumulation of Micropollutants, Veldhoven, The Netherlands, May 25, 1993.

Keynote Presentation. NIEHS Sponsored Workshop on the Bioaccumulation of Hydrophobic Organic Chemicals in Aquatic Organisms, June 29, 1992.

Modeling the Role of Bacteria in Carbon Cycling. Gordon Research Conference, New Hampton, New Hampshire, June 17, 1992.

Calcium Magnesium Acetate Biodegradation and its Impact on Surface Waters. Symposium on the Environmental Impact of Highway Deicing, University of California, Davis, October 13, 1989.

Food Chain Modeling in the Green Bay Mass Balance Study. International Association for Great Lakes Research 32nd Conference on Great Lakes Research, Madison, WI, June 2, 1989.

Modeling the Fate of Bacteria in Aquatic Systems. American Society for Microbiology Annual Conference, New Orleans, LA, May 18, 1989.

Application of a Food Chain Model to Evaluate Remedial Alternatives for PCB-Contaminated Sediments in New Bedford Harbor, MA, Superfund '88, Washington, D.C., November 29, 1988.

Modeling the Accumulation of Organic Chemicals in Aquatic Animals. Joint USA/USSR Symposium: Fate of Pesticides and Chemicals in the Environment, The University of Iowa, Iowa City, IA, November 15, 1987.

Modeling Kepone in the Striped Bass Food Chain of the James River. Virginia State Water Control Board, Richmond, VA, August 15, 1983.

Predicting the Effects of Toxic Chemicals in Natural Water Systems. U.S. Environmental Protection Agency, Environmental Research Lab, Athens, GA, November 3, 1982.

Modeling Toxic Substances in Aquatic Food Chains. Clarkson College Environmental Engineering Graduate Program, Potsdam, NY, October 29, 1982.

Predicting the Effects of Toxic Chemicals in Natural Water Systems. U.S. Environmental Protection Agency, Environmental Research Lab, Gulf Breeze, FL, September 13, 1982.

Modeling of Fate of Toxic Chemicals in Aquatic Systems. U.S. Environmental Protection Agency, Office of Toxic Substances, Washington, D.C., March 16, 1982.

PUBLICATIONS

Comment on "The Long-Term Fate of Polychlorinated Biphenyls in San Francisco Bay, (USA)". Connolly, J.P., C.K. Ziegler, E.M. Lamoureux, J.A. Benaman and D. Opydke, *Envion. Toxicol. Chem.* 24:2397-2398.

p,p'-DDE Bioaccumulation in Female Sea Lions of the California Channel Islands. Connolly, J.P. and D. Glaser, *Continental Shelf Res*. 22:1059-1078, 2002.

A model of p,p'-DDE and total PCB bioaccumulation in birds from the Southern California Bight. Glaser D, J.P. Connolly, *Continental Shelf Research* 22:1079-1100, 2002.

Use of a Bioaccumulation Model of p,p'DDE and Total PCB in Birds as a Diagnostic Tool for Pathway Determination in Natural Resource Damage Assessments. Glaser, D. and J.P. Connolly, *Continental Shelf Res*. In press.

Modeling of Flood and Long-Term Sediment Transport Dynamics in Thompson Island Pool, Upper Hudson River. Ziegler, C.K., P. Israelsson and J.P. Connolly, *Water Quality and Ecosystem Modeling* 1:193-222, 2000.

Modeling of Natural Remediation: Contaminant Fate and Transport. Peyton, B.M., T.P. Clement and J.P. Connolly, In: *Natural Remediation of Environmental Contaminants: Its Role in Ecological Risk Assessment and Risk Management,* Swindoll, C.M., R.G. Stahl & S.J. Ells, eds., SETAC Press, 472 p., 2000.

The Use of Ecotoxicology and Population Models in Natural Remediation. D. Glaser and J.P. Connolly, In: *Natural Remediation of Environmental Contaminants: Its Role in Ecological Risk Assessment and Risk Management,*

Swindoll, C.M., R.G. Stahl & S.J. Ells, eds., SETAC Press, 472 p., 2000.

