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Water

Water Quality Standards for the 21st Century

Proceedings of the Third National Conference
Las Vegas, Nevada
August 31-September 3, 1992

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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OFFICE OF
WATER

Dear Colleague:

I am pleased to be sending you the Proceedings of the Las Vegas Conference on Water Quality Standards for the 21st Century.

With such a large number of ideas and suggestions being raised in forums such as this along with the time it takes to implement changes in programs, it is sometimes difficult to judge how effective such conferences are. We believe such conferences are valuable and directly impact our work in both water quality criteria and standards. While we would like to be able to implement every suggestion and every new program, that is unrealistic. However, our programs are influenced by meetings such as this conference.

As a result of the third conference, we'll make some changes in specific activities and in broad program priorities. This results from detailed suggestions and from responses to our Strategic Planning Survey.

You can expect to see a greatly expanded effort in the coming year on the question of how to control metals in ambient water. Through a continuing series of meetings, we will focus on the scientific, technical, and policy issues, determine what near and long term actions can be taken, and move towards either a resolution of the issue or identify practical means for program implementation based on available information and procedures.

The methodologies used to derive both human health and aquatic life criteria are being reviewed and revisions suggested. Subsequent to the conference, we have had meetings on both methodologies. The revisions, which will be made available for peer and public review and comment, will reflect suggestions made at the conference.

You may also expect to see more attention to guidance, technical training, and assistance that focuses on the implementation of standards. This will be especially the case as the program solidifies its scientific basis for sediment criteria and biological criteria--areas of future priority for standards development.

Numerous improvements or clarifications in the water quality standards program operating regulation, suggested or based on ideas debated at the conference, will be presented to the public for consideration through preparation of an Advanced Notice of Proposed Rulemaking. The result of that public review may lead to a major effort to revise the existing standards regulation.

The meeting evaluation forms were overwhelmingly favorable on the substance and format of the conference. They also included valuable suggestions that we will consider for the next National Conference in fiscal year 1994.

We appreciate very much the contributions made by all the panel participants at the conference, and by the audience in the question and answer sessions. We hope the overall experience at the conference was satisfying and we look forward to continuing to work together to preserve, protect, and enhance water quality in the United States.

Sincerely yours,

Tudor T. Davies, Director
Office of Science and Technology

Enclosure

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Welcome

WELCOME

Tudor Davies
Director
Office of Science and Technology
U.S. Environmental Protection Agency
Office of Water
Washington, D.C.

Good morning, my name is Tudor Davies, Director of the Office of Science and Technology, Office of Water, EPA. I am sure of this because it says so right here in my notes. Apparently my staff felt I would need this reminder after a night or two on the town.

Welcome to Las Vegas and the Third National Conference on Water Quality Criteria and Standards. We selected Las Vegas as an optional means of financing water pollution control programs--we figured we had about as much chance at the slot machines as we had with Congress or OMB.

We are pleased to see so many people representing all the regulated community. We have people here today from industry, environmental groups, academia, technical consultants, Native Americans, municipal governments, interregional organizations, other Federal agencies, and of course, the States. This is good. Protecting the quality of water and the public health requires all of our best efforts. As we share ideas, as we begin to understand the needs and views of all the different people and groups involved in this great challenge, we can implement better programs.

The question is . . . why have we asked <u>you</u> to come?

This is a good time to have a national discussion of the Criteria and Standards Program. We have essentially completed meeting the statutory requirements placed on us by Congress to adopt standards for toxic pollutants. We are on the verge of being ready with the scientific basis for the development of sediment criteria and biological criteria. Reauthorization of the Clean Water Act will be occupying the attention of Congress next year. A number of ideas will be discussed. One of these ideas is to change the fundamental basis of the program to place more specific limits or requirements on the States as to what standards they need to adopt and within what time frame. The concepts embodied in the guidance implementing the Great Lakes Critical

Programs Act could potentially be applied to the standards program nationally. Ideas are being formulated on how to implement antidegradation, how to derive criteria without a full database, concepts of developing and implementing criteria to protect wildlife Very specific requirements are being proposed for granting variances, and for specifying uniform permit limits impacting a single water system. Are any of these appropriate for national application?

Also, the Criteria and Standards Program continues to evolve into a much broader and different entity than what it dealt with in the early years. It's been a long time since our most serious debate was whether the dissolved oxygen criterion should be 4.5 or 5. Now we are dealing with toxic pollutants on the order of parts per quadrillion. There are new scientific advances in the form of new types of water quality criteria. Statutory requirements have changed--court decisions have affected the program. We understand the nature of water quality impairments better, and you, our customers, have increased and different demands. Most important of all, I believe, is that the public is demanding more from us in the way of protecting and enhancing water quality.

Probably the most important reason we are glad you are here is that the States are usually the innovators in our programs. This is true in many areas, not just in water pollution control. We need your ideas, your suggestions, your expertise on where the program should be headed in the upcoming years. What have you been experimenting with in criteria development or in implementing standards? What have you learned? What seems to have worked? What failed? What are you doing that could be applied on a national or at least regional scale?

It is impossible for us to do everything everybody would like, and you can't do it either. So, what do we need to do the most? You will help us answer that question.

The focus of this year's national conference is to help us in EPA, specifically the Office of Science and Technology, in determining how best to meet these changing demands.

My philosophy is straightforward--I want the Office of Science and Technology to do the right things, and I want to do them the right way. Unfortunately, not everybody agrees on what the right things are or how they should be done. But, if we have a focused effort among all of us involved in improving water quality, we can and will overcome very difficult challenges. Without a focused effort, we'll be lucky to make any real progress at all.

Our central goal for the conference is to solicit a broad range of perspectives on each of the agenda topics and debate the merits of alternative approaches. If you would prefer to argue rather than debate, that is alright, too. I hope each session will bring into sharper focus the policy, legal, scientific, and program choices facing us. Each of us brings a bias to this conference based on our training and the job we now hold. For most of us, this means program decisions seem to be clear. The problem comes when people from other disciplines and having a different set of responsibilities get involved and mess things up. Well, I hope we mess things up a bit during our discussions. I hope we can discuss why what appears to be good policy founders because there is not legal or scientific basis and vice versa. To the senior managers at EPA, this is important because we rarely ever get to make a decision based on one discipline. Policy, legal, technical, economic, scientific issues all become part of the decision making process.

These discussions are important. They will be used in making far-reaching decisions on what program areas will become our priorities for the coming fiscal years and where we can best expend our limited resources. These decisions will then directly affect what we will expect from the States in their role as the primary implementors of the Criteria and Standards Program. What we hear at meetings such as this will also help frame EPA's position on Clean Water Act Reauthorization proposals.

YOUR ROLE IN THE MEETING

I mentioned earlier that you are going to help us decide what the program should do in the future. Specifically, we are going to do this in three ways.

First, the number of formal speakers has been reduced from previous years. With the help of the moderators, we have planned that at least half of the allotted time for each panel will be available for audience participation. We want to hear from you folks what your ideas are. We encourage you to actively participate. We know you have ideas and concerns. Please get them on the table. The panel members have been directed to focus on specific aspects of the topic to encourage debate from the audience.

Second, you will find, in your registration packet, a priorities survey. We want you to complete these surveys. We will combine your views with similar surveys we took at several Criteria and Standards workshops earlier this summer as another vehicle to help us select national program priorities, <u>based on what you think and not just what we in EPA might believe ought to be done</u>. Read the directions for this survey carefully. You will not be able to make everything a priority--you will have to pick and choose carefully, just as we do at EPA. As you make your choices, think about what could result in the largest risk reduction or program benefit. In the upcoming elections, you get to vote only once (at least that's the way it's done in most places). Our survey allows you multiple votes, but you have to decide what program areas to use them on. The results of these surveys and the discussions at this conference will be examined along with any statutory or judicial requirements mandated for the Agency to establish future national program priorities. Please complete and return these surveys at the registration table by noon tomorrow.

Third, on Wednesday afternoon, there is an agenda item called "Advocates Forum." This is where we at EPA, along with you in the audience, get to ask some hard questions to the advocates of various interest groups. In your registration packet, you will see a card on which we ask you to write the question you would like to see directed to one or more of the advocacy group representatives. We'll collate them and get as many of them on the floor as we can. Turnabout is fair play--you get to ask the EPA senior managers anything you want on Thursday.

THE AGENDA

I want to spend a few minutes describing the agenda and some of the underlying questions we hope to discuss over the next 3 days.

The topics selected for discussion at this conference were chosen from suggestions offered by cities, States, and others in the regulated community. We believe they are the ones dominating most of the current discussions on criteria and standards.

Let's take a look at the agenda.

We've just gone through a major effort to establish criteria for toxic pollutants. What now? We have issues of national consistency versus geographical flexibility, of the potential to change the roles of EPA and the States. Congress seems to be moving toward being more specific in its directives on criteria and standards. Does this help, or does this make it more difficult for us to set risk-based priorities? Do we need fundamental changes in the act, or should we not tamper with provisions that are at the core of the statute and have resulted in relative success?

We will be discussing human health risk management and human health risk assessment. The questions to be debated include: (1) Who should we protect? (2) What is an adequate level of protection? (3) Is our methodology for deriving human health criteria too conservative? (4) Should States be given more or less flexibility in risk assessment and management decisions?

What are we going to do about two of the major activities identified in previous national meetings--the application of biological and sediment criteria? Can and should these types of criteria be implemented? Are the resources available to implement these types of criteria? How can they be used in a regulatory context? Is their scientific support solid enough to support regulatory programs? Are we going to be able to set priorities for issuing sediment-based permit limits? I expect answers to these questions in the next 5 minutes.

EPA has established a policy of independent applicability of chemical-by-chemical criteria, whole-effluent toxicity testing, and biological measures.. Does that policy make sense? Some States flatly oppose it. Do we know enough about any of these measures to allow one to override another? Can we establish a balance among these different tools?

Some of our time will be spent on ecological risk assessment. Can we actually make ecological risk assessments, and how could we implement such assessments in terms of regulatory programs?

Forty-three million people in the United States are served by 1,200 combined sewer systems, mostly in the northeast part of the country. There are a whole host of issues to be considered by the Criteria and Standards Program, not the least of which are the relative risks of wet weather events compared to other threats, and the characteristics of wet weather discharges that pose the greatest risk to human health. In what area of the criteria-to-standards-to-permit process should EPA focus its efforts?

While the easterners among us can debate that topic, the people from the arid west will be talking about how to apply standards to ephemeral- and effluent-dominated streams. The question raised by interested groups is whether some different interpretation and application of the Clean Water Act is more appropriate for the arid west. Alternatively, is there sufficient flexibility in the current program regulation and policies to cover such situations?

In all of these areas, an underlying question is do we need statutory or regulatory changes to accomplish the desired objective?

As we identify the national program priorities for the coming years, I think it is important to maintain a focus on the reality of getting things done, all the way from the basic scientific research through setting the enforceable water quality standards, having available implementation procedures, and being able to reflect the requirements in permits.

LOGISTICS

As the first speaker, I get the honor of making all the miscellaneous announcements required at the beginning of a meeting. So, here goes.

Outside this main meeting room, you will find copies of many EPA publications. We invite you to look them over and order those you feel can be useful to you.

We also will be showing a number of videotapes on the Criteria and Standards Program at the breaks. These tapes are available free for your use. Order forms are available.

In addition, please use your time here to meet with the EPA staff, get to know each other, and share ideas.

If there is anything we can help you with at the meeting, please go the registration desk and we'll help you out.

T. DAVIES

I want to thank AMSA for taking the time and trouble for putting together yesterday's field trip. It always helps to get into the field and see what the environmental problem or challenge is.

We appreciate your being here, and I hope you will be able to say it was time well spent at the end of the conference.

To get us started, I would like to introduce the Assistant Administrator for the Office of Water, LaJuana Wilcher.

Applying EPA's Risk-Based Approach and Commitment to Sound Science to WQC/WQS Priority Setting

EPA'S COMMITMENT TO SOUND SCIENCE AND WATER QUALITY STANDARDS

LaJuana S. Wilcher
Assistant Administrator for Water
U.S. Environmental Protection Agency
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Washington, D.C.

INTRODUCTION

Good morning. It's a pleasure to join you at the Third National Meeting on Water Quality Standards for the 21st Century. Although it is mid-morning, this is probably pretty early for some of you--that field trip to the effluent-dominated stream yesterday must have been pretty exhausting. Either that, or some of you have made field trips to the casino floor. I know you've just gone to assess the risks, though, in the name of science.

If you've found significant risks at the tables, you'll agree with the Greek philosopher, Petronius, who called gaming:

> . . . that direst felon of the breast
> [which] Steals more than fortune from its wretched thrall,
> Spreads o'er the soul the inert devouring pest
> And gnaws, and rots, and taints, and ruins all. (Gaius Petronius, 66 A.D., *3,500 Good Quotes for Speakers*)

I mention that not only in sympathy to some, but also as a service to others who might have thought of playing "hooky" from today's meetings. See how much better off you are in here!

STATE ACHIEVEMENTS THROUGH WATER QUALITY STANDARDS

Numbers take on extra importance in Las Vegas. Today, I like the number 42. Lucky 42 is a winner because that is the number of States and territories which have adopted and received EPA approval for numeric criteria for toxic pollutants. These 42 jurisdictions have met the objective that Congress established in 1987.

Those of us in EPA's Office of Water know that it wasn't easy. Every one of those States had to face challenges to get the job done in a timely manner--challenges from many interest groups, from legislatures, and even from us at EPA. There have been challenges on the need for criteria, challenges on their scientific bases, and challenges on the costs of adopting them. Yet, 42 States and territories persevered, made the tough choices, and adopted clear standards which will form the basis for sound environmental control programs for years to come.

All of that tough work has paid off. We've been cleaning up the water. The most recent data compiled by the States indicate that 63 percent of assessed river miles, 44 percent of assessed lake acres, and 56 percent of estuarine square miles support their designated uses.

In the Water Quality Standards Program, there are 57 different jurisdictions working to implement the requirements of the Clean Water Act. While all of their programs contain the same basic elements, there are many differences. Innovative States have taken the lead in implementing advanced concepts such as biological criteria, and ecoregional studies and controls. Sediment criteria have been examined for application to the Puget Sound. Multi-regional efforts to set common standards are under way for the Chesapeake Bay, Great Lakes, and Gulf of Mexico. In a variety of ways, States are working to give real regulatory meaning to narrative standards so that permits can be written to meet standards. States are trying different ways of implementing antidegradation. State standards serve as benchmarks for effective pollution prevention programs.

DELAYS MAY BRING MANDATES

But not every State has adopted all the standards necessary to control toxic pollutants. The delays from some States have made their environmental problems worse, which reflects on all of us and keeps us from fully enjoying our successes. EPA is also behind now in promulgating toxic pollutant criteria for those 15 jurisdictions that did not fully comply with the congressional directive. Congress did not envision so much foot-dragging on this issue.

It is unlikely that we will see reauthorization of the Clean Water Act before this Congress adjourns. But as the 103rd Congress takes up reauthorization next year, some members will be absolutely ready to mandate standards, such as those which the Great Lakes Critical Programs Act specifies, along with timetables for State and EPA action. All this year, EPA has been urging Congress not to change a law that is largely working well. But standards are the foundation of the Clean Water Act, and State failures to adopt them weakens our ability to intercede with Congress.

ADVANCING SCIENCE

During this conference, we will examine the future of our water environment, new forms of water quality standards, priorities based on risk assessment, and the continuous striving for the strongest scientific basis possible for criteria and standards.

It is a fascinating agenda. We know that the future of our water environment will depend upon sound science; upon our ability to measure ecosystem effects in the field as well as individual effects in the laboratory. The kind of good science we need is no longer just a scholarly convenience; it has become absolutely necessary to defend sound environmental regulation.

Two years ago this month, EPA's independent Science Advisory Board issued a landmark report calling for more and better data of all kinds, especially relating to human health risks; and better methodologies for assessing and comparing risks.

EPA's Administrator, Bill Reilly, took that recommendation to heart. Just last March, Bill accepted the recommendations of an expert panel to change the way the Agency does research and uses scientific information. One of its principal recommendations is to ensure:

> . . . that all relevant scientific information . . . [including that] from outside the Agency, is brought into the decision-making process. (*Safeguarding the Future: Credible Science, Credible Decisions*, The Expert Panel on the Role of Science at EPA, March 1992)

Another important panel recommendation is that EPA ". . . improve communications with the scientific community . . . ."

Bill Reilly is establishing a team of world-class scientists to advise him and the Agency, and he is setting up a peer-review system. We want to be absolutely certain that the regulations we set are grounded in scientific fact.

Good science fosters good public policy. Think how far our science has brought us! Original basic water quality criteria such as dissolved oxygen have become more precise, and we are able to measure and include many more pollutants in State standards than we could even a few years ago. We can now recognize differences in water chemistry and the adaptability of aquatic life, and develop criteria to apply to a specific site. State water quality standards programs have been completely restructured, and some are already making extensive use of biological criteria.

CRITERIA MEASURE VALUE

The wider focus on ecosystem approaches and biological criteria is useful because problems in natural ecosystems often serve as early warning signs of problems. When humble species like cave crayfish and microscopic water animals begin to suffer, we know the environment is suffering, too. We know that a damaged environment leads to human health problems. We know also that a healthy environment is essential to long-term economic growth. Wild plants and animals have proven their economic value as sources of food and medicine, and as sources of valuable domesticated species. Healthy wetlands prevent floods and treat water pollution efficiently and with little or no cost. The list of benefits goes on and on.

Understanding the need for healthy ecosystems, the report of the Science Advisory Board identified two of the highest environmental risks as:

- Habitat alteration and destruction, and
- Species extinction and loss of biological diversity.

To address these issues, EPA has set priorities for the development of wildlife criteria, biological criteria, and sedimentary toxics criteria.

Wildlife Criteria

EPA's authority to develop and set wildlife criteria is contained in section 304(a) of the Clean Water Act. But because we lacked data, we have delayed in setting those criteria. Some of the Earth's finest creatures have paid the price of that delay. The Florida panther is endangered--threatened not only by shrinking habitat, but by mercury contamination in the food chain. In the Great Lakes, species including bald eagles, cormorants, and other shore birds carry PCBs and other toxic pollutants which interfere with their reproduction.

Instead of waiting for wildlife to become sick or die, EPA wants to provide States with the tools they need to evaluate water with wildlife health in mind. We want to determine the extent of the problem. We are developing a national methodology that will:

- Accommodate site-specific situations identifying chemicals of concern and species at risk;

- Identify and evaluate the best, most scientifically sound methods for developing wildlife criteria; and

- Incorporate proven criteria into our regulations.

But we don't want this to be a top-down effort. We want to work in all phases as partners with scientists, the Department of the Interior, and States.

This past April, just such a group of partners convened in Charlottesville, Virginia, for a national meeting on wildlife criteria. One approach the group discussed is the one taken in the Great Lakes Water Quality Initiative. The findings of the conference will be published later this year.

EPA and its partners are developing a database of all available mammalian, avian, reptilian, and amphibian data to help us develop sound, inclusive wildlife methodologies and criteria. The database, called Wildlife Assessment for Residues and Toxicity--WART for short--will be incorporated into the Agency's database of ecotoxicological information, or ECOTOX, and will be available to all States and territories.

We hope that States will see these efforts as a foundation on which they can build strong programs to protect wildlife from toxic pollutants.

Biological Criteria

Biological criteria present an even more difficult challenge, but they are a tantalizing goal. More than anything else, biological criteria will make it possible to directly measure the health of the ecosystem by measuring the structure and functions of aquatic communities. Since resident plants and animals continually monitor environmental quality, they can help detect spills, dumping, treatment plant malfunctions, and nonpoint source pollution, which may not be happening when we take samples. They can also help us measure sedimentation from stormwater runoff, and habitat alterations from dredging, filling, or channelization. Biological criteria will make possible more holistic, integrated, and complete evaluations of water quality.

States are eager to integrate biological assessments and criteria into water quality management programs. More than 20 States use some form of standardized biological assessments in their waters now. Several States, including Ohio, Florida, Maine, and North Carolina, use biological criteria in establishing aquatic life use classifications and in enforcing water quality standards. These States have an eye on the future.

But biological assessments cannot forecast problems, and they require difficult measurement and careful data interpretation. Biological criteria may never supplant chemical and toxicological methods, but they will complement other surface water quality criteria.

Sedimientary Criteria

Even where water column levels meet criteria, toxic sediments in lakes, rivers, wetlands, and coastal waters keep alive the potential for continued environmental degradation. Studies show us that human health, aquatic life, and even wildlife are at risk from toxic sediments. Field studies find that contaminants leaching from sediments over time can produce fish tumors and fin rot, and diseases which can wipe out entire aquatic communities. As you know, several States have closed water supplies and have put up seafood warnings and swimming bans where sediments have become contaminated.

In some places where waterfowl eat fish contaminated by toxics from sediments, the waterfowl have problems breeding, and their young do not develop properly. People who hunt ducks in parts of Wisconsin are warned by the State not to eat them because the ducks consume food contaminated by Great Lakes sediments. That's a danger signal to us, like a dying canary in a coal mine. We need sediment quality criteria to assess contamination and to stop it.

Various Federal agencies work with contaminated sediments, so we're working on a combination solution, likely a tiered approach that would require more testing at increasing contaminant thresholds or when toxics show synergistic, antagonistic, or additive effects. We have already held one workshop, including our partners from States, other agencies, environmental groups, industry, EPA Laboratory, the Science Advisory Board, contractors, and university scientists. They have identified a model that may meet all of our needs. Later this year, we expect to issue for public comment a criteria development methodology for endrin, phenanthrene, fluoranthene, acenaphthene, and dieldrin. Next year, we intend to present to the Science Advisory Board a methodology for developing sediment criteria for metal contaminants.

HOLISTIC MANAGEMENT AND WHOLE EFFLUENT TOXICITY

Two words--complementary and holistic--point the way to our water quality standards future. We see that we cannot control water pollution with chemicals alone. Studies from the Ohio State EPA show that the chemical approach for protecting aquatic life failed in more than a third (36 percent) of their (431) sites. We must do better than that. To do better, we need complementary, holistic tools, which we find in Whole Effluent Toxicity testing. These tests allow us to measure the total toxic effect of an effluent through a biological test, without identifying specific toxicants. It is the best way we have found to replicate the actual environmental exposure of aquatic life to effluent toxicants. One EPA study shows that 89 percent of the Whole Effluent Toxicity tests accurately predict toxicity effects. An independent analysis of several studies parallels our findings, showing 90 percent accuracy in these tests.

Those are the kinds of results we need at a time when advancing science and economic development keep moving environmental quality goal posts farther and farther away. As we ask citizens to spend their tax dollars on increasingly complicated and expensive control measures, we are responsible for ensuring that they are buying the best, most comprehensive, and cost-effective safeguards possible. We must see that their money is spent on the highest risks first.

EPA's Science Advisory Board has called on the Agency and the Nation to do a better job of setting environmental risk priorities. The SAB report says:

> . . . there are heavy costs involved if society fails to set environmental priorities based on risk. If finite resources are expended on lower priority problems at the expense of high priority risks, then society will face needlessly high risk.

EPA recognizes that we must provide more guidance to States and other Federal agencies on high-priority risks, and we are working to do that.

