Comments on US EPA Region 9's Response to DSCSOC's Request for Technical Review of the Reliability of Using Co-Occurrence-Based SQGs in a LEHR Site Ecological Risk Assessment

Submitted to DSCSOC

by
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Julie Roth, Executive Director
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Julie,

In early January 2005, DSCSOC requested that the US EPA Region 9 review the technical validity of the University of California-Davis's (UCD) use of co-occurrence-based sediment quality guidelines (SQGs) for assessing if the concentrations of chemicals at the LEHR Superfund site are a threat to aquatic life. The basis for that request was the well-recognized unreliability and unsound technical foundation of that approach for assessing the potential for sediments to cause adverse impacts, and the consequent unreliability of the remediation decisions made on the basis of such an assessment. As part of this request, DSCSOC provided a recent discussion (Jones-Lee and Lee, 2005) of the technical aspects of this issue developed and published by numerous, recognized authorities in the field.

The response to that inquiry, provided by N. Black, Regional CERCLA Ecologist/Microbiologist for US EPA Region 9, was basically a statement that the co-occurrence-based SQG approach is appropriate because that is what the US EPA uses, and that some of those who use this approach reportedly state that it is appropriate. While he provided citations to selected examples of the application of the approach and writings of the developers, he failed to address the technical issues that render the approach unreliable. He did not acknowledge, much less comment upon, the substantial, peer-reviewed, long-standing and recent literature published by internationally recognized authorities in sediment quality evaluation (citations provided with my comments) that discusses the technical shortcomings of the co-occurrence-based SQG approach and the reasons that this approach is technically invalid and unreliable for use in regulation and remediation of sediments.

N. Black did make it quite clear that he considers the questions about the validity of that approach to be unsubstantiated opinion by out-of-touch individuals unaware of the peer-review process in scientific literature. That tenor, curiously, was expressed with the display of his ignorance or disregard of the current literature delineating the technical flaws and inadequacies of the approach, as well as writings and conclusions of the Agency, itself.

Contrary to the statements made in his response, this is not a matter of differing "points of view" in the scientific community – differences between the learned view of those he cited and the opinionated ill-informed view of others. In making his flippant referral to the editorial policies of several journals, he was apparently unaware that I have published

more than 1,000 papers and reports, the majority of which have been peer-reviewed, have served on the editorial review boards for several journals, and am routinely (at the rate of about one per month) requested to peer-review papers, reports and proposals on issues of water quality. I am familiar with the strengths and weaknesses of the peer review process and strongly support properly conducted peer reviews.

The DSCSOC request for review of the use of the co-occurrence-based SQG approach by US EPA Region 9 for the LEHR site was not an inquiry into whether the US EPA Region 9 had used co-occurrence-based guidelines as regulatory values. I am well aware that Region 9 has a long history of using (misusing) co-occurrence-based SQGs; I am also aware, however, that the public has been trapped into spending many millions of dollars in "remediation" specified on the basis of an approach that cannot reliably characterize sediments as to their potential to cause adverse impacts to aquatic life (see Lee and Jones-Lee, 2002). By submitting this request for review, along with substantial technical support of refereed papers by experts in the sediment quality evaluation field, I had hoped that the US EPA Region 9 would have conducted a critical review of this issue. Instead, DSCSOC received a dismissive statement that this approach has been used in the past and therefore it is appropriate for continued use. The superficially and tone of N. Black's response is indicative of an inadequate academic background, expertise, or experience for undertaking a credible technical review of the issues raised by DSCSOC.

In his response to DSCSOC's request for a proper technical review, N. Black, on behalf of the US EPA Region 9, did not address the technical issues. It cannot be refuted that the fundamental science, as well as the findings and conclusions drawn by numerous highly regarded professionals in the technical, peer-reviewed literature, clearly demonstrate that the co-occurrence-based sediment quality guidelines are not valid or reliable for determining the level of a chemical that does or does not represent a threat to aquatic life or to assess whether or not a particular sediment represents a threat to aquatic life. The use of an unreliable approach for any decision-making can only render unreliable conclusions.

In making my comments on this matter, I cited the conclusions of Dr. R. Engler, Dr. T. Bridges, Dr. T. O'Connor, and Dr. A. Burton that co-occurrence-based SQGs are unreliable for evaluating sediment toxicity.

O'Connor (2004) provided additional information on the unreliability of using co-occurrence-based approaches for assessing sediment toxicity. He concluded, for example,

"While it is being used as such, the sediment quality guideline ERL (effects range low) is not a threshold of any chemical concentration in sediment at which the probability of toxicity shows an abrupt increase. Similarly, while it has been done, there is no basis for assuming that multiple concentrations above an ERL increase the probability of toxicity."