A Model of PCB Fate in the Upper Hudson River. Connolly, J.P., H.A. Zahakos, J. Benaman, C.K. Ziegler, J.R. Rhea and K. Russell, *Environ. Sci. Technol*. 34:4076-4087, 2000.

Modeling the Fate of Pathogenic Organisms in the Coastal Waters of Oahu, Hawaii. Connolly, J.P., A.F. Blumberg and J.D. Quadrini, *J. Environ. Eng.* 125:398-406, 1999.

Bacteria and Heterotrophic Microflagellate Production in the Santa Rosa Sound, Fl. Coffin, R.B. and J.P. Connolly, *Hydrobiologia* 353:53-61, 1997.

Hudson River PCBs: A 1990s Perspective. Rhea, J., J. Connolly and J. Haggard, *Clearwaters*, 27:24-28, 1997.

Modeling the Environmental Fate and Transport of Metals. Connolly, J.P., In: *Reassessment of Metals Criteria for Aquatic Life Protection,* Bergman H.L. and E.J. Dorward-King, eds., SETAC Press, 1997.

The Use of Vertical Groundwater Circulation Technology: A Preliminary Analysis of the Fate and Transport of Polycyclic Aromatic Hydrocarbons in a Shallow Aquifer. Connolly, J.P. and J.D. Quadrini, In: *In Situ Bioremediation and Efficacy Monitoring,* Spargo, B.J. ed., Naval Research Laboratory, NRL/PU/6115-96-317, 1996.

A Model of Carbon Cycling in the Planktonic Food Web. Connolly, J.P. and R.B. Coffin, *J. Envir. Eng.* 121:682-690, 1995.

The Impact of Sediment Transport Processes on the Fate of Hydrophobic Organic Chemicals in Surface Water Systems. Ziegler, C.K. and J.P. Connolly, *Toxic Substances in Water Environments: Assessment and Control*, Proceedings of the Water Environment Federation Specialty Conference, May 14-17, 1995.

Uncertainty in Bioaccumulation Modeling. Glaser, D. and J.P. Connolly, *Toxic Substances in Water Environments: Assessment and Control*, Proceedings of the Water Environment Federation Specialty Conference, May 14-17, 1995.

Toxicologically Based Ecological Risk Assessment. Connolly, J.P., In: *Critical Issues in Assessing Ecological Risk*, Summary of Workshop held at Asilomar Conference Center, Pacific Grove, CA, University Extension, University of California, Davis, January 23-25, 1995.

Availability of Dissolved Organic Carbon to Bacterioplankton Examined by Oxygen Utilization. Coffin, R.B., J.P. Connolly and P.S. Harris, *Mar. Ecol. Prog. Ser*. 101:9-22, 1993.

Do Aquatic Effects or Human Health End Points Govern the Development of Sediment-Quality Criteria for Nonionic Organic Chemicals? Parkerton, T.F., J.P. Connolly, R.V. Thomann and C.G. Urchin, *Environ. Toxicol. Chem.* 12:507-523, 1993.

An Equilibrium Model of Organic Chemical Accumulation in Aquatic Food Webs with Sediment Interaction, Thomann, R.V., J.P. Connolly and T.F. Parkerton, *Environ. Toxicol. Chem.* 11:615-629, 1992.

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Simulation Models for Waste Allocation of Toxic Chemicals: A State of the Art Review. Ambrose, Jr., R.B., J.P. Connolly, E. Southerland, T.O. Barnwell, Jr. and J.L. Schnoor, *J. Wat. Poll. Con. Fed.* 60(9):1646-1655, 1988.

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A Post Audit of a Lake Erie Eutrophication Model. DiToro, D.M., N.A. Thomas, C.E. Herdendorf, R.P. Winfield and J.P. Connolly, *J. Great Lakes Res.* 13(4):801-825, 1987.

Movement of Kepone (Chloradecone) Across an Undisturbed Sediment-Water Interface in Laboratory Systems. Pritchard, P.H., C.A. Monti, E.J. O'Neill, J.P. Connolly and D.G. Ahearn, *Environ. Tox. Chem.*, 5:647-658, 1986.