CONCLUSION

It always seems to come back to risk here in Glitter City. We all want to minimize it and not end up feeling like poor Petronius did. We in this room have a duty to minimize risk on behalf of the Americans who trust us. Working together, using good science, we can stack the deck in their favor. Playwright Damon Runyan once said:

> It may be that the race is not always to the swift nor the battle to the strong--but that's the way to bet. (Damon Runyan, quoted in *Friendly Advice*, by Jon Winokur)

In the race to improve environmental quality using sound science and effective controls, EPA is betting on you.

Thank you.

Life After Toxics: What Direction Now?

LIFE AFTER TOXICS: WHAT DIRECTION NOW? NATIONAL CONSISTENCY VS. GEOGRAPHIC FLEXIBILITY & THE ROLE OF RISK IN PRIORITY SETTING

William R. Diamond (Moderator)
Director
Standards & Applied Science Division
U.S. Environmental Protection Agency
Washington, D.C.

The first two speakers described the purpose of this Conference in terms of debating the future direction, priorities and pressing issues of the water quality standards program. This initial session focuses on two cross-cutting issues that are central to that debate:

1. What approach should be taken to water quality criteria development and water quality standards State adoption and Federal approval--
   - Emphasizing national consistency, or
   - Maximizing geographic flexibility?
2. What is the appropriate role of risk in priority setting?

The provisions of the Clean Water Act strike a balance between some degree of national consistency (i.e., national water quality criteria guidance under section 304; national policies and regulations; and EPA oversight, review, and approval of States standards) and permissible flexibility to adapt national guidance to local circumstances (i.e., State primacy, and site-specific criteria). This approach worked well for the initial development and adoption of simple water quality criteria and standards. However, recently a number of events have brought this balance under scrutiny, and there have been calls to alter this fundamental Clean Water Act principle. These events include the following:

- As States have adopted water quality standards for toxic pollutants, some have questioned the disparity among States in the risk levels and exposure assumptions relative to protection of human health. They have argued that at a minimum there should be consistency among the States in human health risk levels.

- Others assert that advances in science allow more accurate tailoring of standards to local and regional conditions. They claim it runs counter to good science to establish nationally consistent water quality standards that are more stringent (and more expensive) than is necessary to protect the ecology.

- Some congressional actions, such as the Great Lakes Critical Programs Act, indicate a preference for greater consistency in water quality standards and implementation practices across States and water bodies.

- Some recent EPA actions, such as the Watershed Initiative, are moving the Agency toward a water body focus and greater flexibility for criteria and standards.

- Major bills pending for Clean Water Act reauthorization (e.g., Senate 1081) include provisions that move strongly in the direction of uniformity in water quality criteria and standards. Proponents assert such provisions assure greater equity among dischargers in different States and speed the cleanup of distressed waters by avoiding the long delays that have become the norm in State adoption of water quality standards.

- Actions to address concerns about "environmental equity" could take the form of either greater national consistency (setting criteria and standards to protect highly exposed populations through stringent assumptions on risk levels and consumption parameters) or increased use of site-specific standards (based on local information on consumption patterns and highly exposed subpopulations).

The CWA has traditionally included broad program mandates that leave EPA with flexibility to decide the specifics of implementation. However, the trend of recent amendments has been toward greater statutory specificity. This limits the ability to set priorities based upon risk at a time when there is increased ability to set risk-based priorities and more calls to rely on risk-based decision-making.

These issues raise several questions for the future of the program. The fundamental ones are obvious:

- Should the water quality program be geared to greater national consistency or increased geographical flexibility and tailoring?

- Does the answer vary depending on the type of criteria (chemical-specific numeric vs. biological vs. whole effluent vs. wildlife)?

- Should a distinction be made between standards to protect human health vs. ecological standards?

- What should be the role of risk in setting program priorities? Are risk assessment and risk management sufficiently developed to rely upon for this type of decision-making?

- Is a statutory change necessary or desirable to address these issues? If so, what form should it take?

- Are sufficient data available to decide these issues at this time?

Related issues can also influence decisions on this subject:

- Are these issues impacted if there is a requirement to move aggressively toward the Clean Water Act goal of zero discharge?

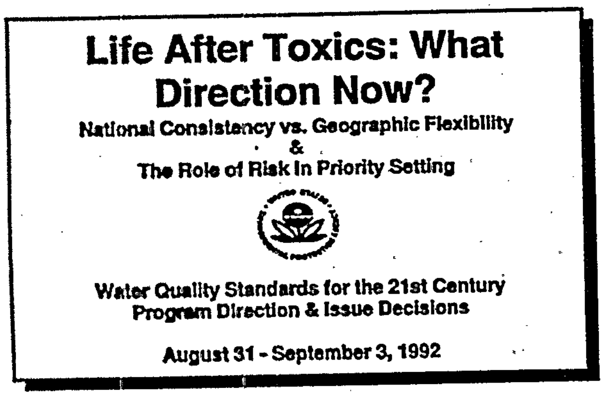
- Should EPA alter its allocation of scientific and research resources away from development of methodologies and criteria documents and toward assistance at the local level to speed tailoring of criteria and implementation?

- Given the relative success of the Clean Water Act programs, should we tamper with provisions that are at the core of the statute?

These issues require close examination and lengthy debate much more than can be accomplished in the short time allowed us in this session. However, today's presentations will enhance that debate by presenting the perspectives of three speakers with strong experience and diverse backgrounds in this area. Each has recently given these issues extensive consideration through a variety of activities or forums.

Slide Presentation

Slide 1



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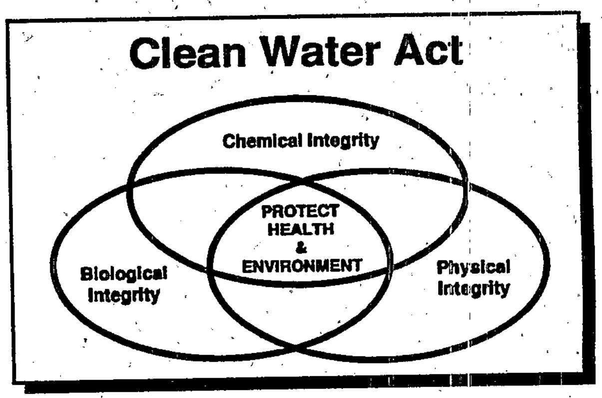

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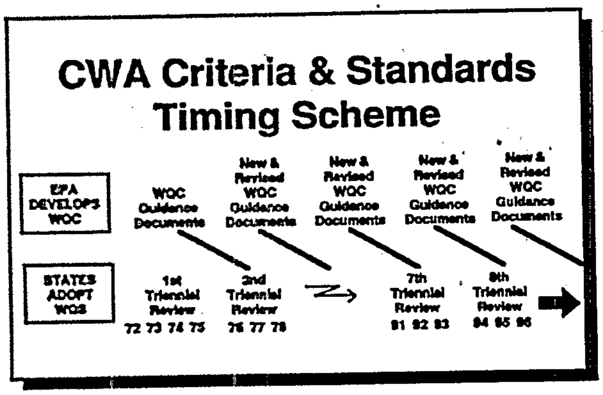

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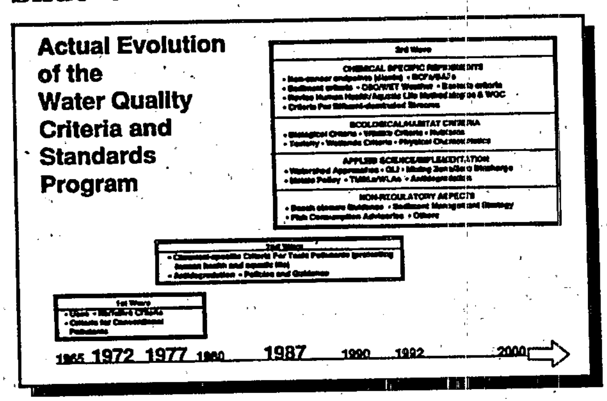

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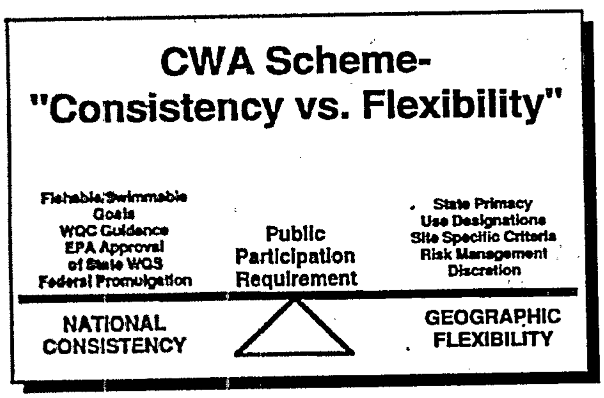

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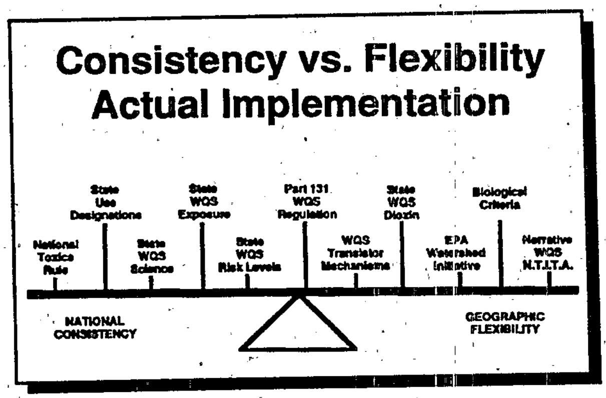

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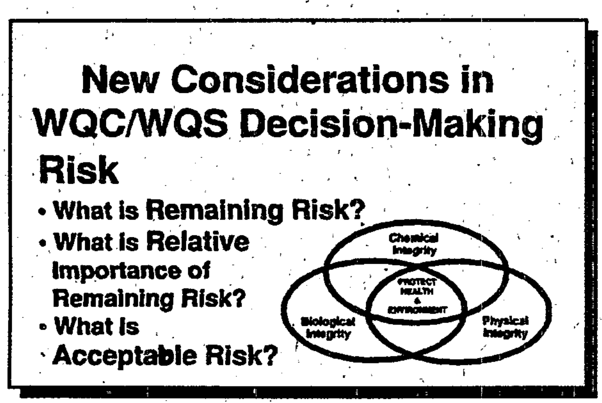

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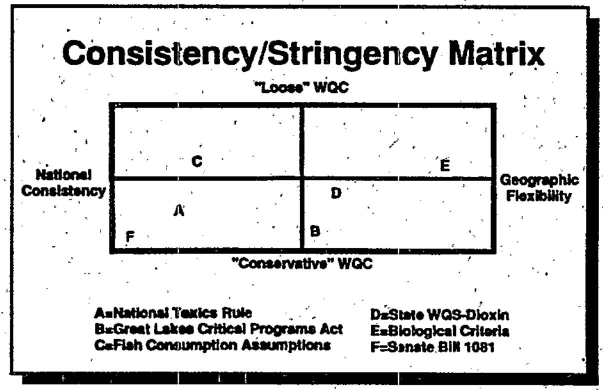

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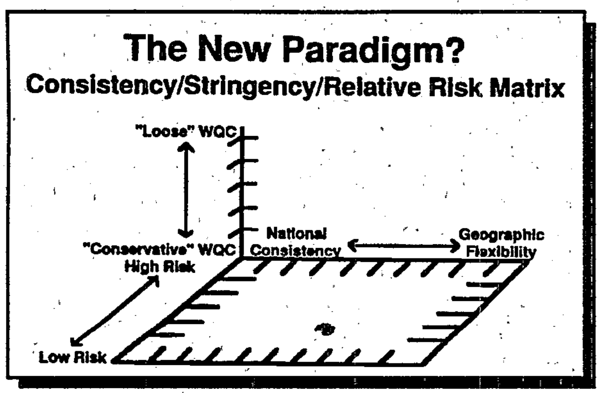

A STATE VIEW ON THE NEED FOR NATIONAL CONSISTENCY: DISCUSSION PAPER

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The purpose of this paper is to bring up for discussion issues resulting from a lack of consistency in EPA-approved water quality standards among States and territories, and to suggest alternatives for consideration.

Many of the waters in the United States cross State boundaries or are, in fact, the borders between States. When there is no national consistency on standards, it presents several problems.

In Arkansas, a lawsuit was filed by a downriver State, Oklahoma, which felt "its" water quality standards weren't being met because of dischargers upriver in another State operating under a different water quality standard (See *Arkansas* v. *Oklahoma* article attached.) The Supreme Court held that EPA has the authority to require that point sources in upstream States not cause violation of water quality standards in downstream States. The Court declined, however, to decide whether the Clean Water Act required EPA to do so. The unfortunate point here is that one State has to sue another State, or EPA, expending resources, and straining relationships in an attempt to attain approved water quality standards. The standards in Oklahoma and Arkansas are both approved by EPA.

In many States, the environmental community holds up as "good" programs that have stringent numeric standards, using those "good" States as examples to pressure other States to follow suit. Industry, on the other hand, uses the States that are "reasonable" as examples to pressure other States that have tighter standards and are therefore considered "unreasonable." They cite the need for a level playing field and "good" science. States are constantly played off one against the other. The weapon of inconsistency extends to legal actions and formal testimony in both administrative and court cases initiated by both industry and environmental groups. States end up being the playing field upon which this battle is fought.

Of the States and territories, 42 have adopted numeric standards for toxics and 15 have not. EPA's statutory deadline to adopt these criteria for States not having standards is long past, and no one knows when the final rules will be issued. This adds to the problems of inconsistency. By reporting the status of the quality of water under section 305(b) of the Clean Water Act, States with standards are disadvantaged. EPA and the media are quick to point out where water in one State doesn't meet standards compared to all other States, including those which don't have numeric limits.

States devote a great deal of money and usually a good deal of stressful effort, State by State, to develop and review scientific and technical information and adopt standards. Then they are increasingly put in the position of legally or legislatively defending those standards, State by State.

SUPREME COURT REACHES DECISION IN *ARKANSAS* V *OKLAHOMA*

On February 28, 1992, the Supreme Court unanimously ruled in EPA's favor in *Arkansas* v. *Oklahoma*, a case challenging EPA's issuance of an NPDES permit to a publicly owned treatment plant in Fayetteville, Arkansas, for a discharge into a river flowing into Oklahoma. In an opinion emphasizing EPA's discretion, Justice Stevens held that the Clean Water Act clearly authorized EPA to require that point sources in upstream States not violate water quality standards in downstream States, and that EPA's interpretation of those standards governed. The opinion also held that the Act did not mandate a categorical ban on discharges to a water body that is in violation of standards.

The Court declined to decide the question of whether the Act itself mandates EPA, in drafting and issuing a permit to a point source in one State, to apply the water quality standards of downstream States. The Court found the EPA clearly had the statutory authority to do so, and that its regulations imposing such requirements constitute a reasonable exercise of the Agency's statutory authority. State water quality standards approved by EPA are part of the Federal law of water pollution control, and EPA's reasonable, consistently held interpretation of those standards is entitled to substantial deference.

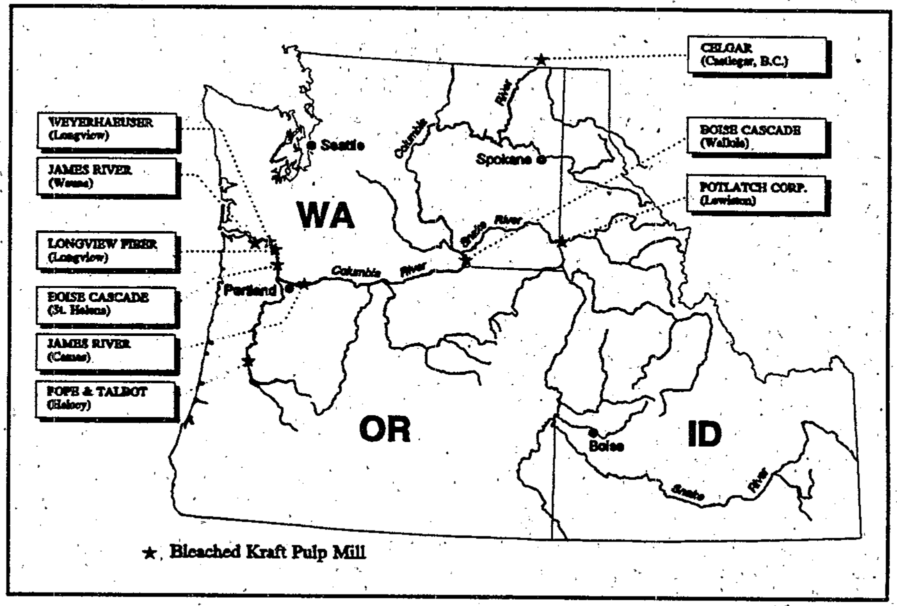
Additional details are available for the Office of General Counsel in Washington, D.C. 20460, Catherine Winer, and also through the EPA regional offices, particularly the Office of Regional Counsels.

In Oregon, we have a numeric instream water quality standard for dioxin (2,3,7,8-TCDD). The States that share with Oregon the Columbia River (see map) are Washington, which has a narrative standard on toxics; and Idaho (a non-delegated State) which operates under EPA criteria. Each has bleached kraft pulp mills discharging to the Columbia River or one of its major tributaries.

The quantity of dioxin being discharged into the Columbia caused it to be listed in both Oregon and Washington as not meeting water quality standards. Oregon and Washington asked EPA to develop a TMDL (Total Maximum Daily Load) for the Columbia River for dioxin, which EPA did.

Washington was subsequently sued when it placed waste load allocation numbers in pulp mill permits based on this TMDL and lost the appeal because it did not have a numeric standard on which to base its permits. Washington, in an attempt to settle the lawsuit, might agree to a discharge compliance number which in Oregon's view will neither meet the requirements of the TMDL nor allow the Columbia River to meet Oregon's water quality standards for dioxin.

What should Oregon do? We don't know. Will EPA require Washington to adopt a numeric limit for toxics? We don't know. What if Washington adopts a less stringent standard for dioxin in the near future? Will EPA approve it? Probably. The Agency has approved a variety of dioxin standards across the country ranging from 0.013 ppq to 1.2 ppq. Then what will Oregon do about the Columbia River? Will we be put in the position of jeopardizing our excellent working relationship with the State of Washington over the issue. Will we be put in the position of suing EPA?



The lack of consistency by EPA in either requiring that standards be adopted, or in approving State standards at different levels, is causing major public policy problems.

Industries are not treated equally across the United States, and this is a valid concern on the part of business. Individual citizens perceive that they are not protected at the same risk level from State to State.

WHAT IS THE SOLUTION?

Standards could be developed on a regional basis, proving consistency on regional waters. Unless a formal regional or interstate water pollution control authority is formed, the burden of coordinating such an approach would invariably fall to EPA. It isn't likely, with EPA's present staffing levels, that they should embrace such an effort. Standards might be developed under this scheme which achieve the lowest common denominator in order to reach consensus. Since most of the major rivers in the continental United States cross State boundaries, this approach could leave very little to each individual State's discretion.

Another approach might be to develop some mechanism (a trigger) that would cause a coordinated standards development effort to occur. For example, when a river exceeds the water quality standard of one of the States on an interstate water body, it could trigger a coordinate effort to establish a uniform standard for that river or river basin. This would mean that coordinated efforts wouldn't occur until waters didn't meet standard, contrary to a preference for preventing water from exceeding standards. It would have the benefit of limiting such efforts to areas where they were really necessary.

Uniform standards could be developed and adopted at the national level. This solution gives States great pause. First, EPA timelines to meet statutory goals often lag far behind expectations. States could wait a long while to see new or revised standards developed. Second, the amount of weight given to States' technical or scientific concerns might be insufficient in developing standards. On the other hand, this solution would offer a reduction in conflict between States on interstate waters. It would also move the debate between States, industries, environmental groups, and the EPA to the national level. This would result in the debate being resolved once, uniformly, rather than 57 times inconsistently. It would also relieve pressure from State agencies who frequently face State legislatures asking questions about whether standards are more stringent than elsewhere in the country or more stringent than the EPA would require. It would provide a level playing field for industry across the country.

Although none of the alternatives offered is completely palatable, maintaining the current status will become increasingly difficult and litigious. States should take a serious look at uniform national standards being developed by EPA.

LIFE AFTER TOXICS: WHAT DIRECTION NOW?

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INTRODUCTION

I appreciate having the opportunity to be with you today. Our topic covers national consistency versus geographical flexibility and the role of risk in priority setting. My comments will address these two topic areas as they are impacted by policy on toxicity, biological monitoring, and watershed management. In this context, I'll also share some ideas on pollution prevention, nonpoint pollution, and CSOs.

MANAGEMENT OF TOXIC POLLUTION

I think that the legislative/regulatory train has been chugging down a conceptual track that may benefit from some rethought and redirection. The current conceptual track goes something like this: *For eons plant and animal life existed in a natural dynamic balance with the forces of nature, such as nutrients, moisture, sunlight, oxygen, grazing and predation. Then, man's ingenuity produced industrial activities which have created a new deadly factor--toxicity. By controlling the impact of industry, which is insinuated throughout human activity, we can bring toxicity under control.*

It is understandable that this concept would find acceptance, given the long history of man's accidentally generated poisons, including lead and mercury, and the 20th century advances in the development of poisonous organic chemicals.

What's wrong with the concept? Well, it seems that as we have developed more and more precise toxicity tests aimed at identifying the concentration at which toxic effects can be discerned in the most sensitive organism, we are discovering that toxicity is everywhere. Samples of natural earth can't pass the leachate toxicity tests. Pristine water samples don't comply with EPAs toxicity criteria. There are two possible explanations. First, maybe the toxicity testing protocols need some improvement. Second, maybe our original conceptual model, based on industrial toxins, needs some rethinking. I think both explanations are true.

I'm beginning to think we left something out of the list of natural forces that control the balance of nature--namely, geologically and biologically produced toxins. On the strength of what we are now learning, some people are concluding that one species' micronutrient is another species' toxic metal. Plants and plant eaters, bacteria and molds, predators and prey, and plants and animals competing for an ecological niche of their own have evolved the production and use of organic toxins that provide them with competitive advantages. Similarly, organisms have evolved mechanisms to resist both biologically and geologically produced toxins. Under this new understanding, the dream of a toxics-free environment begins to look quite naive.

Without belaboring this point, I suspect that when our understanding of the ecology of toxins is clearer, we will begin to look at water quality objectives somewhat differently. Chemical-specific criteria should diminish in importance, to be replaced by an increased emphasis on ecological and human health criteria. Of course, we will have to control real and measurable toxicity to indigenous species introduced into the natural receiving water as a result of human activity. We need to adjust our thinking, however, when we apply imputed effects to the most sensitive, often non-native, species caused by toxins that may be in nonrepresentative chemical states.

Ideally, the water environment management objective should be the establishment of a healthy, balanced ecosystem. The abundance, balance, and diversity of indigenous species should be our goal. Measurements of and criteria for instream toxicity, eutrophication, toxic tissue burden, and reproductive success might be examples of more suitable criteria that need to be developed. It is obviously not a simple task. When developed, these ecological criteria could, perhaps, be applied nationally. In addition to these ecological objectives, the health effects on people who may be exposed to the natural food web would be the basis of our regulatory approach. To do this correctly, we also need to improve the approach we use to estimate small risks to human populations. Such an approach would appear to provide a better fit with the national goal of swimmable and fishable waters.