Black cited the work of Ed Long as supportive of Region 9's use of co-occurrence-based SQGs. Long (2004) recently commented that it is possible to predict the broad scope of relationships between sediment chemical concentrations and toxicity. However, review of his and others' work shows that the error bars are very large which renders such predictions worthless for site-specific or area-specific assessments. He, himself, concluded,

"*The presumption that you can predict benthic impacts with sediment chemistry data alone is very weak*."

With respect to Patti Collins' suggestion that I take this matter to peer-reviewed journals for review, as indicated in the supporting paper that was provided with the request for review, the unreliability of co-occurrence-based sediment quality guidelines to estimate toxicity of a chemical(s) in sediments has been extensively peer-reviewed by experts in the field of sediment quality evaluation. I provided references to the series of papers presented at the 2002 Fifth International Symposium on Sediment Quality Assessment (SQA5), and most recently (October 2004) at the Society for Toxicology and Chemistry meeting World Congress that was held in Portland, OR. There, paper after paper provided data that showed that the co-occurrence-based approach is unreliable for estimating sediment toxicity.

As discussed at length in my reviews, and as discussed by numerous others cited, there are several fundamental deficiencies and faulty presumptions in the use of co-occurrence-based sediment quality guidelines as a stand-alone basis for evaluating the potential impacts of Superfund and other hazardous chemical sites, and sediment located in industrial areas where there could be complex mixtures of chemicals in the sediments. These include:

- This approach erroneously presumes that there is a cause-and-effect relationship between the concentrations of chemical contaminants in sediment and toxicity caused by the sediment. This presumption ignores the vast knowledge, and limitations in knowledge, of aquatic chemistry and aquatic toxicology. This fallacy of this presumption has long been recognized, yet it is a fundamental presumption of co-occurrence approaches.
- Even if there were a cause-and-effect relationship between concentration and effect, this approach assumes that the only chemicals in a sediment that can be toxic are those for which there are co-occurrence-based SQGs. Thus it can erroneously "clear" or overlook sediments – even in screening – that contain toxicants not included among the SQGs.
- It ignores additive and synergistic toxicity.
- Most important, it allows those want to minimize sediment toxicity problems to assume that there is no need to conduct an evaluation for impacts of unmeasured chemicals.

By far one of the most important problems with this approach is that it gives credibility to a fundamentally flawed approach to assessing sediment quality that ignores aquatic chemistry/toxicology and leads others to believe the co-occurrence-based approach is valid for assessing sediment toxicity.

It is true that some in the US EPA, and others, claim that co-occurrence-based so-called sediment quality guidelines, such as Long and Morgan ERL, ERM and MacDonald PEL, TEL values, can be used to determine if a chemical in sediments requires consideration in an ecological risk assessment. Also understood is the drive for regulators to grasp onto simple, numeric tools that do not demand technical understanding for implementation. To do so, however, is to ignore the fundamental principles of aquatic chemistry and aquatic toxicology that govern the behavior of chemicals, the current literature on factors influencing the impact of chemicals on aquatic life, as well as the basis and assumptions used to develop co-occurrence-based so-called SQGs. Review and understanding of these principles and information indisputably shows that the co-occurrence-based SQG approach is technically invalid for sediment evaluation and management. Basing remediation decisions on that approach can waste public and private funds for unjustified actions, and can fail to identify truly hazardous situations that need remediation to protect aquatic ecosystems.

Aside from the fundamental technical flaws of the approach, and the limited spectrum of chemicals and impacts it considers, using an SQG guideline as a brightline regulatory limit – by which a sediment with concentrations below the SQG values is judged to not represent a threat to aquatic life – also ignores the potential for additive and synergistic impacts of chemicals in aquatic systems. The SQGs are based on a limited set of mixtures of chemicals compared to the range of mixtures of chemicals that exist in aquatic systems. As discussed by Lee and Jones-Lee (2003) and Jones-Lee and Lee (2005) a mixture of chemicals can readily exist that can cause aquatic life toxicity at a particular location even though all chemicals in the sediment of interest are below the SGQ values.

It is well-established in the literature that many chemicals exist in aquatic systems in a variety of chemical forms, only some of which are toxic/available. This is the fundamental reason that co-occurrence-based sediment chemical guidelines are obviously technically invalid to estimate sediment toxicity. Dr. D. DiToro (2002), an internationally recognized authority on sediment quality evaluation and a keynote speaker at the 2002 Fifth International Symposium on Sediment Quality Assessment (SQA5), characterized any apparent relationship between exceedance of an SQG and measured aquatic life toxicity as a "coincidence." In their recent review, Jones-Lee and Lee (2005) discussed the substantial current literature that demonstrates the unreliability of co-occurrence-based sediment quality guidelines for predicting sediment toxicity. The introduction provided by them bears repeating:

"*Many Superfund/hazardous chemical sites include waterbodies whose sediments contain hazardous chemicals. With the need to assess, rank, and remediate contaminated sediments at such sites, as well as in other waterways, regulators seek a simple, quantitative assessment approach that feeds easily into a decision-making scheme. Numeric, co-occurrence-based "sediment quality guidelines" have emerged with the appearance of administrative simplicity. However, the very foundation of the co-occurrence approach, based on the total concentrations of a chemical(s) in sediment, is*

technically invalid; its application relies on additional technically invalid presumptions. Use of technically invalid evaluation approaches renders any assessment of the significance of sediment contamination, unreliable. This paper reviews the technical roots and assumptions of the co-occurrence-based SQGs, the fundamental flaws in the rationale behind their development and application, and their mis-application for sediment quality evaluation. It also reviews concepts and approaches for the more reliable evaluation, ranking, and clean-up assessment of contaminated sediments at Superfund sites and elsewhere."

In order to determine whether a chemical, or group of chemicals, in a sediment is toxic to aquatic life, it is necessary to measure the toxicity using a suite of sensitive organisms. It is naïve, at best, to attempt to use chemical concentration measurements and SQGs to try to estimate toxicity. There are far too many factors that influence the manifestation of toxicity by sediment-associated chemicals to ever be able to reliably assess toxicity based on chemical measurements.

Some claim that since the toxicity data are often not available, we must use the co-occurrence approach. Clearly that is no rationale for using an unreliable approach, and claiming that it provides a technical foundation for sediment evaluation. It would be less costly, and more reliable, to flip a coin to decide which sediments to "remediate."

N. Black cited the US EPA's recently published updated National Sediment Inventory as an example of the Agency's support for using the co-occurrence-based values. He failed to reveal, however, that the US EPA has provided a discussion of the unreliability of using co-occurrence-based values as stand-alone values in sediment quality evaluation. As discussed by Lee (2004) in the Stormwater Quality Newsletter's review of the US EPA's recently released, updated National Sediment Quality Inventory, the Agency relied on toxicity testing to determine if a sediment was toxic. It did not, contrary to N. Black's implication, use the co-occurrence approach to determine if a sediment was toxic. The US EPA stated in the Inventory,

"The sediment chemistry screening values used as the basis for comparison in this report are not regulatory criteria, site-specific cleanup standards, or remediation goals. Sediment chemistry screening values are reference values above which a sediment ecotoxicological assessment might indicate a potential threat to aquatic life."

"The empirically derived or correlative approaches (e.g., predicted proportion toxic) rely on paired field and laboratory data to relate incidence of observed biological effects to the dry-weight sediment concentrations. Correlative screening values can relate measured concentration to a probability of association with adverse effects, but they do not definitively establish cause and effect for a specific chemical."

The US EPA Region 9 should show leadership in promoting and using technically valid approaches for evaluating the potential water quality significance of chemicals in aquatic sediments. By ignoring the technical information, and allowing and perpetuating the claims made by N. Black regarding co-occurrence-based sediment quality guidelines,

Region 9 is sanctioning UCD's use of an obviously technically invalid approach to determine if a sediment represents a threat to water quality and to claim that the chemicals in a sediment represent no threat to aquatic life since the chemicals for which there is a co-occurrence-based guideline represent no threat if their concentrations are below a guideline value. Furthermore, it misleads others to believe that this approach has some validity as a regulatory tool in Superfund and other programs.

Other Perspectives

In the interest of promoting firm technical foundation for evaluation and management decisions, I provided N. Black's response to DSCSOC's request for US EPA Region 9 review, to a number of internationally recognized authorities on issues of sediment toxicity and evaluation who are well-published in the area. Responses received to date follow.

"I am not surprised. It's the easy way to go for regulators. Yes, a lot of recent research is showing a lot of synergism out there."

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"Ignorance is bliss!!"

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"It is not just us cranks who preach against using SQGs as stand-alone indicators of hazard. If, on the other had, screening means that the sediment is declared hazardous on the basis of an SQG that is wrong.

I had plenty of technical comments on the Second National Sediment Quality Survey but I applauded the way it repeatedly states that chemical data are only screens indicating where further analysis will be necessary before any regulatory or management actions are undertaken. Clearly the Second NSQS did not recommend SQGs as stand-alone tools."

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"What all this boils down to is what someone means when they say 'screening' and how one constrains the scope of conclusions drawn from the use of these values in a manner that is consistent with the uncertainties associated with their use."

DSCSOC Recommended Approach

If the US EPA Region 9 continues to allow UCD to use obviously technically invalid approaches for characterizing the hazards of the LEHR Superfund site, I will recommend that DSCSOC critically review any remediation decisions that are based on technically invalid approaches. Where I can see those decisions affecting the provision of reliable protection the public health and the environment, I will recommend that DSCSOC/the Public not support those parts of the ROD.

If there are questions on these issues please contact me.
Fred

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