Bioaccumulation of Kepone by Spot (*Leiostomus xanthurus*): Importance of Dietary Accumulation and Ingestion Rate. Fisher, D.J., J.R. Clark, M.H. Roberts, Jr., J.P. Connolly and L.H. Mueller, *Aquatic Tox.* 9:161-178, 1986.

A Model of Kepone in the Striped Bass Food Chain of the James River Estuary. Connolly, J.P. and R. Tonelli, *Estuarine, Coastal & Shelf Science* 20:349-366, 1985.

Predicting Single Species Toxicity in Natural Water Systems. Connolly, J.P., *Environ. Tox. Chem.* 4:573-582, 1985.

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A Model of PCB in the Lake Michigan Lake Trout Food Chain. Thomann, R.V. and J.P. Connolly, *Environ. Sci. Tech.* 18(2):65-71, 1984.

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Adsorption of Hydrophobic Pollutants in Estuaries. Connolly, J.P., Armstrong, N.E. and R.W. Miksad, ASCE *J. Envir. Eng. Div.* 109(1):17-35, 1983.

Calculated Contribution of Surface Microlayer PCB to Contamination of the Lake Michigan Lake Trout. Connolly, J.P. and R.V. Thomann, *J. Great Lakes Research* 8(2):367-375, 1982.

Mathematical Modeling of Water Quality in Large Lakes, Part 2. Di Toro, D.M. and J.P. Connolly, Lake Erie, U.S. Environmental Protection Agency, Ecological Research Series, EPA-600/3-80-065, 1980.

The Effect of Concentration of Adsorbing Solids on the Partition Coefficient. O'Connor, D.J. and J.P. Connolly, *Water Research* 14(10):1517-1523, 1980.

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PROFESSIONAL HISTORY

Quantitative Environmental Analysis, LLC, Senior Managing Engineer, January 2005 to present
University of Texas at Austin, Environmental and Water Resources Engineering, Adjunct Professor, January 2003 to present
Quantitative Environmental Analysis, LLC, Managing Engineer, October 2002 to December 2004
Cornell University, Department of Civil and Environmental Engineering, EPA STAR Fellow, September 1999 to October 2002
Quantitative Environmental Analysis, LLC, Senior Project Engineer, February 1999 to October 2002
Quantitative Environmental Analysis, LLC, Project Engineer, February 1998 to January 1999
HydroQual, Inc., Graduate Engineer II, 1996 to 1998
Univ. of Texas at Austin, Department of Civil Engineering, NSF Fellow, 1994-1996
Brevard County, Florida, Surface Water Improvement Division, Graduate Engineer, Summer 1994
E.A. Thaner and Associates, Surveying Company, Intern, Summer 1993
Univ. of Hawaii at Manoa, School of Ocean and Earth Science and Technology, Research Assistant, Summer 1992

EDUCATION

Cornell University, Ph.D., Civil and Environmental Engineering, 2003
University of Texas, Austin, M.S., Civil Engineering, 1996
Florida Institute of Technology, B.S., Civil Engineering, 1994

REGISTRATION

Engineer-in-Training, October 1993

EXPERIENCE SUMMARY

Dr. Benaman's experience has focused on environmental modeling of natural systems, its application to Geographic Information Systems (GIS), and uncertainty analysis. The modeling has involved watershed management, Total Maximum Daily Load (TMDL) development, the fate of toxic chemicals in the environment, and eutrophication with nutrient loading analysis. Dr. Benaman has experience and expertise with numerous water quality and watershed models, including SWAT, HSPF, WASP, GWLF, and BASINS.

A primary focus of Dr. Benaman's recent work is TMDLs, their development, implementation (including adaptive implementation), and impact on various stakeholders. Dr. Benaman has developed professional workshops on the TMDL process in order to educate stakeholders, including industry and agency professionals, on the science and policies behind TMDL development. Most recently, Dr. Benaman is a member of an expert panel being led by Dr. Ken Reckhow that is compiling a follow-up document to the 2002 NRC Report on TMDLs. This expert panel is focused on establishing how to do adaptive watershed management and adaptive implementation of TMDLs. In addition, she has participated in a number of public meetings with stakeholders, politicians, and local scientists in order to educate them about the watershed models and the impact of their development on the pollution control process. Dr. Benaman also has experience with a county organization focused on controlling non-point source pollution from urban and open areas to a lagoon in Florida. While at the Surface Water Improvement Division of Brevard County, Florida, Dr. Benaman reviewed retrofit designs for urban BMPs, attended public meetings to educate homeowners on non-point source controls, and assessed non-point source pollution potential in different subwatersheds based on land use and drainage.