It is often exceedingly difficult to have newer, better knowledge reflected in changed regulations. In a way bound to make any seeker of the most intelligent solution shudder, some would use the ill-advised language of the anti-backsliding clause to prevent future permit requirements from reflecting improved knowledge. Nevertheless, if we are able to change in response to new information on this subject, I expect that we will someday look on our 1992 understanding of toxicity and current regulatory approach as a good, but very primitive beginning.

BIOLOGICAL MONITORING

I think that the role for biomonitoring as a water quality management tool should grow. I think that biological indicators should play a primary role, both in measuring receiving water quality and in predicting the effect of contaminant discharges. The biggest obstacle to having this happen is complacency with the current state of the tests. They are just not good enough.

The Whole-Effluent Toxicity Test is represented as a regulatory safety net, catching the subtle effects of synergism and antagonism among contaminants and, thus, acting as a better predictor of the discharge's effect on the receiving water biota. For this to be true, local species should be used. For purposes of compliance monitoring, we will have to continue to use synthetic dilution water. But for overall watershed planning and management, it would be good to see protocols developed to determine the toxic effects of effluents blended with receiving water.

The statistical procedures need to be improved to weed out erratic results due to inter- and intra-test variability (including species variability), and by doing so, to give a higher level of confidence in the results. The PQL Methodology can be adapted from chemical analysis to assure a 90 percent or 95 percent confidence to the results.

Furthermore, we need better ways to learn what the lethal pollutant was that caused the measured effect in the test organisms. The very expensive TRE/TIE can be helpful, but often serves as no more than an educated guess. I'd like to see EPA fund a study to produce a table of predictable histological effects that result from exposure to the 10 or 12 most probable toxins. If we were trying to figure out what poison killed a person, we wouldn't use a TIE procedure. We would look at muscle/reflex reaction, skin or eye color, or other presumptive indicators, which would be confirmed by autopsy. Often, by the time you realize you have a toxic effect, the effluent and the sample have changed. The only thing you can turn to is an affected test organism.

WATERSHED WATER QUALITY MANAGEMENT

The Federation has been encouraging our Federal legislators to require that future water quality standards be determined through detailed watershed-specific plans, and that local citizens have a say in setting priorities. At this point our feeling is that the legislators and their staffs, as a whole, are unconvinced. The specter of a hodgepodge of standards and the possible loss of control of the standard-setting process are understandably unsettling.

I think that their concerns are not well founded. We have actually had watershed water quality management for years. There already is a hodgepodge of requirements for nutrient removal across the United States. Through decentralization and distribution of authority, the system works. As to the loss of control, welcome to the democratic process. EPA is getting good experience in managing public processes in their Bays and Estuaries program. At least in California (Region 9), they have done a respectable job. EPA and the States have got to retain final authority. What we are asking for is not local control, but local involvement in deciding which local water quality problems to tackle first and how much can be done in the near term. These same legislators, who are not so sure the public should be brought in to water environment priority setting, blessed us all with public involvement through NEPA and its State-level analogues. These laws did not create public participation--they just democratized it, providing the opportunity for influencing public policy to the average citizen--not just the rich and powerful. This has, of course, made NIMBY control a major element of modern public works management. But, at least, after the public has their say, there is a greater understanding when the bills have to be paid.

POLLUTION PREVENTION

Like just about everyone I know, I am a strong supporter of pollution prevention. We have applied this approach to many substances from DDT to asbestos to mercury and lead over the past two decades, and we need to extend it more broadly.

My principal concern with the current rhetoric on pollution prevention is that I sense that many believe we can achieve full control of toxins through pollution prevention. I believe that this is unrealistic. There will be very few substances that we can ban across the board, as we did with DDT in 1972. Yet, we are still seeing DDT/DDE concentrations in the water environment, comparable to levels which were detected in the late 1970s. We are seeing some real improvement in copper and lead resulting from water system corrosion control. However, as long as copper, zinc, cadmium, and lead remain in plumbing systems, elevated levels of these metals will continue to be found in treatment plant influents. Several so-called toxic metals are valued as minerals in the food we eat. Where do you think that stuff ends up?

The plant effluent concentrations may not actually be toxic to indigenous species in the receiving water, but chances are that the EPA chemical-specific criteria will not be met by a great many dischargers.

This is where our current optimism over pollution prevention can be a problem. If the chemical-specific criteria remain unchanged, even with the maximum practical level of pollution prevention, we will be confronted with increased treatment requirements. I have seen little evidence of affordable treatment technology, specifically aimed at toxics removal, being developed.

TOXICS TREATMENT

When we consider processes for the removal of trace metals, we turn to reverse osmosis and lime precipitation, both of which must be questioned because of their resource demands and residuals disposal problems.

We have to remember that toxics are toxic because of their biological reactivity. I would like to see researchers investigate biological processes for the removal of toxins, preferably by process improvements in existing plants. Biological processes already remove substantial amounts of toxins. What will it take to remove more?

Of course, jacking up the toxics removal performance of existing plants does not touch urban and agricultural runoff, the major sources of toxins in the water environment. Here again, biological processes may be used. But, I'd like to have us find the right way to develop wetlands to ensure that after a couple of decades of accumulating toxics, we haven't created tens or hundreds of thousands of acres of new RCRA sites. By the way, many natural wetlands have been receiving storm runoff for decades. I wonder if anyone has ever done a comprehensive survey of existing urban wetlands to confirm that we are using the right approach.

COMBINED SEWER OVERFLOWS

CSOs are an inextricable part of the watershed management issue. We firmly believe that best professional judgment must be relied upon to develop CSO solutions to meet water quality goals. National technology-based controls are not only guaranteed not to fit all situations, but also will be a gigantic wet blanket to innovation and creativity. Allowing flexibility will permit some mistakes to be made, but mandating a confining national program is likely to force a second best option on a large number of local agencies. Given that the cost of full and immediate CSO control is unaffordable, we should be doing everything possible to help stimulate creative solutions, and we also should be providing compliance time schedules that will soften the economic impact on the public. Perhaps our regulatory people should throw some of their weight behind a program to develop a national infrastructure policy, including a sound funding base. If we do this, and add a training program for unskilled workers, we may have a tool to solve problems such as CSOs and to strengthen our economy at the same time.

A brief aside on nonpoint source contamination--I would be cautious of the data you will be getting on storm and agricultural discharges. I suspect that not enough care has gone into sampling techniques. Take it from one who has been dealing with the problems of getting a representative sample in wastewater for years; it is not easy. In open channel flow, it is best to gather the sample at a point of free fall where the bed load of sediments and the surface accumulation are all mixed into the flow. Simply scooping a sample out of a flowing stream won't give you the right answer.

RECOMMENDATIONS

1. EPA should undertake the development of ecological criteria which can be applied nationally and by which we can establish the biological health of the water environment.

2. EPA should continue improving the methodology for setting human health criteria.

3. Chemical-specific criteria should be recognized for what they are, a surrogate indicator, and should be of value only until reliable ecological criteria are developed. After this occurs, the Gold Book will serve to help solve water quality puzzles but will not serve as a national standard.

4. Eliminate the anti-backsliding language from the Clean Water Act, EPA regulations, and analogous State laws and regulations.

5. Reopen the Biomonitoring Protocols for further improvement.

   - Broaden the number of permitted species, and require that indigenous species be used.

   - Develop protocols for measuring the toxicity in blends of effluent and receiving water.

   - Apply the same statistical concept used in chemical determinations to develop the practical quantitation limits. Set the confidence limits at 90 percent or 95 percent.

   - Develop information on observable symptoms of the toxic effects of a limited number of common effluent toxins in the most common test organisms.

6. The new Clean Water Act should establish a new basis for national water environment standards. Permit requirements should be established by the adoption of watershed plans. These plans, which would be subject to public

involvement, would evaluate specific water quality needs and set priorities for correction.

7. Continue to support the development of treatment technology for toxics, in POTWs and industrial plants, and also for agricultural and urban runoff.

8. Encourage innovation and the use of local discretion in the solution of CSO problems. Maximize the exchange of knowledge between regulators and professionals regarding workable solutions to stimulate further creativity.

9. Review the urban runoff sampling procedures to be sure that the data you are receiving give an accurate picture of the actual water quality impacts.

Biological Measures: Can and Should They Be Implemented?

APPLICATION OF BIOMEASURES TO BASIN WATER QUALITY STUDIES IN OREGON AND IDAHO

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INTRODUCTION

The objective of the Federal Water Pollution Control Act, as amended, is to restore and maintain the chemical, physical, and biological integrity of the Nation's water (Public Law 100-4). Oregon's monitoring efforts and water quality criteria have been, and are presently, centered on the chemical measurement of water quality. An example of the success of this approach is the Willamette River (Gleeson, 1972), where significant improvements have been made in what was once a seriously degraded stream. There is increasing concern, however, that reliance upon conventional pollutant standards alone may not fully protect instream beneficial uses (Karr, 1991; U.S. EPA, 1990).

An integrated approach to beneficial use protection should include biological as well as chemical and physical measurements. Biological measures may be more sensitive to changes in water quality and may provide a more direct indicator of beneficial use protection than conventional parameters. The question is not so much whether to use biological measures, but how best to utilize them.

USE OF BIOMEASURES--CASE STUDIES IN OREGON AND IDAHO

Narrative biocriteria are included in Oregon's water quality standards but are not widely used for enforcement purposes. The principal use of biomeasures in Oregon has been as background information and as supportive evidence of water quality conditions. Biological measurements are also being used as tools to aid in developing pollution control strategies and in monitoring the effectiveness of those strategies.

The following case studies discuss Oregon's use of biological indicators in pollution control efforts on the Grande Ronde River and the Willamette River, and Idaho's plans for the

Upper South Fork of the Salmon River. In all three cases, Total Maximum Daily Loads (TMDLs) are required for the water quality limited streams; the TMDL studies provide the basis for the pollution control strategies.

The Salmon River TMDL provides an example of a phased approach to the use of biocriteria in setting regulatory goals. Oregon is using a similar phased approach to help define water quality management objectives for streams in the State. The phased approach allows goals and criteria to be set and reviewed as information is developed; biological trends can be used as a frame of reference for evaluating biocriteria and determining the effectiveness of Best Management Practices.

Case Study: Grande Ronde River, Oregon

Background: The Grande Ronde River in northeastern Oregon has been identified as water quality limited due to violations of the pH standard resulting from periphyton growth; suspected sources include municipal and industrial discharges. The key problem, however, is a decline in the population of Spring Chinook salmon over the past several decades (Figure 1). Historical returns, or escapement, of Spring Chinook to the upper Grande Ronde River have been variously estimated at greater than 12,200 (Anderson et al., 1992) and at approximately 20,000 (State Water Resources Board, 1960). Spring Chinook salmon adult populations have dropped to an estimated 24 fish in 1991 (Boehne, 1991). This decline has been attributed to passage problems at Columbia and Snake River dams (Anderson et al., 1992); however, habitat and water quality degradation also reduce the fisheries potential of the Grande Ronde.

Although preliminary point source biomonitoring data from the summer of 1992 indicate that point source discharges are degrading water quality in the Grande Ronde, the impacts on fisheries are more directly related to nonpoint source activities. Several agencies have recognized that temperature problems and habitat degradation are critical factors contributing to impacts on beneficial uses: The State Water Resources Board (1960) noted concerns that poor land-use management was degrading the fisheries resource; several agencies have documented severe impairment of water quality due to sedimentation and thermal problems (Anderson et al., 1992); and riparian habitat is in a moderate to severely degraded state throughout the watershed (Oregon Department of Environmental Quality, 1988). In the Grande Ronde, these problems have not been, and likely could not be, resolved using a conventional point-source pollution reduction effort. Nonpoint sources must be addressed to reduce the impacts on fisheries resources.

Efforts to improve water quality and fisheries habitat in the Grande Ronde will affect both public and private lands. A local steering committee has been established and partially funded by the State to coordinate the efforts in the Grande Ronde. Effective coordinating efforts between agencies and cooperative landowners will be important for implementing voluntary compliance efforts.

Current Studies: The U.S. Forest Service and the Oregon Department of Environmental Quality (DEQ), along with several other agencies, are currently involved in water quality monitoring efforts in the Grande Ronde. DEQ's efforts focus on several areas:

- Collecting synoptic data for water chemistry and continuously monitoring for river flow and temperature; the data will be used to support conventional water quality models.
- Conducting intensive diurnal studies on selected reaches to measure *in situ* levels of periphyton production and diurnal changes in pH, dissolved oxygen, temperature, and nutrients.
- Biomonitoring for abundance of periphyton, macroinvertebrates, and fish at selected locations.
- Long-term monitoring of macroinvertebrates and fish at selected locations prior to, during, and after implementation of Best Management Practices (BMPs). Monitored BMPs on private lands are implemented through voluntary efforts partially supported by a grant from EPA.

Strategy: The strategy for the Grande Ronde River Basin TMDL is to integrate information on water quality parameters with indices of biological integrity. Information on the life history of the Spring Chinook, their occurrence in the basin, and their thermal requirements will be used to help establish water quality goals. Methods and strategies for attaining criteria, such as riparian protection or minimum stream flows, will be based upon data developed specifically for the basin. The effectiveness of management strategies will be evaluated using both conventional and biological measures. Ultimately, effectiveness will be determined by the response of the fisheries resource.

Case Study: Willamette River, Oregon

Background: The Willamette River provides an example of significant improvement in water quality resulting from pollution control efforts focused on conventional parameters. However, limited biological data indicate that impacts to beneficial uses may be occurring that are not apparent through monitoring of conventional pollutants.

The Willamette River in western Oregon receives wastewater from a large percentage of the State's population. For nearly half a century, the Willamette River experienced severe oxygen depletion resulting from large loads of organically rich municipal and industrial wastewater (Hines et al., 1977). In 1945, Dimmick and Merryfield noted that pollution had caused decreases in productivity in portions of the river, and tributaries were seriously degraded as measured by fish and invertebrate populations. Since then, the level of oxygen in the mainstem Willamette River has improved--current levels of dissolved oxygen are above 85 percent of saturation. By the 1970s, the Willamette was recognized as the largest river with restored water quality (Huff and Klingeman, 1976).

Although dramatic improvements in water quality in the Willamette River have been achieved through the use of conventional monitoring, biological measurements have shown that water quality degradation is still occurring in the Willamette Basin. Hughes and Gammon (1987) conducted a survey in 1983 to evaluate the effects of improved water quality on longitudinal changes in fish assemblages in the mainstem Willamette River and to evaluate the usefulness of two indices of fish assemblages. The report concluded that there has been marked improvement in fish communities since 1945; fish assemblages showed a gradual and expected decline from the upper to the lower river, with only small changes near major point sources of pollution (Figure 2.1). The analysis noted a decrease in the modified index of biological integrity at two locations (river kilometers 232 and 93), indicating a lower quality biological community. The marked increase in disease and morphological anomalies and the marked decrease in biomass at kilometers 35 and 77 (Figure 2.2) suggested increased levels of sublethal stress (Hughes and Gammon, 1987). A study conducted for DEQ (Curtis et al., 1991) found that indicators of biological stress (EROD and cytochrome P-450 1A1) were strongly induced in fish from the Portland Harbor (river kilometer 11) but not from other locations.

Current Study: Monitoring was initiated in the summer of 1992 for DEQ's current study of the mainstem Willamette River. The study is a multiyear, cooperative effort that will be integrated with an upcoming U.S. Geological Survey (USGS) basin study.

The study calls for data collection to support a conventional water quality model, limited data collection to support a screening model for toxics, and collection of biological and ecological data. Biological monitoring provides a direct measurement of the resources which the pollution control strategies are attempting to protect, and should provide insight as to whether current strategies are working.

The biological monitoring plan incorporates evaluation of several indices of the biological community, including abundance and diversity of periphyton algae; fish-community health (IBI); fish health assessments; invertebrate abundance and diversity; and juvenile-fish skeletal abnormalities at selected locations. In selecting sites, it was assumed that different biological communities would occupy specific areas in the river based on the predominant physical habitat of a given reach, and that the communities would respond to different "stressors," such as pollution sources, within these reaches. A single biomonitoring effort will be conducted coincident with a conventional synoptic survey. Although the data will reflect seasonal and long-term variation, it should provide an overview of the ecological health of the mainstem.

The relative costs of the conventional and biological monitoring efforts for the Willamette mainstem are summarized in Table 1. However, conventional and biological costs may not be directly comparable because they provide different types of information, and each has different advantages:

- Although synoptic data for both biomeasures and conventional parameters can be thought of as "snapshots," biological indicators provide a more integrated picture over time and may be more sensitive.

- Data generated through biological and ecological monitoring are of less certain utility than the conventional pollutant data collected for model calibration, but many of the pollution problems associated with the conventional pollutants have already been addressed.

- The biological data will provide a measure of the effectiveness of existing pollution control strategies which were previously developed using conventional monitoring.

- Biomonitoring data will also provide guidance for directing future efforts in the basin, particularly as programs shift to address toxics and nonpoint source pollution.

Case Study: South Fork of the Salmon River, Idaho

Background: The South Fork of the Salmon River in central Idaho provides an example of the use of biological criteria in the stream recovery (TMDL) process (U.S. EPA, 1992). The TMDL identifies fine sediments as the pollutant of concern and salmonid spawning as the related beneficial use. Highly erodible sediments are washed into the river and its tributaries from nonpoint sources; the sediments have contributed to the degradation of spawning and rearing habitat for Chinook salmon and Steelhead trout, whose numbers have declined in recent years. The TMDL establishes goals, monitoring requirements, and review schedules. Uncertainty in predictions of the effectiveness of nonpoint source controls and biological criteria is addressed through phased implementation.

TMDL Assessment: TMDL provisions and a water quality assessment were developed jointly by the U.S. Forest Service, EPA, and the State of Idaho. With the aid of computer models, it was estimated that 85 percent of the sediment yield from the drainage basin was due to natural causes and 15 percent was due to anthropogenic causes. A goal of 25 percent reduction in the sediment loads from anthropogenic causes was established, along with plans for road reconstruction and related sediment-yield reduction projects.

The effectiveness of the sediment reduction efforts will be monitored by measuring changes in sediment yield, habitat, and spawning activity. A 10-year timeframe has been established to implement controls, evaluate effectiveness, and monitor trends. If Chinook and Steelhead spawning capability does not increase, additional sediment recovery projects will be required and the attainability of the criteria will be reviewed. This phased approach is being used because of the difficulties in addressing nonpoint source pollution problems.

DISCUSSION

As the emphasis of water quality programs shifts from point source control and conventional pollutants toward nonpoint source problems and nonconventional pollutants, the complexity and diversity of dilemmas facing resource managers will grow, along with demands for increased monitoring of nonconventional pollutants. It will be increasingly important that the most effective and efficient methods are used for measuring water quality impacts and protecting resources. As indicated by the Oregon and Idaho case studies, a single approach is not applicable to all pollution problems. It appears, however, that an integrated approach which utilizes both conventional (chemical and physical) and biological measures may prove to be an effective tool for assessing and correcting many water quality problems.

While the inherent degree of uncertainty that exists with biological measures and with the types of assessments in which they are used, such as for toxics and for nonpoint sources, must be recognized, so must their value. Bioindicators and biocriteria can be used: to indicate where changes in water quality are occurring that might not be evident from conventional measurements alone; to evaluate the combined effects of numerous chemical and physical pollutants over time; to directly monitor impacts on beneficial uses; as a reference for establishing objectives; and as a reference for evaluating the effectiveness of pollution control strategies and compliance with resource management objectives. A phased implementation that allows both the objectives and management strategies to be evaluated as new information is generated is a particularly useful approach for application of biocriteria in a regulatory setting.

Additional research is warranted for a better understanding of biological measures. Equally important is the need to link biological measures to resource management strategies and to the protection of beneficial uses. The coordinated efforts of the various Federal and State agencies, particularly the land-use management agencies such as the Forest Service and the Bureau of Land Management, will be necessary for establishing and achieving biological criteria.

CONCLUSION

In conclusion, additional research on the use of biological indicators should be a high priority for both State and Federal agencies. In conjunction with conventional pollutant measurements, the use of bioindicators should provide a useful tool for protecting beneficial uses. Oregon plans to continue to integrate the use of bioindicators and biocriteria into its established program for water quality protection.

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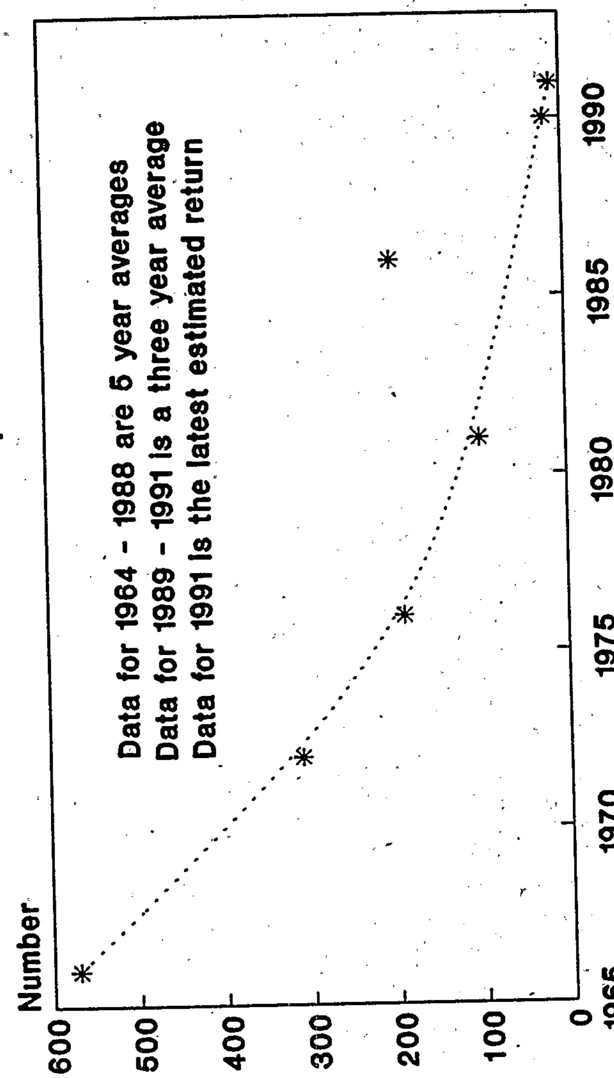
Table 1. Estimated Monitoring Costs for Data Collection and Laboratory Analysis: Willamette River Synoptic Surveys, 1992

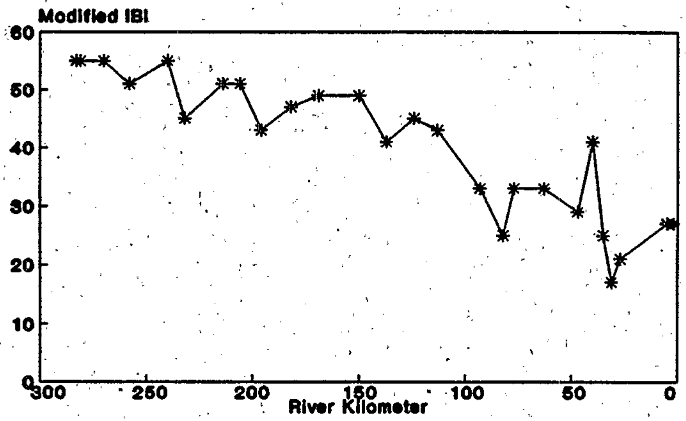
Monitoring Category	#	Cost	Data Type
CONVENTIONAL QUALITY AND LOADS			
Ambient--Consultants	14	$38,000	Grab with selected diurnal parameters (DO, temperature, pH)
Ambient--DEQ	10	$ 3,000	Grab
Point Source--Local	10	$10,000	Multiple grab samples throughout diurnal sampling period
Total: $51,000			Synoptic data set for conventional water quality model
BIOLOGICAL MEASURES			
Invertebrates	33	$46,500	Kick-net and sediment samples keyed to lowest practical taxonomic level (DEQ, 1992)
Fish Community	19		Electroshocking, identified to species, length-weight, and external anomalies.
Fish Health	7		External anomalies, internal organs, and blood samples (Goede 1988)
Skeletal Abnormalities (Bengtsson 1988)	4		Seining to capture juveniles, fixed and stained, observations made on skeletal condition
Periphyton Abundance/Diversity	46	$8,000	Abundance and diversity as keyed to lowest practical taxonomic level
Periphyton Productivity	8		In-situ and laboratory respirometer used to determine dissolved oxygen production
Total: $54,500			Synoptic data set describing community health

Figure 1
Spring Chinook Escapement
Upper Grande Ronde River, OR.



