Contaminated Sediments: State of the Science and Future Research Directions

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It is a real pleasure to be here today and speak at the first National Sediment Bioaccumulation Conference. As many of you know, when Bob Huggett came into the Office of Research and Development (ORD) as the Assistant Administrator, he brought with him a strong belief that sediment contamination is one of the compelling research issues that we face as a nation. He still holds that belief. Bob is at an international meeting for the Agency, so I am presenting for him today on behalf of ORD. However, my comments reflect my own perspective.

This conference is exciting because it represents the culmination of many years of work related to sediments. It also demonstrates, better than many other examples in environmental research, how science can be applied in a partnership of researchers, risk managers, regulators, private interest groups, and agencies at all levels of government to accomplish risk reduction.

About ten years ago, Jim Falco, Director of Environmental Processes Research in EPA, asked that I meet with him and several members of the Office of Water. He wanted to discuss building the scientific framework necessary to establish the concept of sediment quality criteria. The existing methods then were highly empirical and often unreproducible, and they did not allow us to predict effects. We needed criteria to make sense of the field measurements we were making. He asked if the ORD laboratories could provide support for development of sediment quality criteria, and we agreed to get the laboratories involved.

Soon after we organized scientists familiar with sediment issues and began research, a Senator involved in revising the Clean Water Act visited our laboratory and wanted to know about sediment contamination and why it needed attention. After giving a technical presentation that included an explanation of bioaccumulation factors under steady-state conditions, he surprised us by asking "what is a sediment?" There is a communication challenge, in addition to the challenge of developing a workable regulatory strategy for contaminated sediments. In the last ten years, research has taught us how to begin making sense out of the data on sediment effects.

In addition to developing sediment toxicity tests, we have established methods to measure the bioaccumulation potential of sediment contaminants. When we published our first work on bioaccumulation, we chose the term "bioaccumulation potential" rather than "bioconcentration factor" because kinetics and thermodynamics really intersect in bioaccumulation testing. It is very difficult to predict the kinetics of uptake because it is largely experimentally controlled and most of the bioaccumulation methods are operationally defined. "Bioaccumulation potential" is primarily a thermodynamic term that separates chemicals that bioaccumulate from those that do not. If organic chemicals are unlikely to bioaccumulate, they would probably not even be in the sediments. The "bioaccumulation potential" represents the probability that a chemical is going to penetrate an ecosystem by dispersing from a source and moving up food chains to cause effects at levels we might not have anticipated.

Sediments were recognized as the final repository for contaminants as early as the 1970s. During that decade we were still struggling to define toxicity and to establish permitting and control programs. Today, the issue of reducing risks from sediments that have already been contaminated is an important problem that merits attention. Right now we are making good progress on work in dredged material management, food chain modeling, and development of tissue-based residue methodologies to address this problem. The academic community and agencies at all levels of government have efforts underway to describe the dynamics of food chains and to define how to use this information in a risk assessment. The Office of Water is spearheading one such effort by developing the bioaccumulation paper entitled *Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment: Status and Needs*. About 40 people from several EPA offices are collaborating to draft that report, which will include information on chemicals of concern and methods for assessing bioaccumulation, an Agency summary on bioaccumulation data collection and interpretation, and recommendations for further research.

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Another sediment-related effort being conducted at an ORD laboratory is the development of toxicity identification evaluation (TIE) procedures to analyze complex chemical mixtures.

I want to summarize briefly how we formulate priorities for budgeting in ORD and how conferences like this can help. Surprisingly enough, when we went through the budget planning process, some participants expressed the belief that contaminated sediments are not a serious national problem, that sediments do not present a significant risk to the environment, and that sediments do not merit further research based on their negligible risks. At first I laughed because I did not think they were serious, but then I realized that they were serious. They made their case using some of the same data we were using to try to show that sediment contamination is a significant problem. Data from a spatially subsampled survey conducted under the Environmental Monitoring and Assessment Program (EMAP) in ORD covered estuaries in the Virginian, Louisianan, and Carolinian provinces. Looking at the benthic condition with some of the EMAP indicators, one could see that about 29 percent of the estuaries had degraded benthic condition.

That information alone, however, does not convince skeptics that sediment contamination is a significant problem. The skeptics viewed 29 percent of our estuaries as impacted to mean 71 percent were not.

I realized that we have not clearly answered the "So what?" questions with respect to ecological consequences. How much impact is too much? When are fisheries and the productivity of coastal waters affected? How much degradation could exist in the benthic systems to streams and lakes before there are ecological consequences and loss of integrity? We can say that there are 17,000 square kilometers in our estuaries where you can measure an effect in the benthos, compared to reference conditions. That is a large area. So what? Similarly in the Great Lakes, many have overlooked the fact that reproduction in major species of the food chain has been shut off since the 1940s due to chemical residues. EMAP combines measures of effect with stressors and has associated the degraded communities with sediment contaminants. For example, when you link some of the areas of degraded benthic condition with measures of observed toxicity, you will find that these are the sites where survival of benthic organisms in bioassays was below 80 percent. This evidence establishes an association strong enough to say that parts of the benthic community degradation are due to contaminated sediments. The question that remains is how we can establish a cause-effect relationship between the loss of integrity and the sediment residues over large areas.