In addition to watershed analysis, Dr. Benaman has extensive experience with data analysis for contaminated sediment issues. Dr. Benaman also has significant experience with the application of GIS to a variety of projects for data analysis, data management, model input generation and presentation of model results. Before coming to QEA, Dr. Benaman performed environmental modeling and data analysis at HydroQual, Inc. in Mahwah, New Jersey. Prior to working at HydroQual, she conducted research in water quality and watershed models at the University of Texas at Austin. During that time, her work focused on the use of GIS in hydrologic, water quality, watershed management and general environmental modeling. Dr. Benaman has extensive experience in the use and programming of the GIS platforms, ArcView 3.1 and ArcInfo 7.03. Dr. Benaman also recently conducted research at Cornell University in the area of watershed modeling and uncertainty analysis in pursuance of a doctoral degree.

MAJOR PROJECTS

Waste Load Allocations/TMDLs

TMDL Adaptive Implementation Expert Panel

Client: Center for the Analysis and Prediction of River Basin Environmental Systems, Duke University

Participating on a panel of expert scientists and engineers to investigate the use of Adaptive Implementation in the TMDL process. Work includes workshops and meetings with the panel and other professionals performing TMDLs across the country. Final product will be a monograph to be released for public use and potentially reviewed by USEPA. This monograph is meant as an follow-up document to the 1002 NRC Report on TMDLs.

Fort Cobb, Oklahoma Nutrient TMDL Review

Client: Oklahoma Farm Bureau

Managing project that entails critical review of a nutrient TMDL developed on Fort Cobb Reservoir by the state of Oklahoma. Review consists of evaluation of the application of SWAT and EFDC to the watershed, as well as evaluating the TMDL development and proposed implementation. Final comments will be submitted to the Oklahoma Department of Environmental Quality (DEQ) on behalf of the Oklahoma Farm Bureau. Work also includes attendance to public meetings and interaction with the Oklahoma DEQ.

Stone Dam Creek, Arkansas Nitrate/Ammonia TMDL

Client: Parsons/USEPA Region 6

Project manager for the development of a nitrate and ammonia TMDL for Stone Dam Creek, Arkansas. TMDL development includes data acquisition, analysis, source assessment, and load allocations. Duties also include responding to comments from the USEPA and general public concerning the TMDL.

TMDL Workshops

Client: Various

Developed and implemented workshops for different stakeholder groups to educate industry and agency professionals on the TMDL process. Focus of the workshops were primarily on the development of TMDLs, their implementation, and their impact on the various stakeholders involved in the process. Content focused on outlining guidance documents, reviewing past TMDL developments, and discussing the policies of the current procedures.

San Francisco Bay PCB TMDL

Client: General Electric Company

Involved in a comprehensive review of a PCB TMDL developed by the San Francisco Bay Regional Water Quality Control Board. Review includes detailed analysis of the system, including understanding of the current PCB contamination in sediment, water, and fish, review of San Francisco Bay food web, estimation of external loadings to the Bay, and critical assessment of the modeling used for the TMDL development.

General Electric TMDL Workshop

Client: General Electric Company

Developed and implemented full day workshop for General Electric plant managers. Purpose of the workshop was to educate managers on the TMDL process. Involved approximately 20 participants and included lectures, on-site demos, and hands-on exercises.

State of Texas Total Maximum Daily Load Modeling Assessment

Client: Texas Natural Resource Conservation Commission University of Texas at Austin

Primary responsibility is to perform an independent assessment of existing water quality and watershed models in relation to their application to the Texas TMDL project. This task entails evaluating watershed models, as well as in-stream water quality models to determine their appropriateness to the Texas environment. An additional focus lies in assessing effort required to integrate a given model and an ArcView Graphical User Interface.