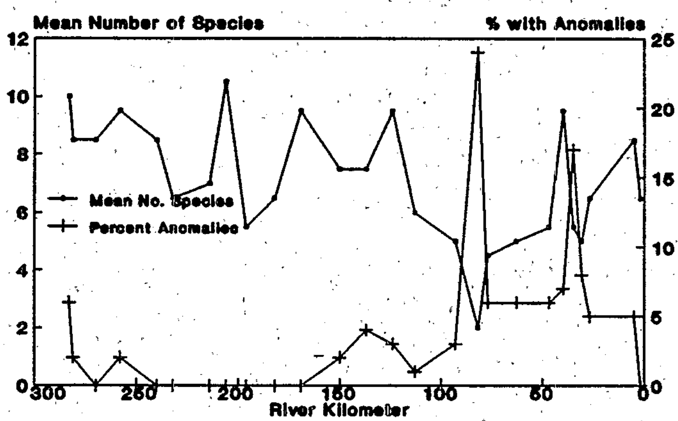
Sources:
ODFW In Anderson et. al. 1992
Boehne (1992) Pers. Comm.

Figure 2.1
Quality of Willamette Fish Assemblages
Modification of Karr's IBI



In Hughes and Gammon (1987)

Figure 2.2
Quality of Willamette Fish Assemblages
Mean No. Species and % with Anomalies



In Hughes and Gammon (1987)

CONCERNS FROM THE PERSPECTIVE OF THE REGULATED COMMUNITY

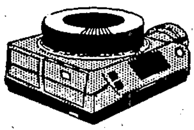
Warren C. Harper
U.S. Department of Agriculture
Forest Service
Washington, D.C.

Measurements of biological parameters hold some promise for evaluating the effects of various land management activities on water quality and identified beneficial uses of water. It cannot be assumed, however, that such measurements will provide all the answers necessary for development of effective land management programs, or the information necessary for an enforceable control program needed by regulatory agencies. In developing management programs to reduce sediment production from land management practices, it is important to consider changes in the physical characteristics of stream channels and stream systems. Such measurements are practical as a field-applied technology, will provide information relative to changes over temporal and spatial scales, and can assist in cumulative effect analyses.

SLIDE PRESENTATION

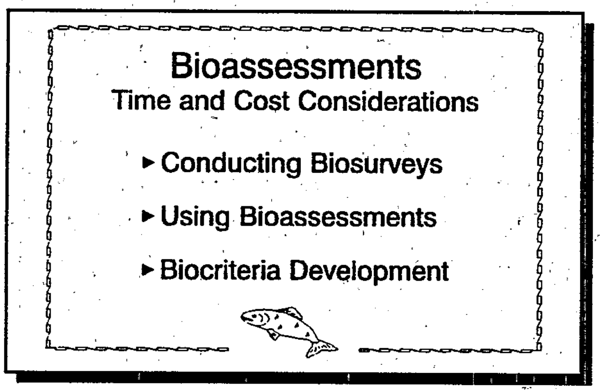
Evan Hornig
U.S. Environmental Protection Agency
Region 6
Dallas, Texas

In lieu of a paper, the slide presentation is as follows:

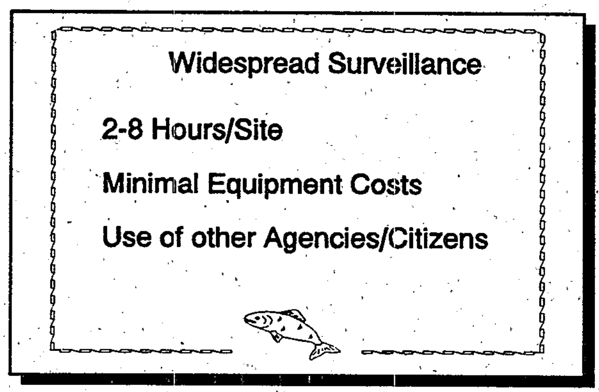


Slide Presentation

Slide 1



Slide 2



Slide 3

State Ambient Network*

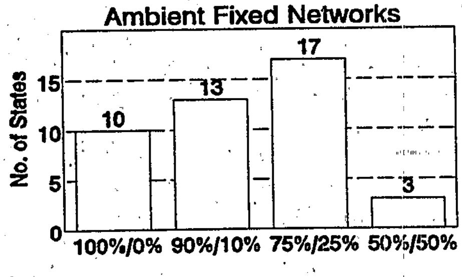
	Chemistry	Biology
No. Sites/yr	22	100
Cost/Site	$3000	$840
Total Cost	$66,000	$84,000

*Approximate costs estimated from Nebraska resources

Slide 4

Distribution of State Resources

Ambient Fixed Networks



1988 Survey of 43 States

Slide 5

Site Specific Costs

	Chemistry	Toxicity	Biosurvey
Cost/Site Visit	1000-2000	1000-2000	1500-3000
Frequency/yr	4	4	2
Cost/Year	4000-12000	4000-12000	3000-6000

Slide 6

Biocriteria Implementation

Tasks Involved

Reference Site Selection

Collection of Data

Metric Development

Slide 7

Biocriteria Implementation

Resources Needed

3 - 5 years

$50,000 - 100,000 / year

Slide 8

Acquiring Resources

- Restructure Monitoring Programs
- Obtain State/EPA Management Commitment
  - Demonstrate Use of Biosurvey Data
  - EPA Provide Regulatory/Policy Support
  - States Adopt Narrative Biocriteria
- Coordinate Reference Database with Neighboring States; Region/ORD support

CSOs/Wet Weather: Are Today's WQC Relevant?

CSOs/WET WEATHER: ARE TODAY'S WQC RELEVANT?

Richard Kuhlman (Moderator)
U.S. Environmental Protection Agency
Office of Wastewater Enforcement and Compliance
Washington, D.C.

BACKGROUND

Approximately 1,200 combined sewer systems in the United States serve a population of 43 million. Almost 85 percent of the systems are located in 11 States in the Northeast and Great Lakes (Maine, Massachusetts, Vermont, New Jersey, New York, Pennsylvania, West Virginia, Illinois, Indiana, Michigan, and Ohio). Such systems are prevalent in smaller communities--approximately 62 percent of combined sewer systems serve 10,000 people or fewer. Only 7 percent of the systems serve populations greater than 100,000, but these systems account for 70 percent of the people served by combined sewers.

Combined sewer overflows (CSOs) consist of untreated mixtures of sanitary sewage, industrial wastewater, and stormwater runoff. CSO discharges may contain high levels of suspended solids, bacteria, heavy metals, floatables, nutrients, oxygen-demanding organic compounds, oil and grease, and other pollutants. Discharges of these pollutants in high volumes over a short time can cause exceedances of applicable State numeric and narrative water quality standards. Such exceedances may pose risks to human health, threaten aquatic life and their habitat, and impair the use and enjoyment of receiving waters. Stormwater and urban runoff can cause similar problems. In the 1990 National Water Quality Inventory, States identified urban runoff, stormwater runoff, and CSOs as the sources of impairment, where the sources were identified, for 13 percent of the river miles, 31 percent of lake acres, 14 percent of the Great Lakes shore miles, 38 percent of estuarine square miles, and 40 percent of ocean shore miles.

PROGRAM STATUS

On August 10, 1989, EPA issued the National Combined Sewer Overflow Strategy. The strategy reaffirmed that CSOs are point sources subject to National Pollutant Discharge Elimination System (NPDES) permit requirements, including both technology- and water quality-based requirements of the Clean Water Act (CWA). The strategy recommended that all CSOs be identified and categories developed according to their status of compliance with the technology- and water quality-based requirements of the CWA. The strategy requested that States develop a statewide permitting strategy by January 15, 1990, for the development and implementation of measures to reduce pollutant discharges from CSOs.

In August 1991, the Office of Water (OW) initiated an Expedited Plan to accelerate the implementation of the strategy. OW established work groups to:

- Evaluate how States can use their water quality standards development and implementation procedures to prepare permits for CSOs that meet water quality standards (standards-to-permits); and

- Develop permitting and enforcement policies to expedite compliance with the 1989 National Strategy and CWA.

STANDARDS-TO-PERMITS REVIEW

The Office of Science and Technology (OST), in the Office of Water, is leading the effort to examine the appropriateness of the decision factors and assumptions used in the water quality criteria development, water quality standards adoption, waste load allocation, and permitting processes for wet weather discharges. The effort is intended to examine the contention that existing water quality criteria and standards development and implementation processes need to be modified to more accurately reflect the characteristics and environmental concerns of wet weather events. Where presently used assumptions are appropriate for wet weather discharges, their scientific defensibility will be affirmed. Where presently used assumptions are not appropriate, or where additional guidance is needed, recommendations will be made to enhance the applicability of the standards-to-permits processes to wet weather events.

Analysis

We are analyzing the following:

- The relative risks urban wet weather events pose to human health and the environment compared to other discharges to surface waters and the relative risk among categories of urban wet weather events--CSOs, urban runoff, stormwater discharges.

- The characteristics of wet weather discharges that pose the greatest risk to human health and aquatic life, e.g., toxic chemicals, floatables/solids, dissolved oxygen sags, physical flow.

- The chemical, physical, hydrologic, and biological characteristics of wet weather events that affect the assumptions used in the water quality criteria development, water quality standards adoption, total maximum daily load/waste load allocation, and permitting processes.

Some of the decision factors within the standards-to-permit processes under examination include the following:

- Use of fecal coliform, *Escherichia coli*, or enterococci as indicator organisms for criteria;

- Procedure to correlate the bioavailable or toxic portion of a metal to the measurable portion;

- Refinement of uses, designation of seasonal/partial uses;

- Variances for water bodies impacted by CSOs;

- Modeling approaches to determine pollutant loading rates for CSOs;

- The TMDL allocation to point and nonpoint sources;

- Probability bases for permit limits; and

- Compliance schedules.

PERMITTING AND ENFORCEMENT POLICIES

The Office of Wastewater Enforcement and Compliance (OWEC) is coordinating the overall CSO effort, including leading the development of permitting and enforcement policies to expedite compliance with the 1989 National Strategy and the CWA.

Permitting Policy

Current activities in developing the permitting policy include negotiating with representatives from 14 organizations to develop a consensus on how to establish NPDES permit requirements for sewer systems with CSOs.

Negotiated Policy Dialogue Work Group Members include the following:

- Environmental Protection Agency;
- Management Advisory Group;
- CSO Partnership;
- Association of State & Interstate Water Pollution Control Administrators;
- Water Environment Federation;
- National League of Cities;
- American Public Works Association;
- Natural Resources Defense Council;
- Sewage Treatment Out of the Park (Atlanta, Georgia);
- Environmental Defense Fund;
- Center for Marine Conservation;
- Lower James River Association (Richmond, Virginia);
- Association of Metropolitan Sewerage Agencies; and
- National Association of Flood and Stormwater Management Agencies.

Objective of the Work Group is as follows:

- Develop consensus on a consistent set of criteria with an adequate degree of specificity to be used in determining long-term CSO control programs implemented through NPDES permits.

Work Group discussions include having CSO communities:

- Examine complete rainfall record, and monitor and characterize response of the sewerage system to a range of events and the impacts on receiving waters and their designated uses;

- Identify national targets for limiting the number of overflows or establishing percentages of overflows to be captured by volume or pollutant mass;

- Demonstrate compliance with water quality standards and protection of existing and potential uses, including monitoring requirements;

- Prohibit overflows into sensitive use areas;

- Develop implementation procedures that allow limited exceedances of numeric WQC as long as existing and designated uses are protected; and

- Provide communities time to plan, design, and implement solutions, including phasing and consideration of previous efforts to comply, and financial conditions.

EPA is currently developing a consolidated framework which, in EPA's opinion, represents the concerns/opinions expressed by the work group. The framework will be used to further negotiate the outstanding issues pertaining to establishment of a consistent set of criteria for developing CSO permit requirements. The final work group meeting is scheduled for September 8-9, 1992.

Enforcement Policy

Current activities in developing the enforcement policy include the following:

- Requirement that all communities not in compliance with appropriate permit requirements be placed on enforceable schedules;

- Establishment of compliance dates;

- Use of enforcement tools, administrative orders for schedules within compliance dates, and civil referrals for extended schedules; and

- Use of penalties if schedules are not complied with.

Development of the enforcement policy will be coordinated with the permitting policy to ensure efficient implementation of the CSO program.

COMBINED SEWER OVERFLOW CONTROLS: THE MICHIGAN APPROACH

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Under Michigan Act 245 of 1929, as amended, the Water Resources Commission Act, the discharge of raw sewage is prima facia evidence of a violation of the Act. That is, a showing of damage or injury, or exceedance of water quality standards, is not necessary. The very act of discharging raw sewage is a violation of Act 245. Michigan's CSO program is based on this premise.

In 1986, Michigan's Water Quality Standards were awarded to protect waters for total body contact (bathing) recreation. The discharge of raw sewerage through combined sewer overflows had to be controlled for that use to be protected. Discharge permits issued since 1987 have been requiring CSO communities to address CSOs through a phased approach. Phase I requires the current system to be properly operated and maintained (no dry weather bypasses, maximize in-system storage, monitoring, etc.). Phase I also requires communities to develop a final combined sewer overflow control program, including an implementation plan, which will result in the elimination or adequate treatment of combined sewer discharges containing raw sewage, to comply with water quality standards at times of discharge. The control program shall evaluate financing mechanisms and contain fixed date milestones that result in maximum progress feasible, taking into account site-specific economic and technical constraints. The permittee shall actively involve the affected public in the development of the program and document the steps taken in this regard. The control program shall be submitted to the appropriate District Office of the Michigan Department of Natural Resources by a date established in the permit. The approved control program, including the milestone dates for completion, is subsequently adopted into the permit through permit modification or at reissuance.

The first permits issued with language requiring final CSO control programs to provide adequate treatment were contested by the permittees on the grounds that the requirements were too vague. In response to that concern, the Agency defined a level of treatment which the Agency would accept as meeting the permit requirements for adequate treatment. This approach established a "default" definition for adequate treatment, that is, a level of control which the

State would accept, but which is not binding. This, or other demonstrated adequate treatment, would satisfy the statutory prohibition against raw sewage discharge.

If a permittee prefers the permit not contain the default definition of adequate treatment, it is not included. Otherwise, the permit would contain the following language:

> The following would constitute adequate treatment of combined sewage discharges to meet water quality standards at times of discharge:
>
> - retention for transportation and treatment at the wastewater treatment plant, of combined sewage flows generated during storms up to the one-year, one-hour storm;
>
> - primary treatment of combined sewage flows generated during storms up to the 10-year, one-hour storm (30 minutes detention or equivalent for settling, skimming and disinfection), and
>
> - treatment of combined sewage flows generated in storms in excess of the 10-year, one-hour storm to the extent possible with facilities designed for lesser flows.

These rainfall events were selected because there was some experience with them and they had been historically applied with reasonably good results. The one-year/one-hour storm had been used as a retention basin design criterion for wet weather retention facilities in the 1970s. The 10-year/one-hour criterion was selected because it was often used as the design carrying capacity criterion for separate storm sewers and therefore would reflect the maximum flows that will be delivered to a storage/treatment facility.

The 30-minute detention for settling, skimming, and disinfection is a professional judgment value which Agency staff engineers believe would provide sufficient solids removal to allow effective disinfection without excessive chlorine dosage and also would assure removal of floating and settleable solids.

A key assumption in the Michigan approach is that the Industrial Pretreatment Program would be the vehicle to address nondomestic pollutants that may impact the receiving stream. These pollutants are to be addressed through a monitoring program to identify significant industrial inputs to the sewer upstream of combined sewer overflows and to assess their impact. Potential water quality violations would be addressed through subsequent imposition of industrial pretreatment requirements at the source.

Since 1987, Michigan has been reissuing combined sewer overflow permits based on the above approach. To date, 64 of the 75 combined sewer overflow communities in Michigan have updated permits. The approach allows permit requirements to be tailored to specific situations, and a range of combined sewer overflow control programs is being pursued. A number of communities had already initiated the corrective programs. In those situations, the permit would establish deadlines for those programs and require a final program be developed if necessary to achieve water quality standards. For communities that are not so far along, any feasible short-range improvements would be required while the community develops and implements its long-range program.

Many communities are choosing to separate their sewers to address their combined sewer overflow problems. Since separation eliminates raw sewage discharges, it is an acceptable approach under the Michigan strategy. There are some good arguments to separate sewers. The most obvious is that the sewage and industrial wastes carried by sanitary sewers are completely removed from the storm water flows and delivered to the wastewater treatment plant for full treatment prior to discharge. Even during major storm events, no sewage is discharged to the receiving stream. The program is relatively simple in concept and not subject to subsequent reevaluation or retrofitting should combined sewer overflow treatment requirements change in the future. It is certain and final.

However, there are some serious drawbacks to sewer separation that are often not fully appreciated. The separate storm water discharges can represent a significant pollutant load. There is no first-flush capture; everything in the storm sewer is discharged. The National Urban Runoff Program (NURP) study conducted between 1978 and 1984 found the pollutant loadings from separate storm sewers to be very significant. A community may find that it has spent millions of dollars to separate its sewers, yet the receiving stream remains heavily impacted by wet weather discharges to the point where valuable beneficial uses are still prohibited. Accidental spills previously caught and treated through a combined sewer system now would flow to separate storm sewers and would be discharged directly untreated to the receiving waterway.

Separate storm water discharges must be addressed under the 1987 Amendments to the Clean Water Act. Although small communities were exempted until 1992 (and it is likely that date will be extended), all municipalities will probably have to eventually deal with separate storm water discharges through the NPDES permit program. Hopefully, end-of-pipe treatment will not be needed in most cases, but it certainly is a major "unknown" that municipalities face, if they choose to separate their sewers.

Separate storm sewers are also vulnerable to illegal discharges. If a community builds new sanitary sewers and leaves the existing combined sewers to serve as the separate storm sewer system, great care must be taken to assure all non-storm water inputs are removed from the old combined sewer. Car washes, floor drains, industrial yard drainage, etc., previously discharged to combined sewers, must be rerouted to the new sanitary sewers. This is difficult to accomplish.

If the community builds new storm sewers and leaves the old combined sewers to function as separate sanitary sewers, all significant inflow and infiltration sources of storm water and ground water must be removed or significant wet weather event will cause sewage backups in basements. This has happened more than once in Michigan. One can imagine the intensity of anger from the citizens in communities that have spent millions of dollars on a new sewer project and have sewage in their basements for the first time because of the new project.

Separating sewers is generally more disruptive than storage/treatment projects, since virtually the whole sewerage area has to be excavated and new sewers installed. Nevertheless, a number of communities are choosing to separate their sewers rather than construct retention treatment capability. From a straight cost basis, it is often less expensive to separate sewers if a large part of the city is already separated, especially if future costs for storm water treatment are not factored in. The finality of the separation, i.e., "the community that separates its sewers is no longer a combined sewer community," is very attractive. We should be cautious, however, in assuming that separation is the best environmental alternative.

In some situations, separation is not feasible. Older cities or portions of cities that have completely combined areas usually have only the option of storage and treatment. In Michigan, this was the case in central Grand Rapids and Saginaw. Also, most of the southeast Michigan combined sewer systems are likely to be corrected through storage and treatment.

In the case of Grand Rapids, the city constructed a retention basin to meet the criteria set forth above. The basin went on line this spring and, to date, has functioned very well. Michigan has experienced a very wet year so far, and the basin has either fully contained the storm flows or provided sufficient treatment such that the discharge was of a visually higher quality than the storm-impacted receiving stream. Prior to the basin going on line, a number of advisories issued throughout the recreational season advised the public not to use the river for recreational purposes. No health advisories have been issued in the Grand Rapids area this year.

The new Saginaw system is a combination of basins that are somewhat smaller than the Grand Rapids design, but include additional treatment technology steps such as swirl concentrators and rapid mix chlorination. Also, the ratio of Saginaw River flows to the combined sewer flows is considerably larger than in the Grand Rapids situation. The Saginaw program was judged by staff to represent adequate treatment, but the permit requires an evaluation/assessment period following construction. The basin structures were designed to be retrofitted if additional detention capacity is needed. Other options would include additional sewer separation, which would reduce the flow volumes to be stored. It is not anticipated that subsequent construction will be necessary, however.

A third example is the project at the Milk River in Wayne County, Michigan. The Milk River project, being undertaken by the Wayne County/Macomb County Intercounty Drainage Board, also involves a storage/treatment basin designed to criteria different than the Agency criteria. The basin was sized through use of a wet weather water quality model, which predicted that receiving stream quality standards would be met. Postconstruction monitoring will be conducted to verify the model predictions.

Probably Michigan's biggest challenge is the Rouge River in metropolitan Detroit. The Rouge Basin is a large, relatively flat watershed consisting of a number of small tributaries flowing through urban and rural areas. The basin has been subject to an intense planning process since 1985. Wayne County, Oakland County, and Detroit played leadership roles in working with the Department and the U.S. Environmental Protection Agency in developing the remedial action plan (RAP) for the Rouge River.

The RAP identifies CSOs as the primary source of pollution in the Rouge, and calls for the elimination of raw sewage discharges and protection of public health over a 20-year period at an estimated cost of over $500 million.

A national demonstration project grant of $46 million is being awarded to Wayne County to oversee commencement of work on the first phase of CSO retention basins. The basins are being constructed to provide a range of levels of retention and treatment. The performance will be assessed and the results utilized in the next round of design and construction. The first group of basins will be completed in 1997 in accordance with requirements contained in the NPDES permits for these basins. Following a 2-year evaluation period, the remainder of the basins or other corrective actions will be taken such that the goals of the RAP are accomplished by 2005. Subsequently, another assessment will be made of the whole system to determine if further action is needed.

These examples demonstrate the wide range of corrective programs being pursued under the Michigan approach. The key to the Michigan program is to assure that adequate controls are brought on line as quickly as possible, which will eliminate raw sewage discharges and accomplish water quality standards at times of discharge.