The importance of these field studies in strengthening the risk assessment process for sediment certainly plays into the risk-based priority setting in ORD. The new strategic plan for ORD is based on the risk paradigm. We now evaluate a problem based on whether or not we think the science can reduce the uncertainty associated with estimating effects, exposure, the assessment capability, and risk management. There are some issues where ORD has concluded that we do not need to do more effects research, because further effects research would not contribute significantly to our understanding of the problem. Contaminated sediments is one issue where major uncertainties still exist in effects and exposure assessment. In the process of planning the budget according to risk-based priorities, we have consolidated the intramural research in ORD to focus on contaminated sediments by designating this area as a budget subcomponent. ORD has created a work force of about 45 full-time equivalents (FTEs), which represents an increase in the level of effort for sediment issues in the laboratories. We are revising the research strategy for contaminated sediments, and research recommendations that come out of this conference will be considered in developing the plan, particularly for projects directed at the Office of Water's needs.

I would also like to direct your attention to the extramural research program, known as the Science to Achieve Results (STAR) Program, that ORD initiated in 1995. STAR is a competitive research grants program being run by ORD's National Center for Environmental Research and Quality Assurance in Washington, D.C. This year the grants program included only about $2 million specifically for issues involving contaminated sediments. There were more than 40 proposals and 8 of these proposals received high rankings by the peer review panel. The small STAR budget for the sediment program could only fully fund four or five grants this year, but it is a start. We anticipate a modest increase in funding for contaminated sediment research grants in FY 1997.

We may have temporarily won the battle to convince planners that contaminated sediments are impacting a significant part of our resources. Through the ORD planning process, ORD has agreed to focus more resources on research related to contaminated sediments. In FY 1998 there may even be an increase of about $3 million of extramural money to support the laboratories in the ORD intramural research program. We need to maintain this focus and increase our effectiveness through partnerships with other interested EPA offices and federal agencies, including Office of Water, the Superfund Program, the Great Lakes National Program Office, the Chesapeake Bay Program, the National Oceanic and Atmospheric Administration (NOAA), the U.S. Army Corps of Engineers, and the U.S. Geological Survey. We also need to be refining approaches that are implementable at the state level and work with the states to achieve risk reduction. Today is a good time to rededicate ourselves to working as partners and to make the contaminated sediment issue the best example of how we can work together to solve the environmental problems.

The ORD research program will continue support for pollution prevention efforts. We will be addressing the issues remaining for sediment quality criteria, including data to support the guidelines and response to public comment on the technical basis for the criteria. Another area ORD will support is applying what we know about the sediment effects of chemicals to a cleanup strategy for a particular Superfund site. There are some excellent presentations coming up in this conference on how to apply the concept of criteria to restoration.

The management of risks associated with the disposal of dredged material will require a strong EPA collaboration with the U.S. Army Corps of Engineers and the States in order to develop a workable process. ORD will support that effort. We have identified research needs such as tissue-based effects models to understand the bioavailability and pharmacokinetics that explain why residues bring about long-term damage to ecosystems. Food chain models are becoming ever more sophisticated, but they need further development. There is a critical need to develop population level assessment methods to link up the "So what?" questions of the declining biological diversity and loss of certain species. Assessment of the impact of complex chemical mixtures will be necessary to unravel the causative agents in the chemical mixtures that are often found in sediments.

Finally, I would like to emphasize the importance of the development and application of remediation methods. There has been much progress on remediation of contaminated sediments, with mitigation success at Superfund sites. However, the mitigation options are still too limited for larger areas. In terms of communication challenges, we need a breakthrough to instill hope in our political leaders that we can actually remediate contaminated sediments. We have to overcome what seems to be an overwhelming pessimism that we will ever reduce the risks posed by sediments except by waiting decades. The work that our Region 2 Office is doing on treating harbor sediments in the New York area is resulting in some of the most exciting new developments in the last five years. They appear to be setting the stage for the future in sediment remediation.

As we participate in this conference and prepare for the next decade of work to reduce the impacts of sediments in the environment, I encourage you to avoid letting our energies become fragmented by using data to support a personal or organizational interest. The danger I see in the sediment literature is the number of papers designed to support hypotheses rather than test hypotheses. There is a need for debate in risk management, certainty among uncertainties in our scientific understanding of sediment interactions which merit debate, but the objective application of the scientific method in gathering data to support these debates is crucial.

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