Water Resources/Watershed Assessments

Development of a Watershed/Water Quality Model for the Cannonsville Reservoir System

Client: Delaware County, New York

Primary developer of a watershed model for a New York City water supply reservoir basin using the Soil and Water Assessment Tool (SWAT). Work included data analysis, model input development, calibration, validation, sensitivity and uncertainty analysis. Project also entailed public meetings with stakeholders, politicians, and local scientists. This project was prompted by the desire of NYC to protect the headwaters of its water supply through land use management and proactive BMPs.

LCRA-SAWS Water Project Study Plan Development

Client: San Antonio Water System, Lower Colorado River Authority, CH2M Hill-Austin

Technical contributor on the development of a seven year study plan to evaluate the projected impacts and benefits of the LCRA-SAWS Water Project with respect to the health and productivity of Matagorda Bay and water quality characteristics of the lower Colorado River (downstream of Austin).

LCRA-SAWS Colorado River and Off-Stream Reservoir Water Quality Project

Client: Lower Colorado River Authority

Managing the development of water quality and watershed models on the Colorado River, downstream of Austin, Texas. These models are being developed to understand the impacts of a proposed water transfer project from the Colorado River to San Antonio, TX. Work includes data acquisition and analysis, field sampling and model development, calibration, and projections. In addition, this study is part of a larger project that coordinates information and analysis from 11 different environmental studies and includes public outreach efforts, entailing public meetings and an expert panel review.

LCRA CREMS Phase I and Phase II – Lake Travis Project

Client: Lower Colorado River Authority

Leading consultant team that serves as technical advisors to the LCRA for the development of a watershed and receiving water quality model of Lake Travis, TX. Work includes assessing current data and literature, model development, calibration, uncertainty, and application.

Development of a Watershed/Water Quality Model for North Sandy Pond

Client: Oswego County, New York

Managed the development of a combined watershed/water quality model for North Sandy Pond, located off Lake Ontario. This project included the implementation and customization of USEPA's Better Assessment Science for Point and Non-point Sources Program (BASINS) to simulate the impact of nutrient loadings to the lake. Responsibilities include overseeing data import and quality control within GIS, development of model parameters and loadings, and application of the model to the study area.

Water Quality/Eutrophication Assessment

Brevard County, Various Projects

Employer: Surface Water Improvement Division of Brevard County

Worked for a county department that focused on controlling non-point source pollution from urban and open areas to the Indian River Lagoon in east Florida. Reviewed retrofit designs for urban BMPs, attended public meetings to educate homeowners on non-point source controls, and assessed non-point source pollution potential in different subwatersheds based on land use and drainage.

Jamaica Bay Eutrophication Study

Client: New York City Department of Environmental Protection

Engineer responsible for data analysis in the development of a mathematical model to study eutrophication in an urbanized bay of New York City. Also assisted on a sediment model of the bay to aid in the calibration of the project's larger sediment/water model. Specific tasks included code modification and calibration runs for a one-dimensional sediment nutrient flux model.

Contaminated Sediments Assessment and Management

Data Analysis and Database Management for the PCB Problem in the Hudson River

Client: General Electric Company

Primary duty entails development and management of a GIS database for the analysis of PCB measurements. Tasks include assisting the contaminant modeling effort with model input development and graphical display of data and the analysis of PCB distributions and PCB fate mechanisms within the Upper Hudson River. Tasks also included extensive data analysis to understand the fate and transport of PCBs in the river.

Delineation of Contaminated Sediments in the Hudson River

Client: General Electric Company

Managing effort to delineate the dredging areas for PCB remediation in the Hudson River. Effort includes managing the analysis of over 8,000 sediment cores over 40 miles of river in order to establish the areal and vertical extent of PCB contamination in the river. Tasks entail geostatistical and deterministic interpolations, as well as extensive communication of the delineation effort though reports, maps, and graphs.

Investigation of Mercury in Lavaca Bay

Client: Alcoa

Engineer responsible for data analysis and management using GIS to identify and quantify mercury sources and the ultimate fate of mercury in an open estuarine bay of Texas. Duties include coordination and communication with other subcontractors and state agencies for data information, extensive data analysis and the development of input parameters for the project's hydrodynamic, sediment transport and chemical fate models. Also partly responsible for the development of the chemical fate model to determine the existence of a continuing mercury sources in the bay.