In summary, Michigan uses a phased approach to address combined sewer overflows. Phase I will ensure the current system is properly operating and will develop the long-term control program. Under Phase II, the long-term program will be designed and constructed. The Michigan approach provides flexibility with guidance. The staff criteria for adequate treatment, based on historical design criteria used in Michigan, are acceptable but not mandated. Other levels of control are also acceptable, provided it can be demonstrated that water quality standards will be met at times of discharges. Construction schedules for the long-term program must ensure maximum feasible progress. The overall presumption of the program is that water quality standards will be met and the industrial pretreatment program will address nondomestic pollutants. Subsequent assessments and evaluation will assure these assumptions are valid. If subsequent controls are necessary, it is understood these will be required.

Michigan has proceeded to correct combined sewer overflows and has not waited for the establishment of a national specific uniform level of control. In any national policy, it is extremely important that flexibility be maintained to take into consideration site-specific concerns and to avoid retrofitting of adequate control facilities that have been or are now being constructed.

MASSACHUSETTS DIVISION OF WATER POLLUTION CONTROL COMBINED SEWER OVERFLOW POLICY

Warren Kimball
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POSITION

1. Untreated overflows from CSOs violate the fishable/swimmable goal. Where CSOs are not eliminated, waters must be reclassified.

2. Where the impairment to use is short term and infrequent, a "partial use" designation is appropriate.

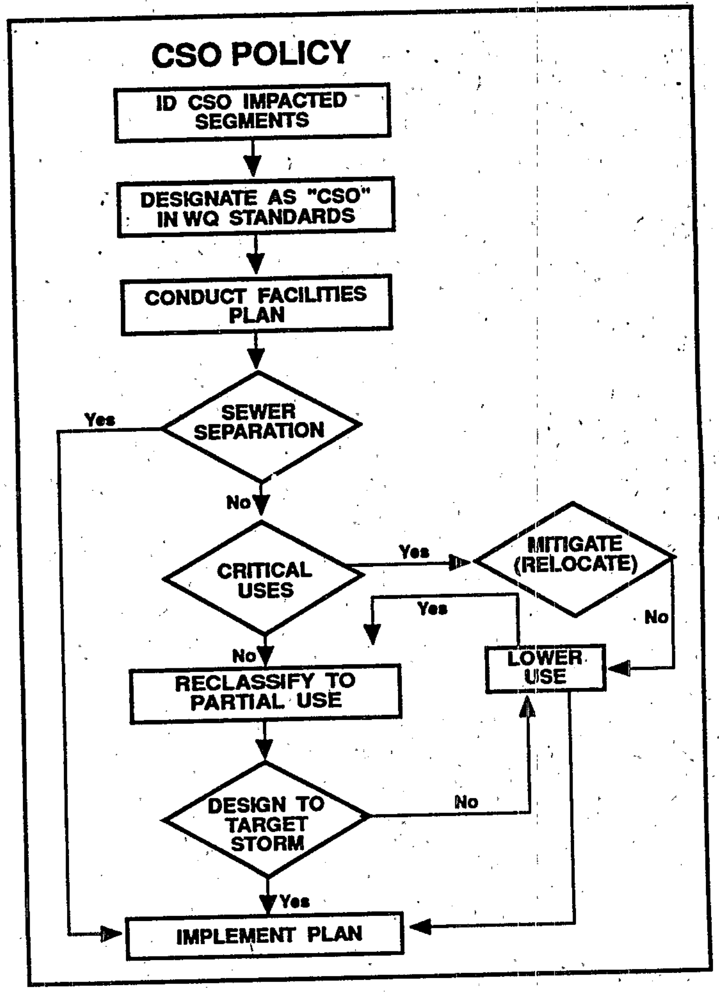
3. Elimination of receiving water impacts is the goal of abatement actions rather than uniform treatment requirements. Engineering targets are useful, but economics and common sense often dictate a "bubble concept" where CSOs causing overlapping receiving water effects are considered a single source of pollution.

LOGIC

Combined Sewer Overflows

Untreated overflows from CSOs violate the fishable/swimmable goal. Since there is no finite limit to the magnitude and duration of a precipitation event, any control strategy for CSOs can only lower the probability of untreated overflows, not eliminate them entirely. Therefore, to meet the goal at all times, CSOs must be eliminated by sewer separation. The impacts on any particular segment may be eliminated by relocating a CSO to another (less sensitive) segment.

Alternatively, the Division's regulations allow for the designation of a partial use subcategory for waters impacted by CSOs. This is appropriate when it is not feasible to eliminate CSO discharges. To demonstrate that the sewer separation is not feasible, the permittee must show that the cost of separation will cause substantial and widespread economic and social impact. This may consist of documentation that the costs are excessive when compared to the benefits to be achieved. When determining the benefits to be achieved, potential interactive/overlapping pollution sources such as discharges from the storm drain system after separation may be taken into account. Once it has been demonstrated to the satisfaction of the Division that elimination of CSO discharges is not feasible, the relocation of CSOs should be evaluated. Relocating alternatives must be examined on a systemwide basis so that the maximum recovery of water uses is achieved, including the protection of critical uses. When it is not feasible to eliminate the CSOs by separation or eliminate the impacts by relocation, the impacted segment may be assigned a partial use subcategory.



The community sewer system response to precipitation events and the assimilative capacity of water bodies throughout the State are highly variable in nature. Therefore, variations in water quality caused by CSOs will vary greatly from segment to segment. However, it is appropriate that the Division set an engineering target for the achievement of designated uses to the maximum extent feasible in partial use segments. The Division has determined that a reasonable target is to protect the use during precipitation events that occur no more often than once in 3 months. This will result in untreated overflows on an average of four times a year. If the average duration of receiving water impacts is estimated at 4 days, then the target translates into achieving full use greater than 95 percent of the time. In some cases, further protection may be reasonable.

The Division shall use information developed in a uniform evaluation procedure and other information that may be available to determine whether the target provides adequate protection of uses. Site-specific factors, such as the presence or absence of critical uses and the duration and area of impact, may influence this decision. Where the cost-benefit analysis and availability of technology so indicate, the Division may require more stringent protection than the statewide target. Where these same factors, as well as other economic and environmental factors, result in the permittee requesting less stringent control than the 3-month storm technology, the permittee shall be responsible for providing documentation that compliance with the target will result in substantial and widespread economic and social impacts.

PARTIAL USE

To designate a partial use subcategory the water quality standards must be amended. The process starts when the permittee petitions the Division for a change in regulations. The permittee must provide adequate documentation in its petition to prove that controls necessary to meet current water quality standards would result in widespread economic and social impacts (40 CFR 131.10 (g)(6)). The permittee must also provide a CSO facilities plan that shows compliance with the Division's 3-month storm technology-based effluent limitation and that demonstrates that further controls are not cost effective.

When making partial use designations, certain uses may be deemed critical in that no untreated overflows are desirable. These include the following:

1. Public Water Supply Intakes. In no case will the Division approve a new or relocated CSO where the impacts are anticipated to encompass an intake for an existing or proposed Public Water Supply. The Division shall not approve an existing CSO upstream of an existing or proposed intake, or water supply wells that are hydraulically connected to the subject water body, without the written concurrence of the Department of Environmental Protection's Division of Water Supply.

2. Shellfish Harvest Waters. CSO discharges to shellfishing areas shall not be approved without consultation with the Department of Public Health and the concurrence of the Department of Fisheries, Wildlife and Environmental Law Enforcement's Division of Marine Fisheries.

3. Public bathing beaches, other recreation areas, wildlife refuges, and areas of ecologic or economic concern may be identified as critical uses through the facilities planning and public participation process. In each case, the goal shall be to eliminate the CSOs in these areas and where this is infeasible, to minimize their impacts.

   When a partial use is designated, the receiving water criteria shall be site-specific. To the maximum extent feasible, they shall conform to the criteria assigned to the Class. Where CSOs are the reason for the designation, criteria may depart from the criteria assigned to the Class only to the extent necessary to accommodate the technology-based treatment limitations of the CSO discharge. Regarding other discharges to these segments, nothing in this policy should be construed as reason not to apply any technology, process, or best management practice that has been demonstrated to be achievable in the judgment of the Division and consistent with fully supporting the uses assigned to the Class.

ABATEMENT MEASURES

Abatement plans may involve phased work plans with the most cost effective control, or control providing the most benefit, given the highest priority. All abatement programs will proceed with a uniform analysis methodology and opportunity for public comment.

Based on this policy's allowable frequency of untreated overflows, the most severe hydrologic condition for which abatement measures must be provided will be determined. In complex situations the abatement plan will identify the sequence of efforts that should be followed to gain the most improvement in water quality. This may involve implementing a phased work plan.

Each plan will be required initially to minimize discharges from CSOs and their resultant impacts on water quality by improved system management. Permittees will be required to develop and institute a regular maintenance program, including sewer inspection; sewer, catch basin, and regulator cleaning; sewer replacement where necessary; and disconnection of connections not authorized by the Sewer Use Ordinance. The goals will be to maintain system integrity and minimize infiltration. Permittees will be required to regularly monitor the flow of major CSOs.

Abatement measures will be implemented to meet water quality standards and support designated uses. CSO effluent limitations will be developed under a "bubble concept." This means that all CSOs with overlapping instream effects will be considered as a single discharge. All individual discharges need not be eliminated or treated to the same degree as long as the total load of pollutants is reduced to meet water quality standards. This allows greater flexibility to produce alternatives and the possibility of more cost-effective abatement measures based on an optimal mix of structural and on-structural solutions.

Effluent limitations for specific discharges will be developed by the Division and delineated in the NPDES Permits. Compliance with standards will be determined through the use of mandatory monitoring by the applicant at the discharge site(s). Specific reporting and notification procedures will be incorporated into all CSO program approvals. Written notifications will be supplemented by telephone notifications where impacts to water supplies or shellfish growing areas are predicted.

PROBLEMS/CONCERNS

The major problem with the policy lies in public perception. In many cases, the public will be asked to expend a great deal of money to implement abatement measures, and at the same time water quality standards will be lowered. Public education is the only immediate answer.

APPLYING WATER QUALITY STANDARDS TO COMBINED SEWER OVERFLOWS

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INTRODUCTION

Combined sewer overflows: CSOs. There is no doubt that uncontrolled combined sewer overflows can cause water quality degradation. The impact depends on the location, duration, and frequency of occurrence. All uncontrolled combined sewer overflows carry at least a high level of bacterial contamination. And, since most combined sewers are located in dense urban areas, they will also carry other contaminants such as heavy metals and polycyclic aromatic hydrocarbons (PAHs). However, not all uncontrolled CSOs will have the same impacts or present the same risks.

In 1989, EPA published the National CSO Strategy. The Strategy established six minimum technology standards to control CSOs. Under consideration now are three additional "technology" standards. With one exception, these standards can be implemented in just a few years to reduce and control the impact of CSOs on a receiving water. But, the National CSO Strategy additionally states that the CSO discharges must also comply with "applicable water quality standards." Since 1972, section 301(b)(1)(C) of the Clean Water Act has required compliance with water quality standards. In the past, however, most cities, States, and certainly the EPA have not focused attention on what these requirements mean for urban runoff and CSO discharges. So the questions before us today are "what does it mean to comply with applicable water quality standards?" and "how do we measure compliance with water quality standards for wet weather events such as CSO and storm water discharges?"

As we have implemented the Clean Water Act over the past 20 years, those of us managing municipal discharges have generally focused on complying with technology-based controls. Our goal was to implement the secondary treatment standards, and we assumed that compliance with water quality standards would be more or less automatic. In some cases, water quality needs required additional treatment such as nutrient control, but for the most part our goal was to meet the technology-based secondary standards. Compliance for technology-based standards is relatively easy to determine. We measure the constituents in the pipe prior to discharge.

In 1987, the emphasis began to shift away from technology-based standards toward water quality. Bioassays are now used routinely to determine directly the potential impact of a discharge on aquatic organisms. And, more significantly, under the National Toxics Rule, we now have the expanded list of chemical criteria being implemented by the States. This shift in emphasis has abruptly changed our expectations. Many municipalities are still struggling to implement our pre-1987 goals of secondary treatment. These communities are now faced with new, more difficult goals. Communities that have met the technology-based standards now face noncompliance and unexpected additional expenditures on wastewater facilities. The new emphasis on water quality standards will probably have the greatest impact on discharges of storm flows, whether from CSOs or from separate systems. The available data suggest that all these discharges will have serious compliance problems if measured against the new water quality criteria.

How do we face this challenge? I prefer to look at the glass as half full. Our post-1987 expectations are based, or most certainly should be based, on risk and protection of beneficial uses. I believe that if we start with beneficial uses, and carefully determine the site-specific risks from CSOs or storm water, we can arrive at an appropriate control strategy.

It is timely that this meeting focuses on the issues of the appropriateness and implementation of water quality standards. We are at a critical juncture in our urban areas. CSO control can be very expensive, and new standards, new policies, and an urban economic crisis have all converged to make this exercise particularly important.

This paper will present several suggestions for implementing water quality standards for storm flows. First, however, as a foundation, I will explain how San Francisco used water quality standards as the basis for planning CSO controls. The San Francisco program can also provide a useful guidepost to what is achievable in controlling CSOs.

SAN FRANCISCO'S WASTEWATER CONTROL FACILITIES

In 1996, after more than 20 years of work and $1.4 billion dollars in construction costs, San Francisco will complete its wastewater facility improvement program. This program implements the Wastewater Master Plan and has been managed by the City's Department of Public Works. When completed, the program will represent an expenditure of nearly $1,900 for every person in the City. This per capita expenditure for controlling water pollution is among the highest of any city in the United States.

San Francisco has combined sewers for nearly 100 percent of the service area. Figure 1 is a schematic drawing of the wastewater facilities. The long box-like structures are underground storage/transport tunnels which ring the City like a moat. During rain storms, the storage/transports hold combined sewer flows for later treatment. Two-thirds of the storage/transport capacity is now in place and operational. The remainder is under construction. The Southeast secondary-level treatment plant has been operational since 1982. The North Point wet weather plant (primary-level) is also operational. This plant is not regulated as a publicly owned treatment works (POTW) but instead must meet BAT/BCT limits. The Oceanside secondary plant is under construction and will be completed in 1993. The cross-town tunnel shown on the figure is under study. This tunnel would move the current bay discharge to the ocean outfall.

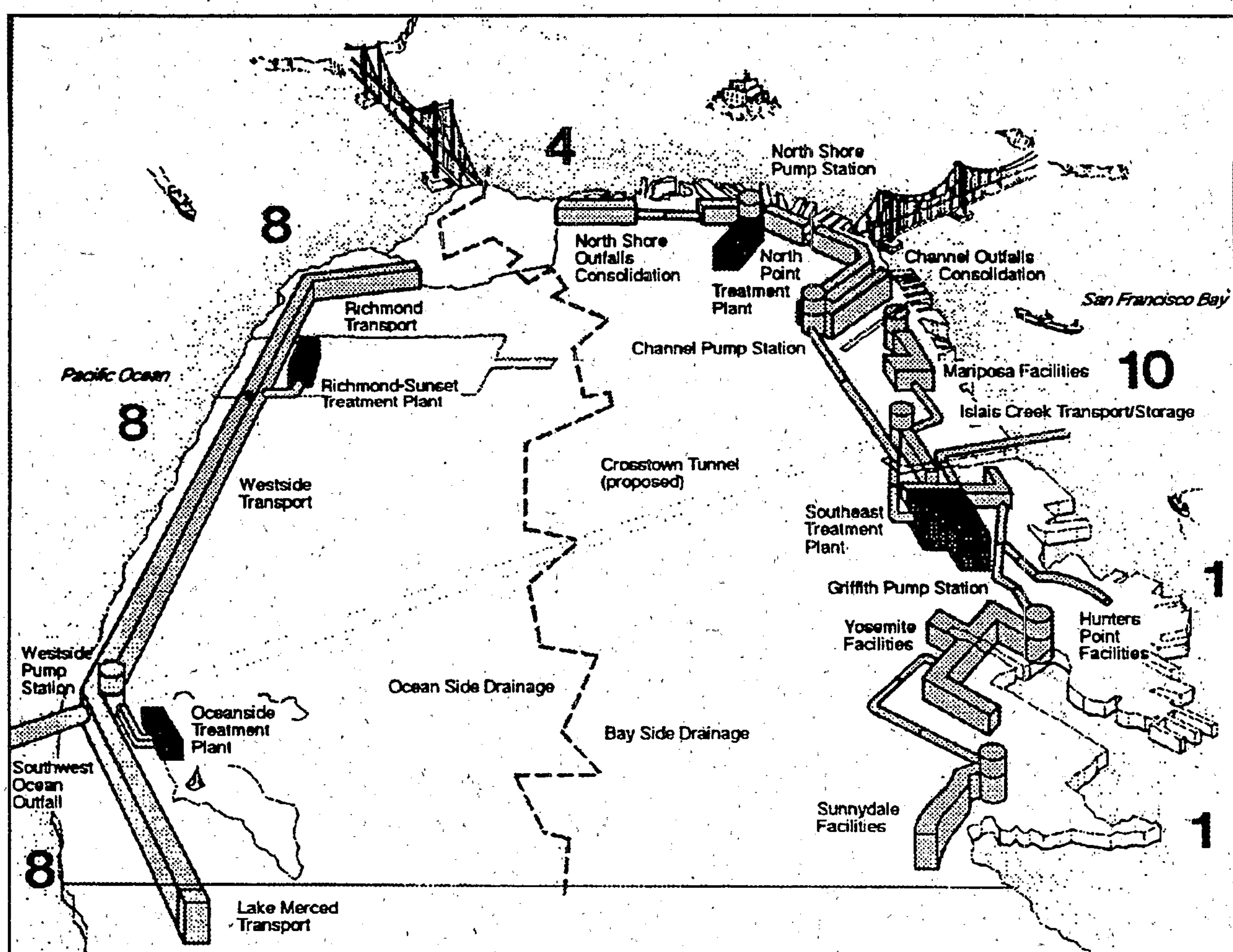

Figure 1. Permitted shoreline discharge frequencies. Figures indicate the number of overflows allowed per zone annually.

The numbers shown around the periphery of the City indicate the acceptable CSO overflow frequencies as specified in NPDES permits. As discussed later, these frequencies were arrived at by determining the cost-effectiveness of attaining beneficial uses.

Most of the expense of San Francisco's program, more than $1 billion, is devoted to facilities needed to control CSOs. Prior to the program, even a mild rain would overload the system and cause the discharge of untreated sewage and storm water at the City's shoreline. At program completion, all of these overflows will be captured by the storage/transports and receive some level of treatment. Figure 2 shows one of these facilities as filled by a major rain storm. Although limited shoreline discharge still occurs, the settleable material and floatables are retained in the storage/transport along with most of the combined flows and held for later treatment at the wastewater treatment plant.

It is worth noting what will not be accomplished by the control system when it is completed. Wet weather flows are discharged at the shoreline if they exceed the capacity of the treatment plants and also exceed the storage capacity of the storage/transports. These remaining shoreline discharges will have received flow-through treatment within the storage/transports or, in the Northshore area, primary-level treatment at the North Point wet weather plant. The flow-through treatment and the primary-level treatment do not achieve pollutant removals equivalent to secondary-level treatment. These discharges would not comply if required to meet the numerical water quality criteria. This potential noncompliance does not mean, however, that these discharges are not treated or that they do not have effluent limitations. The NPDES permits that govern the discharges have directed that the majority of the wet weather combined sewer flows receive treatment to secondary standards. This occurs because the storage/transports will be able to hold most of the flow for later treatment at the secondary-level plants. As discussed later, the frequency of the allowed discharges (overflows) is based on the beneficial uses included in the water quality standards.

The shoreline discharges constitute about 34 percent of the total wet weather flows. Capturing this remaining 34 percent and treating it to the secondary level would be difficult and expensive because this flow results from a few large and intense storms.

SAN FRANCISCO'S PLAN FOR CONTROLLING COMBINED SEWER FLOWS

The City had three major options for handling the wet weather flows: provide immediate treatment (i.e., build treatment plants to handle all wet weather flow when it occurs), store the excess flows for later treatment (with limited additional capacity), or separate the sewers. The City selected a combination of additional treatment plant capacity and large volume storage. Sewer separation was rejected because it was too costly and would not have solved the water

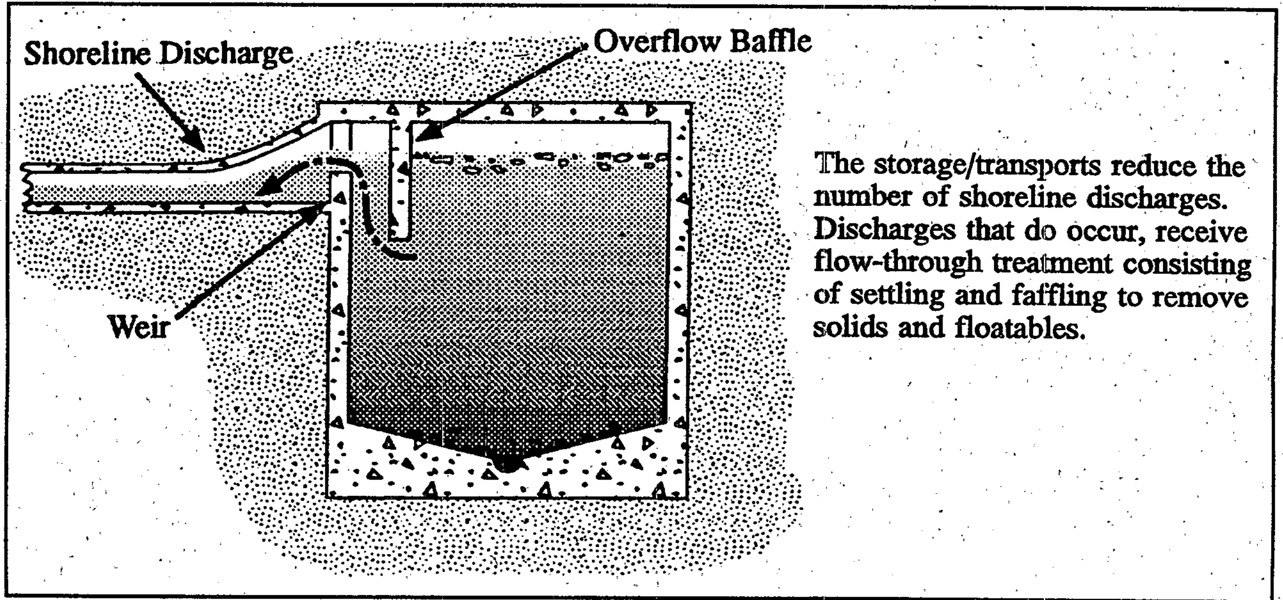

Figure 2. Storage/Transport cross-section.

pollution problems caused by the storm water. In addition, to separate the sewers, the City would have had to excavate every street.

The decisions on the acceptable frequency of shoreline discharges were made during the planning phase in the 1970s. Cost-effective protection of beneficial uses was the basis for the decision-making. At that time, it was necessary to determine to what lower frequency the shoreline discharges could be economically reduced. The City also had to determine how to treat the discharges that did occur. EPA guidance proposed a balancing of facility costs and water quality benefits. In Program Guidance Memorandum-61, EPA required as a condition of project approval that "the marginal costs are not substantial compared to the marginal benefits."