PROFESSIONAL ACTIVITIES

Affiliations

Tau Beta Pi
Chi Epsilon
American Society of Civil Engineers
Water Environment Federation
Society of Environmental Toxicology and Chemistry

Committees and Advisory Boards

1999-present	Water Environment Federation Watershed Management Committee
1999-2002	Water Environment Federation Watershed Conference Program Committee
2002-present	Water Environment Federation TMDL Science Issues Conference Committee

Invited Participation in Technical Workshops

Total Maximum Daily Loads: What General Electric Needs to Know. Full-day workshop given at General Electric Aircraft Engine. Cincinnati, OH. March 2002.

Data Needs in Environmental Modeling. Full-day lecture given at ASCE Qual2E Workshop. Fort Washington, PA. March 2002.

Watershed Modeling and GIS. Full-day lecture given at Tufts University, TMDL Modeling Workshop. Boston, MA. June 2001.

GIS in Environmental Risk Assessment. Pre-Conference Seminar presented at the 1998 ESRI Users National Convention, San Diego, CA. July 1998.

GIS in Water Quality Modeling. Seminar presented at Manhattan College Summer Institute in Water Pollution Control. Riverdale, NY. June 1997.

PRESENTATIONS

Adaptive Implementation for Improved Water Quality Management: When Does it Make Sense? A Follow Up to the 2001 National Research Council TMDL Report. Benaman, J., Freedman, P., Reckhow, K., and Shabman, L. AWRA Adaptive Management Conference. *Abstract Published in Proceedings.* Missoula, MT. June 26-28, 2006

Lower Colorado River Authority-San Antonio Water System Water Project Environmental Studies: Maintaining Quantity for Quality's Sake. Invited Presentation. Flows for the Future 2005. Texas State University River System Institute. San Marcos, TX. November 1, 2005.

The Application of GLUE to Estimate Uncertainty. WEF TMDL 2005 Conference. *Presented as part of Conference Workshop: Uncertainty Analysis: Tools and Methodologies to Support TMDL Development and Adaptive Implementation.* Philadelphia, PA. June 26-29, 2005.

Overcoming Data Limitations to Establish Nitrate and Ammonia TMDLs for Stone Dam Creek, Arkansas. Benaman, J., Opdyke, D., and Franks, J. WEF TMDL 2005 Conference. *Published in proceedings*. Philadelphia, PA. June 26-29, 2005.

Legacy Pollutants, Contaminated Sediments and TMDLs: Applying Better Science with Limited Budgets. Third International Conference on Remediation of Contaminated Sediments. *Abstract published in proceedings*. New Orleans, LA., January 24-27, 2005.

A Better Way to Conduct TMDLs on a Shoestring Budget. J. Benaman, J. Connolly, and K. Russell. WEF TMDL 2003 Conference. *Published in Proceedings*. Chicago, IL. November 16-19, 2003.

Sensitivity and Uncertainty Analysis of a Distributed Watershed Model for the TMDL Process. Benaman J, C.A. Shoemaker. *Published in Proceedings*. WEF 2002 TMDL Conference. Phoenix, AZ. November 13-16, 2002.

Customization of BASINS for the North Sandy Pond Watershed. Benaman J, K.T. Russell, and J.R. Rhea. *Published in Proceedings*. WEF Watershed 2002 Conference. Ft. Lauderdale, FL. February 24-27 2002.

A Calibration, Validation, and Sensitivity Analysis for a Distributed Watershed Model: Hydrology and Sediment Transport in a Northeastern Climate. Benaman J. and C.A. Shoemaker. Abstract Published in Proceedings. American Geophysical Union Annual Meeting. San Francisco, CA. December 10-14, 2001.

Modeling Non-Point Source Pollution using a Distributed Watershed Model for the Cannonsville Reservoir, New York. Benaman J., C.A. Shoemaker and D.A. Haith, ASCE 2001 World Water Environment Congress. Orlando, FL. *Published in Proceedings*. May 20- 24, 2001.