The San Francisco Bay Area Basin Plan contains the State water quality standards. These standards identify the potential beneficial uses around the periphery of the City. These beneficial uses range from shellfish harvesting to maritime (shipping) uses. In 1975, the Basin Plan recommended the City complete cost-benefit analyses for each shoreline zone to determine the appropriate shoreline discharge frequency. Using State and EPA guidance, San Francisco completed cost-benefit assessments for each zone, comparing shoreline discharge frequencies from 16 per year to one per year. As an example, Figure 3 summarizes a part of the cost-benefit analysis for the Westside area. Each bar in the figure shows the incremental costs of going to the next lower shoreline discharge frequency. The costs are based on beach user-days, which are considered the primary beneficial use of this zone. In other words, the incremental costs are divided by the number of beach users and the number of additional days

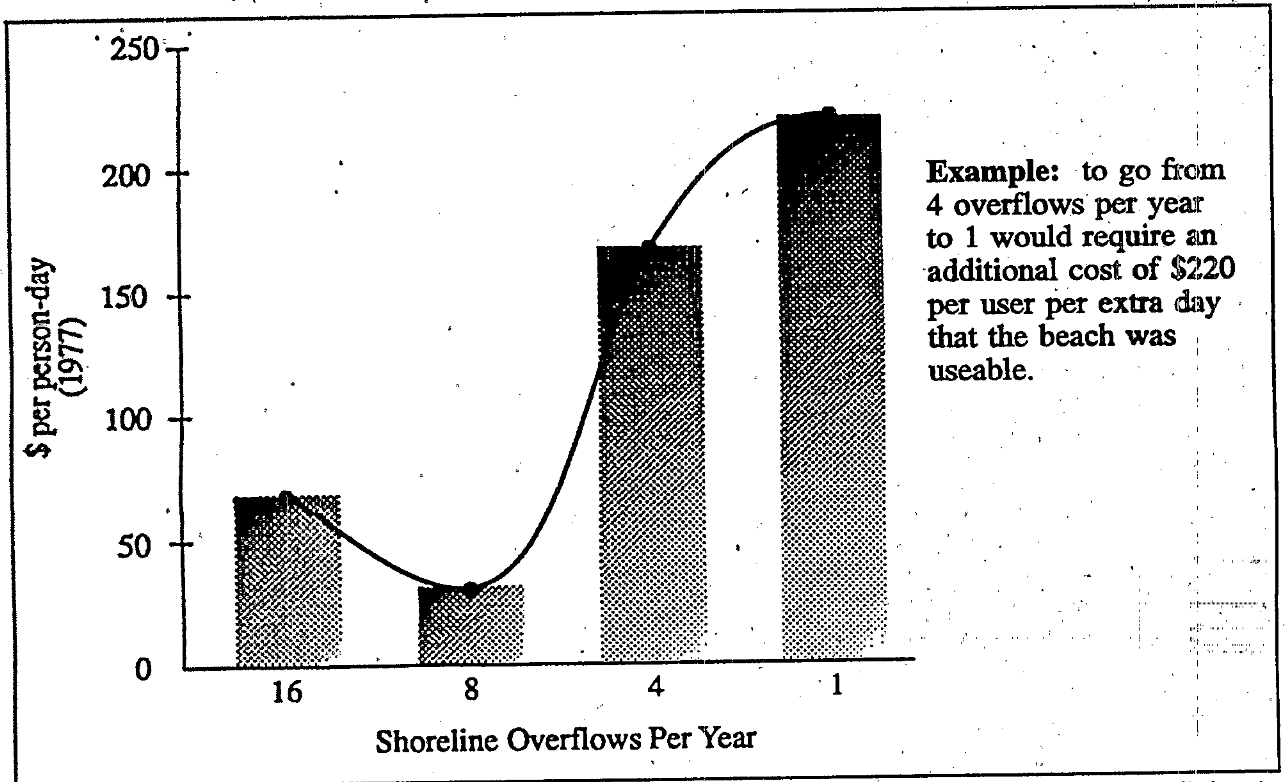

Figure 3. Westside cost-benefit analysis (shows incremental costs per additional beneficiary).

they could use the beach. As shown in the figure, overflow reductions to less than eight per year are incrementally very expensive.

The California Regional Water Quality Control Board prepares the Basin Plan and implements it by issuing NPDES permits. The Board initially proposed that the City reduce CSO discharges to one per year. However, when faced with the cost, time to implement, and associated impacts of the one/year limit, the Board decided to evaluate the cost-effectiveness of the various discharge frequencies. The Board determined that the potential risks to beneficial uses did not necessitate a uniform one/year overflow limit, which would require massive and very expensive control facilities.

On the basis of the cost-effectiveness analyses, the Board tentatively selected the appropriate shoreline discharge frequencies. Depending on the zone, these varied from one per year to ten per year. Receiving waters with shellfish beds have the fewest overflows. Maritime (shipping) areas have the highest. On the ocean side, the large Westside Storage/Transport discharges storm flows direct to the 4.5-mile-long ocean outfall an average of 26 times per year. The discharge or overflow frequencies were incorporated into NPDES permits.

The permits also required the City to design the storage/transports to provide flow-through treatment for the remaining shoreline discharges and for the direct ocean outfall discharge. As mentioned earlier, flow-through treatment consists of settling and skimming, and is equivalent to low-level primary. The removed solids are flushed to the treatment plant after the storm.

Once the discharge frequencies were set, the City was able to determine the size of the storage/transports and proceed with design and construction.

Wet Weather System Performance

Figure 4 shows the level of treatment planned for combined sewage flows City-wide. During rainy weather, approximately 66 percent of the flows will be held for secondary-level treatment at the Southeast and Oceanside treatment plants. The remaining 34 percent will receive flow-through treatment within the storage/transports or primary treatment and disinfection at the North Point plant.

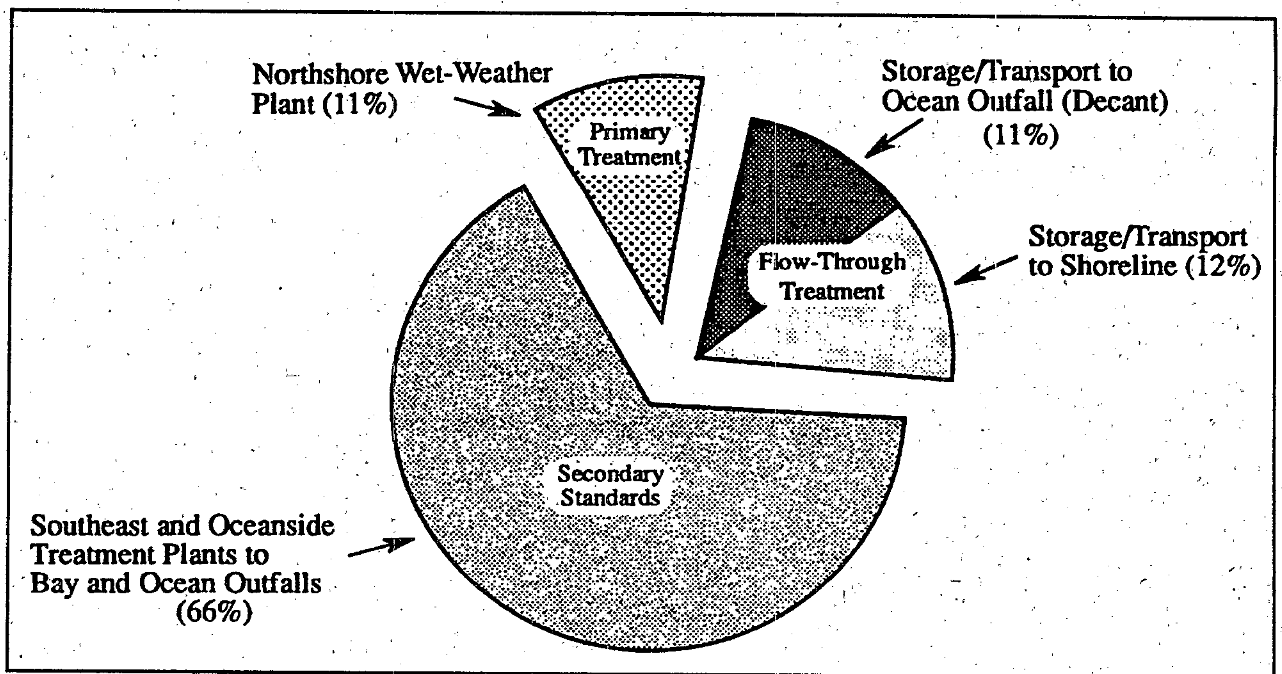

Figure 4. Treatment for wet weather flows.

Another way of looking at program accomplishments is to compare the decrease in volume of shoreline discharges. When construction is complete in 1996, the City will have reduced the volume of shoreline discharges by 80 percent; and, unlike the previous combined sewer overflows, these discharges will receive flow-through treatment. These remaining overflows will not be "raw" and will not carry the unsightly floatables associated with storm water and CSO discharges.

Performance can also be assessed by comparing San Francisco with a hypothetical "standard" city of the same size with a separated sewer system. (See Figure 5.) Both provide a high level of treatment to their sewage. San Francisco, however, also provides significant treatment to the storm water (as part of the combined sewage flow). In Figure 5 (Figure missing), solids removal from the wastewater is used as a measure of pollutant control since toxicants and bacteria are generally associated with solids.

Cities with separate sewer systems will soon be required to have permits for their storm water discharges. If EPA intends to implement its programs equitably, the performance required of combined sewer cities should also be required of cities with separated sewer systems.

Program Costs

At a total capital cost of $1.4 billion through 1996, the San Francisco program will represent an expenditure of nearly $1,900 per resident. (Per capita costs are about $1,300 through 1991.) These expenditures greatly exceed those of most other communities. Figure 6 compares San Francisco's per person costs with other California urban areas. San Francisco's expenditures are high because of the extra expense of controlling storm flows in a combined system. Sacramento has also built storage and treatment facilities for the portion of its system served by combined sewers and thus also has higher costs. The other municipalities on the chart have separate sewer systems.

For those who want to estimate the costs for their own storm flow systems, San Francisco construction costs are currently about $4 to $6 per gallon of storage capacity.

Just under half of the capital costs for the wastewater construction program came from Federal or State grants. The remainder is being paid for by City bonds or by loans.

APPLYING THE NEW WATER QUALITY STANDARDS TO SAN FRANCISCO'S WET WEATHER FLOWS

In the past, EPA and the States regulated storm discharges (CSOs and storm water), differently from continuous discharges. Water quality standards, and in particular, numerical criteria, were not generally applied to these intermittent flows. Now, as the problems caused by these discharges become more evident, we have an emerging policy of using water quality standards as the means of control. San Francisco has made a major investment in controlling

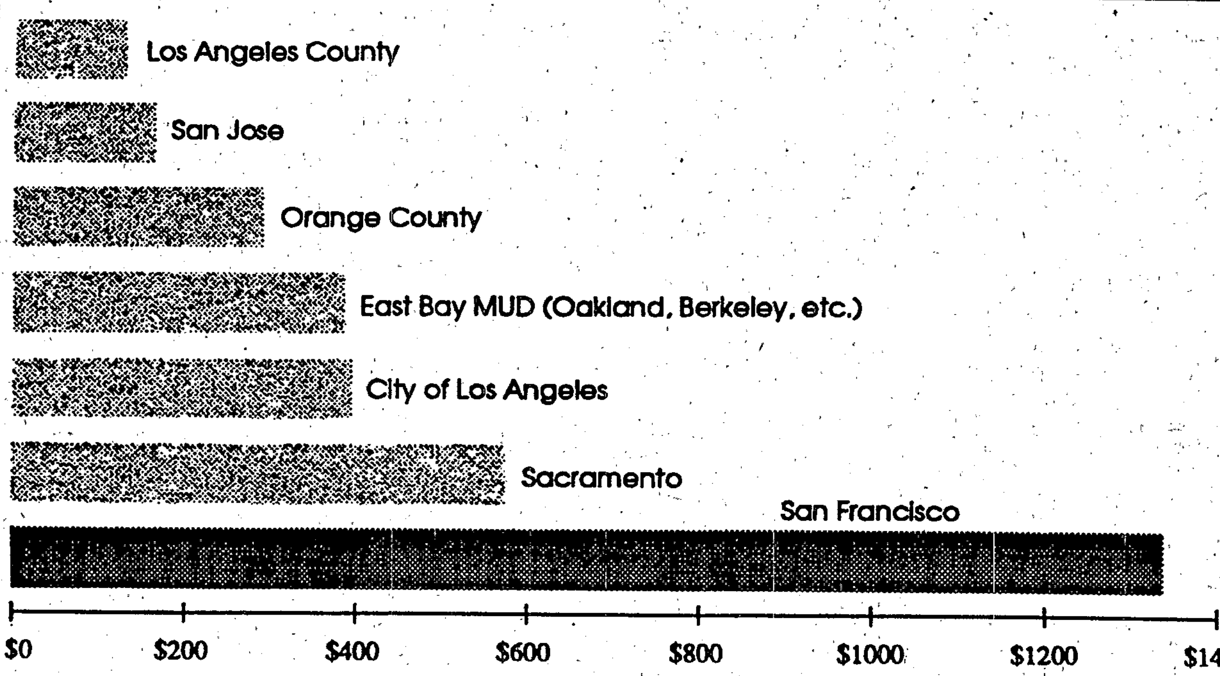

Figure 6. Construction costs per person for wastewater control, San Francisco compared with other cities (costs through 1991).

CSOs and it is useful to compare the City's performance with the standards. (The San Francisco facilities were constructed to provide cost-effective attainment of the beneficial uses contained in the standards but were not based on the standard's numerical criteria as translated into effluent limitations.)

Bacteria standards are exceeded for 2 or 3 days following a shoreline discharge. Currently, San Francisco posts the beaches when this occurs. San Francisco does not chlorinate the discharge because of the technical difficulty and because of the adverse affects on marine life from the chlorination. In addition, the overflows occur during winter months when shoreline use is limited. Regardless, immediately following the discharge, bacteria standards are exceeded and the beneficial use cannot be realized during this period.

The chemical criteria present a more significant problem. If the numeric water quality criteria are translated into effluent limits and applied to the treated storm flows, San Francisco would not be able to comply. PAHs are the worst problem and exceed the criteria by several orders of magnitude. PAHs are combustion byproducts, and the main source in the wastewater is runoff from street surfaces. Even if we were to average in days of no discharge and assume some initial dilution, we would still not be able to comply with the PAH limits.

San Francisco also would have a serious problem with copper, lead, and zinc if effluent limitations were applied to the treated overflow discharges. The undiluted storm discharges exceeds these limitations by a factor of 10. Other heavy metals will occasionally exceed the limits but by lesser amounts. These include cadmium, mercury, nickel, silver, and cyanide.

Our shoreline discharges are 95 percent storm water. The problem constituents are essentially all derived from street runoff. Although we provide treatment to these discharges which approaches primary level, we would still have a significant compliance problem if the water quality criteria are applied directly to the discharges.

It's been suggested that best management practices (BMPs) will solve the problem. BMPs will help, but at this time we do not believe that BMPs will bring the significant reductions in pollutant loading necessary to comply with the water quality criteria. All our streets are swept at least weekly and increasingly, we are using vacuum sweepers. We implemented a comprehensive BMP program over a year ago. It includes a permanent household hazardous waste collection center and number of other measures. The real problem is automobiles and, short of banning them, preventing their associated pollutants does not appear an easy task.

How typical are the pollutant concentrations in San Francisco's storm discharges compared with other CSOs? We believe San Francisco's pollutant concentrations are possibly lower than similar urban areas because San Francisco has only limited industry and because some treatment is provided. The available data also indicate that our wet weather discharges are similar to storm sewer discharges from urban areas with separate sewer systems. The pollutant loading is basically a function of the volume of vehicle traffic in the service area, and so we expect that in other urban areas of similar density, both CSO and storm sewer discharges will have similar or greater pollutant concentrations compared to those in San Francisco.

Our conclusion is that any similarly dense urban area with either combined sewage overflows or storm water discharge will have serious difficulty complying with water quality standards if the chemical criteria are imposed as effluent limitations.

COSTS FOR COMPLYING WITH THE WATER QUALITY STANDARDS NUMERICAL CRITERIA

As noted previously, San Francisco has spent more than $1 billion for wet weather controls. What would it cost to comply with effluent limitations derived from the water quality criteria? We have estimated that to capture the remaining storm flows (up to the 1-year storm) and treat to secondary levels would cost at least $560 million (beyond the $1 billion), excluding the cost of land. And there would still be a water quality violation about once per year.

What would be the costs nationwide? CSO control cost estimates have ranged from $40 billion to $120 billion. Based on our experience, we think these costs are probably low and do not reflect providing full secondary treatment to all combined flows. Equity demands that if the standards are applied to combined sewer communities, they also be applied to those communities with separate storm sewers. The control costs for the storm sewer systems will almost surely dwarf the costs for CSO controls. Recent estimates for comprehensive controls range from $90 billion to $400 billion.

Perhaps these costs appear small compared with the defense budget. They do not appear small to the cash-strapped urban areas that cannot pay for their most urgent needs. We must face this issue. Congress and EPA cannot blithely impose requirements for which there is not the slightest chance of compliance especially if the need is not clearly established.

HOW SIGNIFICANT IS THE PROBLEM?

Before EPA imposes standards which could result in massive expenditures, it should establish that a real need exists. By real need, we mean a determination that human health or the environment is being harmed. San Francisco made this determination in the 1970s by assessing the risk to the site-specific beneficial uses.

We should not necessarily apply numerical criteria developed for continuous discharges to intermittent ones without making appropriate adjustments. We also need to carefully examine the relevance of the criteria for the beneficial uses we are protecting.

Figure 7 shows the frequency of use of San Francisco's wet weather facilities. As shown, shoreline discharge occurs only about 0.4 percent of the year. The expenditures we are talking about are intended to prevent problems during this relatively limited time frame. Compared with the other human health and environmental risks which we face, is this rather limited period of shoreline discharge that significant? We can examine the potential threats posed by this discharge to assess its significance. The main risks fall into three categories: health risk from pathogens in the discharge, toxicity to aquatic organisms, and human health risk from bioaccumulation of hazardous chemicals.

We have some data that help to place these potential risks in perspective. We have completed more than 300 bioassays on our first flush CSO discharge. Just under half of the 96-hour static bioassays showed no measurable toxicity. Less than 10 percent of the assays showed a toxic response at 56 percent concentration (roughly one part sea water to one part CSO).

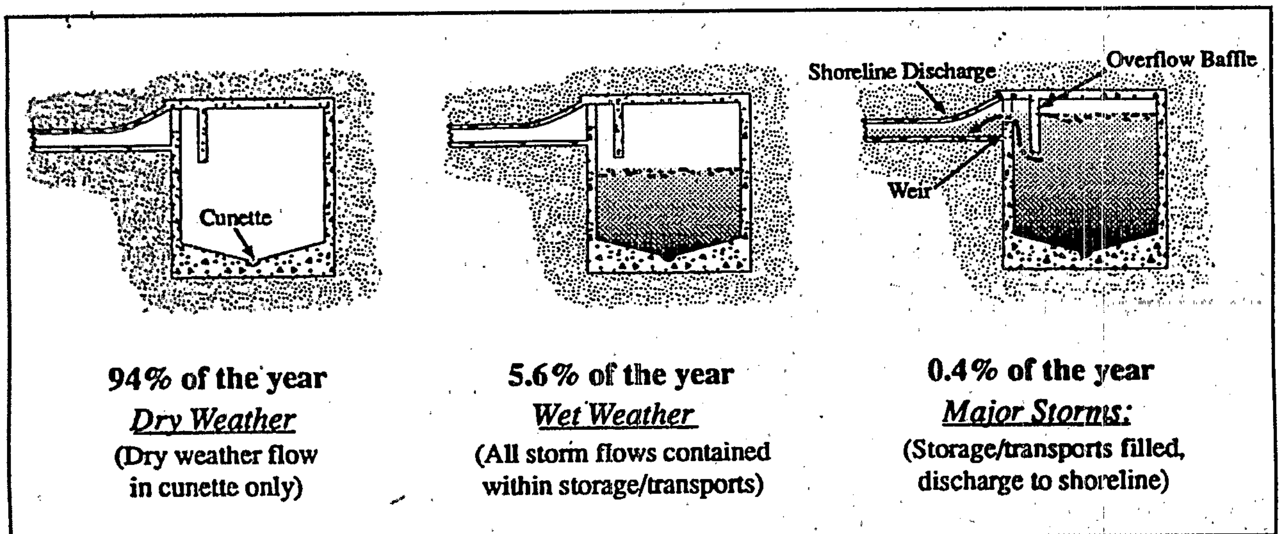

Figure 7. Frequency of storage transport use.

Consequently, the potential for adverse impacts on marine organisms appears limited. As our BMP program further lowers pollutant levels, we expect corresponding decreases in the risk to the environment.

Well what about bacteria? Aren't people getting sick? Prior to starting our construction program we tried to establish the impact on human health of the more than 50 annual overflows. Since the overflows all occur during the winter season, we assumed that health records might show some identifiable trends. The San Francisco Department of Public Health did not have any records of CSO-related illnesses nor did the California Department of Health Services. Because the causes of minor diseases are rarely established, we requested the DPH to complete a statistical regression analysis comparing rainfall (and subsequent overflows) with the most likely enteric diseases to result from the ingestion of CSO-contaminated water. They could find no correlation. Now that our control program is nearing completion, we expect that the health risk posed by pathogens is even less. We are assuming, of course, that we will continue to post the beaches after discharges occur. As with any CSO discharge and many storm water discharges, elevated bacteria concentrations are present and the waters are not safe to enter. In effect, we are foregoing a beneficial use (body contact recreation) for a limited period of time based on a determination that those additional days of use could not be attained in a cost-effective manner.

We must still consider the human health risk posed by bioaccumulative substances. These are apparently our most significant problem. PAHs are a suspected carcinogen and storm discharges violate EPA's criteria by several orders of magnitude. But let's look more closely at this risk. What the standards postulate is that PAHs in the street runoff will enter the receiving waters, bioaccumulate in fish, and when eaten by humans, expose them to these chemicals. Is this a significant route of human exposure? Does it warrant our urban communities shifting hundreds of millions of dollars from other needs to solve this problem? Furthermore, will our solution, wastewater control facilities, reduce exposures to a safe level? These are critical questions for which we must have good answers based on scientific data.

We are concerned that the answers to the questions above will be no. IARC (World Health Organization) reports for benzo(a)pyrene (one of the primary PAHs) that:

> Human exposure occurs mainly through the smoking of tobacco, inhalation of polluted air, and by ingestion of water contaminated by combustion effluents or ingestion of food contaminated by smoking, broiling or exposure to combustion products.

> PAHs from vehicle exhaust are deposited on street surfaces and during wet weather can be washed into receiving waters. PAHs also enter waterways from other sources including aerial fallout. Some aquatic organisms bioaccumulate PAHs; however, most fish will metabolize them. Human exposure may occur as a result of runoff contaminating fish which are subsequently eaten, however, we have not seen a suggestion that this is a route of significant exposure. To the contrary, it appears that if we are exposed to PAHs as the result of eating fish, it is as likely the result of cooking them on our charcoal grill, as from bioaccumulation. Consequently, unless more information is produced, it appears that a massive and expensive control program would at best decrease a minor route of PAH exposure.

In summary, at least in San Francisco, we do not appear to have adequate evidence of real risk to take to our elected officials and citizens to convince them of the need to spend additional hundreds of millions of dollars.

SUGGESTIONS

EPA and the States have only erratically addressed CSOs and storm water discharges in the past. There is a clear need for nationwide direction. First, however, we must recognize some basic facts. CSOs and storm water result from natural phenomena; they cannot be "eliminated." At best we can provide some level of treatment based on an assessment of the environmental and health risks presented by these discharges. Providing full secondary level treatment appears out of the question, although this is the direction we are being driven by the new numeric criteria. Based on our experience in San Francisco, we offer the following suggestions.

1. Implement the National CSO Strategy (baseline program).

   The nine minimum technology (BMP) standards will provide some level of control for all CSO discharges.

2. Base the program on real water quality needs.

   CSOs should not cause health problems or cause acute toxicity to aquatic organisms. If a CSO discharge exposes a significant number of people to elevated bacteria, then the control strategy must address this problem. If the discharge kills fish or is the cause of increased concentrations of hazardous chemicals in marine life, *as determined by actual measurement of fish tissue*, then correction of this problem should be a goal. In other words, the water quality needs must be established on a site-specific basis and must be demonstrated by actual measurements. Hypothetical problems based on theoretical water quality criteria are not an adequate basis for spending hundreds of millions of dollars of limited public moneys.

3. Establish national goals by identifying clear performance standards.

   If national goals are necessary, they should be based on storm flow control system performance, i.e., percentage of solids removed from the storm water and reduction in frequency of overflows. Ideally, as discussed above, the controlling criteria should be local water quality needs.

4. Establish comparability between CSO communities and separated sewer communities.

   To the extent that demands are placed on CSOs, then similar requirements should be placed on storm sewers. CSO systems may have the added burden of correcting bacteria problems; however, the chemical constituents of the discharges are similar. If CSO communities are required, for example, to remove 30 to 50 percent of the solids carried by the storm water component, then separated storm sewer systems should attain the same removals.

5. Recognize our limitations.

   It may not be possible, from the standpoint of public policy, to have all waters fishable and swimmable at all times. In San Francisco, we will spend more than $1,900 per person for wastewater control. Although we believe that we will achieve appropriate control levels, it is clear that our program would not comply with the numerical criteria EPA is considering nor with proposed legislation.

Additionally, we will not be able to attain all beneficial uses at all times. It is not realistic to expect the vast majority of communities, which have not even begun to address storm flow problems, to achieve San Francisco's level of control. The money is simply not there. Almost half of San Francisco's funds came from grants. The grant programs have ended. It is safe to say that the Federal Government is not likely to reinstate them at anything approaching the level necessary to meet the proposed standards. Communities will have to rely on their own resources for these construction costs at a time when cutbacks to schools, police and fire, and health care create much more significant threats to our health and welfare.

6. Base facility planning for CSOs and stormwater controls, not on numerical criteria, but on cost-effective attainment of beneficial uses.

   An assessment of potential beneficial uses can help us identify the real needs and the potential risk to the ecosystem. A cost-effectiveness study can help ensure that we get the most benefits for the funds expended. For intermittent discharges such as CSOs and storm water, EPA's water quality criteria appear to have only limited usefulness for identifying real risks to human health or the environment. The criteria should not be used as the basis for facility planning or for determining compliance.

7. Reexamine our risk assessment procedures.

   Increasingly, we are making decisions for environmental improvements on the basis of risk. This is appropriate and will hopefully introduce consistency across environmental media. A serious problem arises, however, when we multiply a hypothetical worst case risk times hypothetical worst case risk. After several iterations of this practice, we end up with a theoretical risk which is not a valid basis for committing limited public resources. This is especially true in an era of increasing illiteracy, hunger, and homelessness. (It is also possible that we are saddling the private sector with costs that yield only limited benefits.) If we are going to use risk as the basis for major expenditures, we need a risk assessment procedure that strives to determine the "reasonable real risk."

8. Let's cooperate and communicate.

   It is the goal of all of us to have oceans and rivers as clean as we can make them. Many of us at this meeting have, in fact, dedicated our professional lives to this goal. In San Francisco we believed that we were making major strides toward protecting public health and the environment. Recently, however, we were accused by several prominent environmental organizations of wantonly causing sickness and refusing to correct water pollution problems. Several groups have challenged our Oceanside discharge permit and are demanding more facilities whose costs will exceed $1/2 billion. Citywide, the demanded facilities would easily exceed $1 billion. These costs are in addition to the $1.4 billion we are currently planning to spend on wastewater control. These challenges are not based on demonstrated problems with water quality or human health. If, in fact, such risks were present, then yes--more would need to be done. We need more willingness to communicate by all parties involved in these disputes.

CONCLUSION

In the coming months, EPA will establish its program for solving the water quality problems caused by storm water. At the same time Congress is assessing modifications to the Clean Water Act. This is an excellent opportunity to structure the program so that we address the site-specific risks presented by wet weather discharges and assure that our limited resources are used for the most pressing problems.

COMBINED SEWER OVERFLOWS AND THE CLEAN WATER ACT: PROMISE UNFULFILLED

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This year we celebrate the 20th anniversary of the Clean Water Act (33 U.S.C. 1256), one of the earliest and most ambitious environmental acts ever adopted by the U.S. Congress. To the optimist, this anniversary represents the culmination of billions of dollars in water pollution cleanup efforts and a marked improvement in the Nation's general water quality while still accommodating 20 years of economic growth and prosperity. To the pessimist, this anniversary is a bitter pill, with thousands of the Nation's rivers, streams, and lakes closed to the taking of fish for human consumption, the battle for control of toxic pollution still floundering, and raw sewage a common occurrence in many U.S. cities. Regardless of your viewpoint, most will agree that the task of returning all the Nation's waters to the Act's objectives of fishable and swimmable will take considerably more time.

Perhaps one of the most visible tasks left undone under the Act is the control of combined sewer overflows (CSO). Through a combination of EPA failures, lack of money, court decisions, and just plain recalcitrance, we still have over 1,100 cities and towns in the United States that discharge raw sewage, along with untreated or partially treated industrial waste, into our Nation's waters virtually every time it rains (U.S. EPA, 1992).

It is not the purpose of this paper to review the reasons for the failure of CSO controls to date, although some of the reasons will undoubtedly impact our decision process in the future. Rather, this paper is to express an environmentalist view of what must now be done to correct the CSO problem, and how it can best be achieved.

There is an old Chinese proverb that says "unless we change the direction in which we are headed, we will surely get there." Thus, we start the analysis of the CSO problem with a return to the fundamental objectives of the Clean Water Act: that the discharge of pollutants into the navigable waters be eliminated by 1985; and wherever attainable, that water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water be achieved by 1983 [33 U.S.C. 1251(a)(1)-(3)]. Somewhere along the line, some have begun to advocate that those objectives are no longer reasonable, or not applicable to CSOs. The environmental community does not share that view, but believes that the original objectives of the Act, regardless of the date of attainment, are the fundamental and minimal objectives to which we must adhere. Already, our past mistakes have thwarted the realization of these objectives in some areas for decades into the future. But that does not have to be the case with CSO controls.

There is no question that CSO discharges cause pollution. The full impacts of CSO discharges are unknown, since both State and EPA monitoring and reporting for CSO impacts are sporadic and incomplete (U.S. EPA, 1992). We do know that CSO discharges have a significant impact on stream use attainment. Nowhere is this more apparent than in shellfish waters, where CSO discharges have adversely affected as much as 54 percent of the shellfish waters in the Northeast (Leonard et al., 1989), and nearly 10 percent of all harvest-limited areas nationwide (NOAA, 1991).

CSO impacts are not limited to shellfish waters, however. They are also a major factor in the closing of beaches and other recreational areas across the United States. Again, no reliable national statistics are available, but a study by the Natural Resources Defense Council (NRDC) noted more than 2,000 beach closings in our coastal States in 1991, most of which were due to CSOs and other human sewage problems (NRDC, 1992). It is not uncommon for major cities to have numerous CSOs alongside designated park and recreational areas, since both tend to follow stream routes. Even beach closing information, when available, is not comprehensive. Many State Health Departments simply post warnings along stream banks and have long ago given up trying to enforce and maintain recreational water closures in the face of human demands for such resources.

The contravention of established and recognized stream uses in shellfish waters, public beaches, and other park and recreational areas violates the fundamental objectives of the Act, and forms the basis for the first minimum step in CSO control sought by the environmental community (that is, the elimination of CSO discharges in waters designated for use as public beaches, shellfish production, drinking water supplies, and waters containing unique ecological habitats or designated as outstanding natural resource waters).

Elimination, not mere control, of CSOs in these sensitive waters is required because the mere existence of a CSO in such waters contravenes use by its very presence. Responsible health authorities do not wait and cannot wait for bacterial analysis, which may be delayed by 24-48 hours after overflow events, to act to close shellfish waters. They must assume that raw sewage contains bacteria and other potentially harmful wastes (not an illogical or unreasonable assumption) and act accordingly. The same is true for other swimming and recreational waters. In fact, several States and cities [Delaware, Maine (Portland), New York City, Maryland (Cecil County)] now have "rainfall standards" for closing coastal beaches in recognition of this fact (NRDC, 1992). The prohibition of CSO overflow facilities must include the sensitive waters listed above, as well as any CSO located outside such areas, but sufficiently close so as to negate these uses in the same manner as if the CSO were located directly therein.

The elimination of CSOs into sensitive areas would be achieved by either (1) total containment, treatment and discharge at authorized points not impacting sensitive waters; or (2) collection and conveyance to other treatment facilities or treatment and discharge at points that are not located in sensitive waters.

CSOs that discharge into all other waters should receive treatment according to promulgated best practical treatment technology guidelines for CSOs, or that treatment necessary to meet water quality standards, just like all other discharges of pollutants under the Act. At a bare minimum, best practical treatment for CSOs should consist of several stages: screening, solids removal, and disinfection (followed by removal of disinfectant chemicals) where appropriate.

All CSOs should be subject to some form of screening for removal of debris, floatable waste, and other inert solids. Many technologies are available to achieve this treatment. Screening will remove some of the most objectional visible and aesthetic pollutants such as personal hygiene items, styrofoam, and cans, as well as potentially dangerous items such as needles and medical wastes. The American public is tired of beaches littered with condoms, tampons, syringes, and all other manner of sewage debris. While not all stream or beach litter comes from CSOs, every CSO outfall makes a significant contribution, usually of the most undesirable and unhealthful items (New York City Council, 1990). Screening is a feasible and readily available technology that has been employed in standard sewage treatment for decades.

Solid organic wastes should be removed from all CSOs and treated. Solid wastes harbor bacteria and viruses that are difficult or impossible to disinfect without further treatment and extensive contact time with disinfection agents. These solids, which may be many times higher than standard secondary treatment levels, contribute to dissolved oxygen consumption and elevated bacterial counts in receiving waters (NRDC, 1990; Ellis, 1986).

Excessive levels of solids in CSO wastewater also make it extremely difficult to meet water quality bacterial levels in receiving waters. As a practical matter, it is difficult to disinfect water with high solids content, and usually requires long disinfectant contact times, which translate into large holding facilities for both disinfection and removal of disinfection chemicals prior to discharge.

New technologies are being developed to enable solids removal of high-volume wastes over short periods of time. In addition to the traditional holding basin, which is now in use at many cities, swirl concentrators and vortex separators, which employ principles of centrifugal force, are being applied to high-volume CSO wastewater (Rubin, 1990). While these devices are generally less expensive than large holding basins, their application may be limited.

Solids removal is also important for control of toxic pollution. Many toxic pollutants will adhere to sewage solids and become deposited in the sediments of receiving waters, where they may then be resuspended or become soluble in the overlying water. Given the increasing stringency of water quality standards, as well as impending EPA rules on sediment quality standards, many water bodies will probably experience violations of these standards without CSO treatment. At the very least, contributions from CSOs may contribute so much to "background" ambient water quality conditions as to result in ambient water quality standard violations, such that discharges from traditional point sources may be severely limited.

Finally, CSOs must be disinfected if necessary to meet receiving water bacterial standards. Given the tremendous discharges of CSO waters into the populated areas of our major cities, it has been truly remarkable that more serious health effects have not been reported. It is very likely that many instances of bacterial infection such as stomach upset, diarrhea, or skin infections have gone unreported by citizens who failed to seek medical assistance or did not associate their exposure to CSO wastewater with disease incidence.

The time may be limited, however, before a major outbreak of disease caused by CSOs occurs. The American population has become increasingly susceptible to outbreaks of contagious disease (e.g., cholera) because few people continue to receive immunization against serious diseases that have disappeared from the continental United States. These diseases still exist worldwide, however, and carriers are capable of spreading disease through untreated wastewater discharges. Additionally, higher numbers of our citizens are suffering from decreases in their natural immune systems, creating new opportunities for old diseases such as tuberculosis to regain a foothold in the general population. As the demand for water-related recreational opportunities increases, a vulnerable population is drawn ever closer to CSO-contaminated areas.

These basic requirements, screening, solids removal, disinfection (and removal of disinfection chemicals where necessary) form the core of "best practical treatment" technology for CSOs. Properly implemented, with a grain of common sense applied to the receiving stream situation, these facilities will probably be all that is needed for many areas.

In some instances, because of stream uses, location, dilution, etc., attainment of water quality standards will require a higher level of treatment. This is no different than the situation today for all dischargers. Attainment of water quality standards as a minimum requirement has always been a fundamental objective and requirement of the Act. We see no reason to alter that principle now. To do otherwise takes us down the slippery slope of an increasing legacy for future generations of lost resources, pollution, and deferred expenses.

Protection of stream uses, however, upon which water quality standards are based, does not necessarily require full secondary or greater treatment of CSO wastewater, nor the containment of every imaginable overflow event. Basic water uses, such as swimming, fishing, and boating, are not available, or safe, during floods. At some point, nonpoint source pollution from general runoff during large storm events will cause streams to exceed bacteriological standards. On other occasions, large rainfall events occur so infrequently that the construction of treatment facilities is not practical.

Finding the right mix of conditions and treatment requirements for water quality use attainment is the difficult task. The old axiom "the devil is the details" is certainly applicable here. However, municipalities that have seriously considered this problem have come up with remarkably similar conclusions. No matter how it is measured--storm events per year, time/duration, or any other formula--the result is about the same: Only a few uncontrolled, or partially treated, CSO discharges per year can be tolerated without serious adverse impacts on stream uses.

In general, the number of resulting overflows is about four per year, although the number can vary from one to six or more in some circumstances. Treatment levels also may vary, but most CSOs receive basic levels of treatment for solids removal and, if necessary, disinfection. Examples of this variability are tabulated by EPA in their review of nine State programs in EPA's evaluation of wet weather design standards for controlling pollution from CSOs (EPA, 1992). In many areas of the country, correlation between one to four storm events yearly and the ability to enjoy expected stream uses is probably pretty good, although such data have never been specifically calculated in that fashion. For these reasons, we believe that EPA should look at an overflow frequency of four times per year as a generalized approach to water quality use attainment (this excludes, as previously noted, the ban on all discharges to sensitive areas).

The degree of treatment provided for these four overflow events, indeed the degree of treatment provided for even more frequent events, must depend on the receiving stream uses and physical conditions. Extreme overflows, such as major flood events, will probably not receive much, if any, treatment. Most other events, however, can receive basic screening and solids removal, and solids removed should be routed to standard treatment handling facilities. Certainly, all CSO discharges occurring more than four times per year should receive this basic treatment. Whether this basic treatment involves extensive holding basins or flow through separators will probably be dictated by water quality needs. In some cases, only secondary levels of treatment may prevent water quality violations; basic primary settling may be enough in other areas.

Flow volumes exceeding the maximum treatment capacity of existing systems can be held in holding basins and rerouted to treatment facilities when flow volumes decrease. There is no reason, given existing capacity, why these CSO wastewaters cannot receive a modified level of secondary treatment. By using a combination of water conservation, inflow/infiltration elimination, basic system repair, holding basins, expansion of existing treatment facilities, centrifugal solids removal devices, and screening, many CSO events up to four or less times per year can receive basic treatment, or even a modified level of secondary treatment.

With some exceptions, treatment to a lesser degree is likely to result in stream use violations. For this reason, we encourage planners and engineers to seriously consider the maximum utilization of treatment systems and holding to avoid the uncomfortable position of investing millions of dollars into a control system which does not ultimately protect stream uses. Unfortunately, this is happening all too often today as EPA struggles to get any facially reasonable plan in place.

It is absolutely clear that the magnitude of the CSO problem nationwide will require the expenditure of large amounts of money. We have not come to where we are today in pollution control without the expenditure of billions of dollars in Federal construction grants, loans, State and local funds, and private capital. As Congressman Nowak of New York, Chairman of the House Subcommittee on Water Resources, noted at a recent CSO control hearing: ". . . CSO control without some reasonable funding program to accompany it . . . will be an empty promise."

The environmental community is well aware of this need and fully supports the commitment of Federal funds to State Revolving Loan programs to help fund CSO work. Past limitations on CSO expenditures from such funds should be eliminated, and States should be given the flexibility to allocate funds in the most effective manner. It must also be recognized, however, that CSO work, especially the rehabilitation and separation of combined sewers, is also a part of the long-term maintenance and operation of sewer systems. All too frequently, the rate charged for sewer and water services has not accurately reflected the true cost of providing such services. The gap between costs and rates must be closed to place such systems on a sound operational basis.

Programs must also be initiated to reduce sewer flow and the volume of CSO wastewater while increasing existing sewage treatment capacity. Programs to increase water conservation, and to eliminate unnecessary connections to sanitary sewers such as household storm drains and sewer infiltration must be aggressively pursued. Modern sewage treatment is simply too costly to treat spring water and household runoff. Increased use of zoning controls, erosion and sedimentation laws, and other land use measures can be employed to divert and contain storm water. Many cities may find that combining recent EPA storm water controls with CSO programs may be cost effective. Temporary holding by industrial contributors during overflow events may prevent many toxics from entering overflowing systems.

Many major U.S. cities have begun to address their CSO problems. Some have already invested heavily in control mechanisms and are now doing what many have attempted to characterize as impossible or too costly. Where such facilities have achieved a reasonable parity with this proposed program and have protected stream uses, cities should not be penalized and forced, in the name of rote compliance with new standards, to undo what has been done. In such cases, grandfathering provisions should provide for those cities who have substantially completed CSO abatement systems and are meeting established stream uses.

CSO abatement will be expensive and it will take time. But such treatment will restore thousands of acres of shellfish beds and untold stream miles to beneficial uses for boaters, swimmers, and fishing enthusiasts alike. Perhaps even more important, we can look forward to the day when raw sewage no longer flows into our Nation's waters.

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Whole Effluent Toxicity

WHOLE EFFLUENT TOXICITY: THE BASIS FOR EPA'S REGULATORY CONTROL PROGRAM

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With the passage of the Clean Water Act in 1972, the U.S. Environmental Protection Agency (EPA) started a long-term program aimed at restoring and maintaining the chemical, physical, and biological integrity of the Nation's waters. Removing the discharge of toxic materials in toxic amounts to surface waters is one major element in this effort. The initial phases of this program used chemical-specific water quality standards and treatment technology principles to reduce discharges of toxic and conventional substances. EPA data from the early 1980s suggested that further reductions were necessary to achieve the State water quality standards requirement of "no toxics in toxic amounts." These data showed that approximately 40 percent of NPDES facilities across the country discharge sufficient toxicity to cause water quality problems.

On March 9, 1984, the U.S. EPA issued a policy designed to reduce or eliminate toxics discharge and to help achieve the objectives of the Act. The Policy for the Development of Water Quality-Based Permit Limitations for Toxic Pollutants (49 FR 9016), described EPA's integrated toxics control program. The integrated program consisted of the application of both chemical-specific and biological methods to address the discharge of toxic pollutants. To support this policy, EPA issued the Technical Support Document for Water Quality-Based Toxics Control (TSD) guidance. EPA continued the development of the toxics control program by revising the TSD in 1991 and by including some aspects of the policy into NPDES regulations at 40 CFR 122.44(d)(1) in June 1989.

NPDES permitting authorities in EPA Regional Offices and in States authorized to administer the NPDES program are now issuing permits to assess and control the discharge of whole-effluent toxicity. By 1990, States and EPA Regions issued about 2,500 permits with whole-effluent toxicity (WET) monitoring or limits. About 24 percent of these permits had effluent limits for toxicity. The environmental response is also occurring. The Region 4 program has seen a reduction in effluent toxicity from 75 percent of the facilities to 45 percent, a 40 percent reduction.

EPA'S POSITION REGARDING TOXICITY

EPA believes that whole-effluent toxicity controls are needed because chemical-specific controls cannot cover all potentially toxic pollutants present in an effluent. The SARA Title III Toxics Release Inventory database shows the release of many more pollutants than EPA's 126 priority pollutants. EPA's report to Congress on the pretreatment program also shows that significant amounts of nonpriority pollutants enter municipal treatment systems. Chemical-specific limitations alone cannot account for the interactions of toxicants in complex mixtures.

EPA believes that whole-effluent toxicity controls can be applied in a manner similar to those used for controlling specific chemicals. Whole-effluent toxicity controls provide a direct and supportable way to protect aquatic life as shown in EPA's Complex Effluent Toxicity Testing Program studies and in other studies conducted by the State of North Carolina, University of Kentucky, and University of North Texas. Whole-effluent toxicity tests, when properly conducted, are no more variable than chemical analytical methods that have been successfully used to develop and enforce NPDES permit limits. A proper toxicity testing program includes replicate and control exposures, rigorous QA/QC requirements, and standardized statistical data interpretation to minimize method and laboratory variability. EPA believes that the only significant difference between whole-effluent toxicity and chemical controls is that facilities need to conduct the additional step of determining which pollutants cause the toxicity before being able to develop a treatment or source reduction plan for removing the toxicity.

MAJOR ISSUES OF TOXICITY CONTROLS

Two principal issues arise regarding use of whole-effluent toxicity in regulatory programs. Since most regulatory applications of whole-effluent toxicity have been by effluent limits in NPDES permits, most of the issues pertain to permit liability.

First, some members of the regulated community believe that no enforcement action can occur until a facility demonstrates a pattern of toxicity, that is, the toxicity occurs frequently. Besides concerns about permit liability, three factors contribute to this belief: EPA's toxicity identification evaluation (TIE) methods for determining the causes of toxicity require a continued presence of toxicity for successful completion; EPA's field studies that correlated the presence of effluent toxicity to actual ambient impairment of aquatic life were conducted in surface waters that experienced continual toxicity; and environmental engineers may have limited experience in designing wastewater plants that will meet a toxicity objective all the time.

Second, some members of the regulated community believe that no enforcement action can occur if a facility is actively attempting to resolve the problem, that is, the facility is showing the appropriate diligence in trying to comply with the permit limit. Again, in addition to concerns about permit liability, two factors contribute to this belief. In many instances, a facility will not know the pollutants that cause the effluent toxicity. In addition, some POTWs may not know the sources of these pollutants. Therefore, all facilities may not be readily able to identify and remove the causes of effluent toxicity and do not believe they should be subject to enforcement action until they can identify the causes and sources.