The Use of GIS in the Development of Water Quality Models. Benaman J. and J.D. Mathews, 2000 Joint Conference on Water Resources Engineering and Water Resources Planning and Management. Sponsored by American Society of Civil Engineers. Minneapolis, MN. *Published in Proceedings*. July 30 – August 2, 2000.

A Critical Assessment of Watershed and Water Quality Models for the Texas TMDL Process. Benaman J., G. Ward, D.R. Maidment and W.K. Saunders, Published in Proceedings. Watershed 2000. Sponsored by Water Environment Federation. Victoria, BC. *Published in Proceedings.* July 9-13, 2000.

Hot Spots: A Figment of Our Interpolation – Methods and Uncertainty in Spatial Interpolation. Presented at Society of Environmental Toxicology and Chemistry 20th Annual Meeting. Benaman, J. and J. Connolly, Philadelphia, PA. November 14-18, 1999.

Prediction of Natural Recovery and the Impacts of Active Remediation in the Upper Hudson River. Connolly, J.P., H. Zahakos, C.K. Ziegler, D. Glaser, D. Rhea, J. Benaman, P. Israelsson, J. Quadrini, B. Cushing and H.G. Haggard, SETAC 20th Annual Meeting, Philadelphia, PA, November 14-18, 1999.

A Quantitative Framework for Evaluating Contaminated Sediment Sites. Connolly J.P., J.R. Rhea and J. Benaman SETAC 20th Annual Meeting, Philadelphia, PA, November 14-18, 1999.

Validation Over Multiple Time Scales of Upper Hudson River PCB Fate Model. Zahakos H.A., J.P. Connolly and J. Benaman, SETAC 20th Annual Meeting, Philadelphia, PA, November 14-18, 1999.

GIS in Environmental Modeling. Benaman, J., and J.D. Mathews. Presented at North East Arc Users Conference. Long Branch, NJ. September 1997.

PUBLICATIONS

An Analysis of High-Flow Sediment Event Data for Evaluating Model Performance. Benaman J. and C.A. Shoemaker. *Hydrological Processes* 19(3): 605-620. 2005.

Calibration and Validation of a Distributed Watershed Model for Basin-Wide Management. Benaman, J., C.A. Shoemaker and D.A. Haith. *ASCE Journal of Hydrologic Engineering.* 10(5): 363-374. 2005.

Methodology for Analyzing Ranges of Uncertain Model Parameters and Their Impact on the TMDL Process. Benaman J. and C.A. Shoemaker. *Journal of Environmental Engineering* 130(6): 648-656. 2004.

Uncertainty and Sensitivity Analyses for Watershed Models: Hydrology and Sediment Transport Modeling on the Cannonsville Reservoir System. Benaman J. *Ph.D. Dissertation*. Cornell University. Department of Civil and Environmental Engineering. January 2003.

A Robust Sensitivity Analysis Method for Complex Watershed Models with Application to the Cannonsville Basin. Benaman, J., and C.A. Shoemaker. Submitted for Publication. 2002.

A Systematic Approach to Uncertainty Analysis for a Distributed Watershed Model. Benaman, J. Dissertation Proposal. School of Civil and Environmental Engineering. Cornell University. January 2001.

A Model of PCB Fate in the Upper Hudson River. Connolly, J.P., H.A. Zahakos, J. Benaman, C.K. Ziegler, J.R. Rhea and K. Russell. *Environ. Sci. Technol*. 34:4076-4087. 2000.

Effective Decision-Making Models for Evaluating Sediment Management Options. Connolly, J., J. Rhea, and J. Benaman. White paper. Sediment Management Workgroup. 1999.

Modeling of Dissolved Oxygen in the Houston Ship Channel using WASP5 and Geographic Information Systems. Benaman J., N.E. Armstrong, and D.R. Maidment. Center for Research in Water Resources Electronic Report 96-2. University of Texas at Austin. August 1996.

Geochemistry, Mineralogy, and Stable Isotopic Results from Ala Wai Estuarine Sediments: Records of Hypereutrophication and Abiotic Whitings. Glenn, C.R., S. Rajan, G.M. McMurtry and J. Benaman, *Pacific Science* 49(4):367-399. 1995.