QUESTIONS FOR THE PANEL DISCUSSION

Most regulatory applications of whole effluent toxicity have been through effluent limits in NPDES permits. As a result, most of the big questions relating to toxicity have pertained to permit liability. However, this is a water quality standards conference, and it's only fair today to discuss questions about interpretations of water quality standards. I'd like each of the panel to give their perspectives on the following:

- To what types of water does the acute criterion apply: all waters or only those with aquatic life uses?

- To what types of water does the chronic criterion apply: all fishable uses, or only those with high-quality fishable uses?

- Where does the acute criterion apply: end of pipe or edge of mixing zone?

- How are the frequency, duration, and magnitude aspects of criteria inter-related? Do the same frequency (one event in 3 years) and duration (1-hour and 4-day averages) assumptions used for chemical criteria apply?

- What type of organisms should be used in monitoring: indigenous, sensitive, or representative?

- Will a 304(a) criterion document for toxicity provide any benefit?

WHOLE EFFLUENT TOXICITY TESTING: AN EFFECTIVE WATER QUALITY REGULATORY TOOL - THE NORTH CAROLINA EXPERIENCE

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ABSTRACT

The use of whole effluent toxicity testing has become a valuable method for regulation of toxic discharge to the surface waters of North Carolina. The North Carolina experience demonstrates that this technique can be applied as a limited parameter in NPDES permits with expected compliance rates equivalent to those of conventional pollutants. North Carolina applies these limitations to protect instream chronic toxicity at the 7Q10 low stream flow statistic. After a complete 5-year permit cycle where these limitations have been included in NPDES permits, compliance rates across the State are 89 percent. During this permit cycle, all facilities having a complex waste stream or those designated as a major discharge (>1.0 MGD) were issued permits with the previously described limits. Experience has demonstrated that both municipal and industrial waste streams found to be initially toxic can be reduced in toxicity to meet these limits, even when the discharge is to an effluent-dominated stream.

NORTH CAROLINA HISTORY

Traditional methods of regulating the discharge of toxic substances to surface waters use chemical criteria or standards to allocate specific quantities of these substances to a specific water body. These chemical criteria are developed to protect a designated "use" of the receiving waters. The uses typically include support of healthy aquatic communities. A numerical criterion to protect this use can be developed using an array of laboratory exposure data to determine an acceptable quantity of the toxicant of concern. These criteria can then be utilized to develop discharge limitations in an NPDES permit.

Chemical-specific limitations are extremely effective at protecting surface water uses. Effluent discharges, however, are complex mixtures of chemicals. Both the regulated community and regulators need another tool to allow the combined effects of these mixtures of chemicals and unknown constituents to be evaluated. Biological monitoring provides that tool. Because the "use" that is being protected is aquatic life propagation, biological monitoring provides a direct evaluation of attainment of that protection. Biological monitoring may take place either in the receiving waters (field survey) or in the laboratory (toxicity testing). Both of these measures provide valuable information regarding the health of the resource being protected.

Field collections of biological communities provide a summary of the environmental conditions for a period prior to the sampling event. This period is dependent upon both the population being sampled and the type of insult received. A skilled investigator can use these biological surveys to quantify the health of the system and often may identify the cause or causes of any degradation that may have occurred.

Because biological survey of the receiving waters provides such a comprehensive evaluation of the health of the water body, it is difficult to use as a tool to specifically limit the discharge of toxic substances. This is where biological monitoring in the laboratory becomes extremely useful. In the laboratory, the physical impacts to the receiving stream (e.g., destruction of habitat) can be isolated from the chemical impacts. When a laboratory test is performed to evaluate biological responses to a waste discharge it is termed a "Whole-Effluent Toxicity (WET) test."

The WET program began in North Carolina in the early 1980s with a surveillance program administered through the North Carolina Water Quality Section of the Division of Environmental Management. This initial surveillance program identified facilities that were predicted to cause acute lethality to inhabitants of the receiving waters. Initial results published in 1986 indicated that 25 percent of the facilities tested were found to be acutely toxic in-stream (Eagleson et al., 1986).

During these early investigations, cost-effective short-term chronic assays were not available to staff. Therefore, the test results reflect only instances where acute mortality was expected. If chronic techniques had been available, the portion of streams predicted to be impacted would certainly have been greater. These statistics indicate that the typical permitting strategies in use at the time were not completely effective in controlling toxic discharge to surface waters.

Because of the frequent occurrence of discharges predicted to impact our surface waters, North Carolina began a program utilizing WET limits in NPDES discharge permits. This program was begun in January 1987 and has been in place relatively unchanged since that time. Since 1987, all NPDES facilities having a complex waste stream or who had a discharge volume >=1.0 MGD received WET limits based on their instream waste concentration (IWC). Instream waste concentrations are calculated as the percentage effluent in the receiving stream while the facility discharges at maximum permitted capacity during a low stream flow event. North Carolina uses the 7Q10 as its low flow stream statistic. The 7Q10 value represents the lowest weekly average stream flow that has a probability of recurring once every 10 years. These are the same statistics used when allocating a chemical-specific substance for the protection of aquatic life. Testing protocols were based primarily upon the *Ceriodaphnia* chronic procedure published by the U.S. EPA (1985) and modified by the North Carolina Environmental Sciences Branch (North Carolina Division of Environmental Management, 1985). These procedures limit the facility to discharging a waste stream that will cause neither significant survival nor reproductive reductions at the IWC.

PROGRAM VALIDATION

North Carolina's early experience with the WET test procedures has indicated that direct experience of the personnel performing these analyses and rigid adherence to specified protocols are the most important factors in both successful completion of the test and repeatability of the analysis. To ensure that the laboratories performing the analyses are adequately staffed and that the laboratories are following specific quality control requirements, a Laboratory Certification Program was established through the adoption of regulations in 1988. Through these regulations, any WET data submitted as part of an NPDES permit requirement must be performed by a laboratory certified by the State of North Carolina.

North Carolina is extremely comfortable with the utility and effectiveness of the WET program. Our laboratory has performed more than 1,500 toxicity tests and has reviewed an additional 9,500 submitted as self-monitoring data. Overall, the tests have been both repeatable and reflective of toxic impact in the receiving water body. Early in our program we performed and published a series of validations where predicted laboratory impacts were compared with actual instream measures of environmental impacts. In this study, we found that the laboratory tests were strong predictors of environmental impacts (Eagleson et al., 1990). Similar findings are also found in the U.S. EPA Technical Support Document (U.S. EPA, 1991) and by other authors (Dickson et al., 1992; Mount et al., 1992; Mount et al., 1985; Mount and Norberg-King, 1986; Norberg-King and Mount, 1986).

Reliability of aquatic toxicity testing has been widely evaluated, and numerous publications are available for review of the subject. Precision of the analyses (the ability for multiple tests to derive similar results) have been shown to be equivalent to that of many chemical-specific analytical techniques used in the NPDES Program (U.S. EPA, 1991; Anderson and Norberg-King, 1991; DeGraeve et al., 1992). We have reviewed a series of 45 split WET samples submitted by NPDES permittees and have found an agreement rate of 96 percent in determination of compliance/noncompliance where the results reasonably represented the same analysis. Whole effluent toxicity analysis, as applied in North Carolina, is clearly suitable for routine application in the NPDES permitting process. This application, however, though must be accompanied by active quality assurance and data review programs. Data submitted that have been improperly analyzed and that haven't met stated quality objectives are not reflective of a poor protocol but rather of poor application of that protocol. Analytical problems which arise in a particular test do not imply unreliability but rather point directly to safeguards and quality measures built directly into each analysis. These problems should neither be overlooked nor grouped with conclusions that the protocols themselves are flawed. Statistical analysis techniques defined for each method take into account the within-test variation that may occur and account for this variation by decreasing the sensitivity of that analysis, effectively limiting to a defined degree, the possibility that a "false positive" result is declared.

PROGRAM RESULTS

The North Carolina WET program, using chronic limitations in NPDES permits has been in place nearly 6 years. During this time, we have included WET limits on almost every complex waste discharge. Historically, both regulatory agencies and the regulated community have questioned as to whether WET limits based on chronic criteria would establish criteria too burdensome for compliance. Our experience demonstrates that this is not the case. At the submittal date of this manuscript, North Carolina had issued 539 permits that contain WET limits (270 to municipalities and 269 private industrial). Figure 1 depicts compliance rates for these facilities with an overall compliance rate of 89 percent (95 percent for municipals and 83 percent for industrials). These rates are equivalent to those we experience for the conventional parameters of BOD, solids, and ammonia (approximately 85 percent).

These high compliance rates for WET reflect significant effort at toxicity reduction on the part of North Carolina discharging facilities. It is important to note that very early in North Carolina's program, 1 in 4 dischargers was acutely toxic and after only 6 years only 1 in 10 is chronically toxic. When comparing the compliance rates for WET limits with those of conventional pollutants, it is important to remember that wastewater treatment facilities are typically engineered to meet the conventional limits, and that WET limits were placed in most permits after the facilities were designed and built. Even so, compliance with WET limits will soon significantly exceed compliance rates of the conventional pollutants.

For all water quality-limited parameters (including WET limits based on the IWC), compliance becomes more difficult as the percentage of effluent domination (IWC) increases. In these instances, the specific chemical limit more closely approximates the water quality standard, and the WET limit requires no impairment to the test organisms in essentially 100 percent effluent. A review of the data set depicted in Figure 1 but grouped by IWC indicates, however, that the compliance rates are reasonably consistent. These data may be viewed in Figure 2. A strong trend toward noncompliance at the higher IWCs does not exist. These results reflect considerable effort by the dischargers at addressing their WET limitations. They also reflect the fact that when challenged, the facilities are able to address chronic toxicity within their wastestreams even at the higher IWCs.

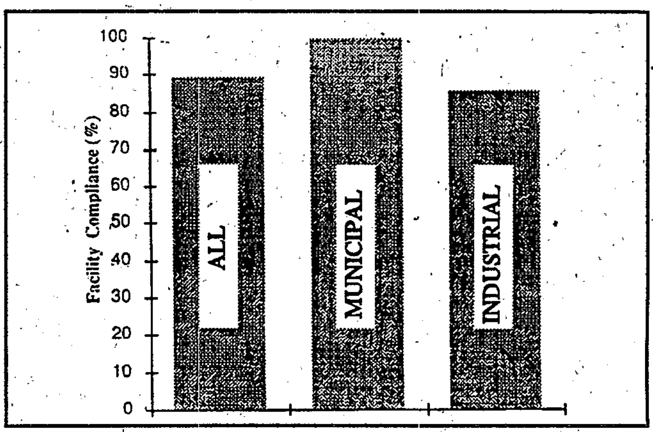

Figure 1. Facility compliance.

Figure 2 indicates that the lowest grouping between 0 and 25 percent waste has a compliance rate of 98 percent, while the most effluent-dominated group (>=76 percent) has a compliance rate of 76 percent. These compare favorably with typical compliance rates for conventional parameters. In many instances of noncompliance, the causes or remedies of the toxic condition have been discovered and actions have been taken that are predicted to resolve a noncompliant condition. Continued efforts on the part of our discharging community will eventually move these compliance rates even higher.

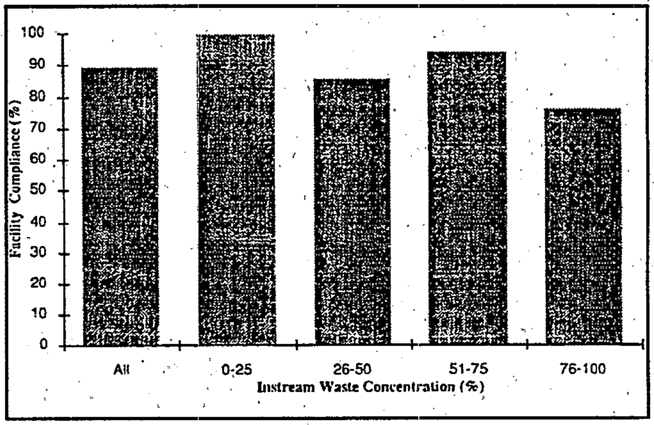

Figure 2. Facility compliance vs. instream waste concentration.

NATIONAL APPLICATION

It is felt that the North Carolina experience validates the use of WET limitations based on chronic criteria allocated at low flow (North Carolina uses 7Q10). Even in effluent-dominated streams, these limits have been found to be reasonably achievable. Waste allocation to these effluent-dominated streams is frequently encountered within North Carolina's permitting program as evidenced by the histogram found in Figure 3. This information depicts frequency of occurrence of the IWCs for the same dataset found in Figures 1 and 2. Effluent-dominated streams constitute the majority of permits that must be addressed in North Carolina. In fact, 20 percent of the facilities constitute 90 percent or more of the receiving stream. Because the objectives of the Clean Water Act and those of the North Carolina General Statutes require protection of aquatic life uses, even these instances in North Carolina are limited at the IWC using chronic criteria.

National application of the WET program should be equivalent to application of chemical-specific limits with regard to protection criteria and allocation. Chemical-specific criteria for the protection of aquatic life (outside a mixing zone) as required by the Clean Water Act demand protection against chronic impacts. WET limits must be set equivalently. They must be enforceable, limited parameters providing protection during the same low stream flow events protected by chemical-specific limitations. In instances where a noncompliant condition exists, North Carolina has found Consent Orders (SOCs, JOCs) to be an extremely effective control method by allowing the facility and regulatory agency to work toward a resolution of the problem. They provide utility when working either with chemical-specific parameters or WET limits.

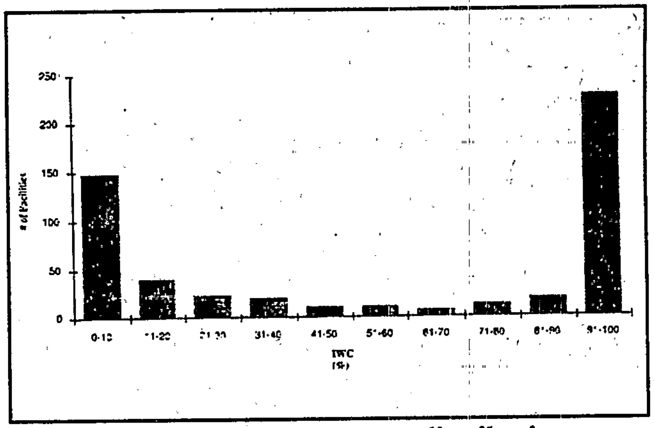

Figure 3. IWC frequency distribution.

North Carolina has found that the use of WET testing as part of its regulatory program has directly benefited surface water environments of the State. The program has been applied using the same administrative techniques as chemical-specific standards. Toxicity problems have been effectively resolved by the discharging facilities, and compliance rates continue to increase. WET limits in NPDES permits have been proven practical and effective at controlling toxicant discharge. North Carolina expects that these same results will be found by other agencies as they pursue application of chronic WET limits in their own NPDES permitting programs.

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WET CONTROL: SQUARE PEGS DO NOT FIT IN ROUND HOLES

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INTRODUCTION

In 1988, the Colorado Water Quality Control Commission, after a lengthy and in-depth hearing process, adopted one of the first comprehensive biomonitoring programs in the country.[1] That original regulation, and the numerous redrafts developed since 1988, have become the cornerstone for two important lessons in regulatory management. First, when floundering in the arena of new, scientifically based regulatory undertakings with a Federal genesis, State agencies will often be best served by remaining on the slow road to heaven if not indefinitely parked in limbo. Second, in confronting a Federal bureaucracy with 18,000 staff and a $4.5 billion budget, those who conform are blessed, those who conflict are damned, and whether one is treated as St. Michael the Archangel or Mephistopheles depends in large measure on who is sitting on the right hand of God on a given day.

To better understand the nature of this controversy and hopefully to identify some middle ground upon which sound future decisions can be made, this article will initially describe the key provisions of the original Colorado biomonitoring regulation and disclose the current status of that enactment. This will be followed by a brief analysis of significant legal and technical arguments. The article will conclude with a commentary upon the significant public policy issues which have fueled the debate, while identifying a possible legislative solution. Though the article will be presented from the perspective of publicly owned treatment works (POTWs), many of the same concerns are shared by private dischargers.

THE COLORADO BIOMONITORING REGULATION

In December 1988, the Water Quality Control Commission of the State of Colorado adopted a biomonitoring regulation which unfortunately became known as the "diligence approach" to whole effluent toxicity control. Under the program, "permit violation and enforcement [were] based on the diligence of efforts to investigate and eliminate toxicity once detected," rather than upon the mere presence of toxicity.[2] Failure of a single quarterly WET test would trigger accelerated testing to determine if a pattern of toxicity existed, or if one was simply dealing with a one-time episode. If a "pattern of toxicity" were detected, the permittee would begin a preliminary evaluation to determine the possible cause. If that investigation proved inconclusive, a two-phased toxicity reduction evaluation process would be triggered, including a Phase I toxicity reduction evaluation (TRE) which would involve an identification and characterization of the source of toxicity, and if necessary, a Phase II TRE which would involve a site-specific plan to further investigate, and take steps to eliminate, the toxicity. Each step in the process was the subject of stringent time frames and identified test procedures, each of which was strictly enforceable. An "enforceable" toxicity incident would arise when there existed a pattern of toxicity and the permittee displayed a lack of diligence in investigating the cause and/or initiating a control response. A failure to perform routine or accelerated testing, a failure to meet required deadlines for completing a TRE, or a failure to develop and implement plans to eliminate the toxicity once it was identified were prime examples of a "lack of diligence." The "intent" of the permittee, as referenced in 40 C.F.R. §123.27(b) (1991), was not relevant if the defined steps were not undertaken in good faith.

The original regulation also provided that if, despite due diligence, the cause of the toxicity could not be located, one could file a request for administrative relief from further investigation and testing if certain other conditions were met, including compliance with all remaining permit conditions. The regulation also allowed a credit if the toxicity was determined to be the result of pass through from the intake water, while providing for relief in the form of episode closure if the toxicity spontaneously disappeared during the preliminary investigation or the Phase I or Phase II TREs. Finally, in the absence of published test protocols, the regulation contained a provision for chronic toxicity testing in the discretion of the State Water Quality Control Division, but did not establish a "chronic toxicity limit" or an "enforceable toxicity incident" based on chronic test results.

In response to EPA objections over the diligence approach, which objections lead to the Region 8 EPA veto of certain individual discharge permits,[3] the Water Quality Control Commission engaged in discussions with EPA in an attempt to reach an acceptable compromise. In April 1991, a public hearing was held in Denver, Colorado, for purposes of reviewing the Colorado biomonitoring regulation as a substantial program revision under Federal regulatory requirements.[4] In June of 1991, and again in November of 1991, the Commission made additional revisions to the State regulation. These were made in response to both EPA's protest that the so-called diligence approach was inconsistent with certain Clean Water Act statutory and regulatory requirements,[5] including EPA's June 1989 changes to the discharge permit regulations,[6] and the cry of certain State permittees that they could not live with "dual" permits, especially if EPA could use the biomonitoring issue to renegotiate other unrelated permit conditions.

The salient features of the current State regulation to which EPA still objects include the following:

- The regulation does not provide for the imposition of enforceable chronic limits, which EPA finds objectionable under §301(b)(1)(C) of the Act and 40 C.F.R. §122.44(d)(1) (1991).

- The regulation does currently provide for a finding of an enforceable violation upon failure of a single quarterly biomonitoring test, but does not consider additional test failures during the accelerated testing, TIE and TRE, to be separately enforceable failures, which EPA finds contrary to §309 of the Act and 40 C.F.R. §123.27(a)(3) (1991).

- The regulation states that acute toxicity limitations are maximum daily limitations, exceedence of which are to be considered a "single day" of violation. EPA finds this contrary to the provisions of 40 C.F.R. §122.45(d) (1991) mandating average weekly and average monthly limits unless impracticable.

- The regulation provides that if a WET test failure is due to a specifically regulated pollutant, the numeric limit shall control, which EPA asserts is contrary to 40 C.F.R. §122.44(d)(1)(v) (1991).

- The regulation provides for an "intake credit" without virtue of reference to the need for a TMDL allocation.

- The regulation states that the Division will ordinarily make a finding that the discharge does not cause or have the potential to cause interference with the attainment of applicable water quality standards if there is a discharge to an otherwise dry stream bed and a biosurvey shows there is no aquatic life, a provision which EPA claims may not adequately implement the State narrative toxic standard.

- The regulation defines "acute toxicity limitation" so as to bar a discharge which results in a statistically significant difference in mortality for organisms between the control and any effluent concentration less than or equal to the instream waste concentration or, if no instantaneous mixing is provided, mortality (in a concentration of effluent) that exceeds 50 percent. EPA questions the adequacy of this provision to implement the State narrative standard as required by §301(b)(1)(C), as it may allow 50 percent mortality in low flow streams.

Thus, like a balloon squeezed in one's hands, once the State Commission changes certain regulatory provisions in response to EPA oversight, other objections pop out from between its fingers.

LEGAL ANALYSIS

During the course of the Colorado controversy, numerous detailed legal analysis defending the State approach have been prepared,[7] including a point-by-point legal refutation to the opinion of the EPA Administrative Law Judge upholding the Agency objection to the biomonitoring provisions of the City of Delta, Colorado, permit.[8] For purposes of this discussion, a summary of the major points, in the form of a step-by-step analysis, is adequate.

1. Section 301(b)(1)(C) of the CWA requires any more stringent <u>limitation</u> necessary to meet water quality standards established pursuant to <u>State</u> law.

2. Section 301(b)(1)(C) does not require <u>effluent</u> limitations.

3. Congress made a distinction between "limitations" under §301(b)(1)<u>(C)</u> and "effluent limitations" under §301(b)(1)<u>(A)</u> and <u>(B)</u>.

4. Section 502(17) and §509(b) of the CWA likewise distinguish between "limitations" and "effluent limitations," as have the courts.[9]

5. Section 303(c)(2)(b) of the CWA, as adopted in 1987, specifically endorses the use of "permit conditions" as a means to control toxicity.

6. The restrictions on the discharge of toxic effluent, as reflected in the original Colorado biomonitoring regulation, qualify as either "limitations" or "permit conditions."

7. Even if "effluent limitations" were required, they are defined broadly under §502(11) of the CWA and include any restriction on quantities, rates and concentrations, including "schedules of compliance." Court cases and EPA itself (1990 Region 9 Storm Water Opinion) have concluded that effluent limitations are <u>not</u> limited to numeric criteria.[10]

8. Under §502(17) of the CWA, a "schedule of compliance" is defined as a schedule of remedial measures.

9. The original Colorado biomonitoring regulation qualifies as a schedule of remedial measures.

10. Any guidance developed by EPA pursuant to §304(a)(8) of the CWA does not rise to the level of enforceable criteria.[11]

11. Through its biomonitoring regulation, Colorado was implementing its narrative water quality standard for toxics.[12] There is no comparable Federal standard. There is no evidence that the original Colorado biomonitoring regulation is not adequate to meet the State standard.

12. The provisions of 40 C.F.R. §122.44(d) must be based on statutory authority.[13] Even assuming such authority exists, the regulation merely references to need for "effluent limitations," and does not prescribe single test pass/fail limits. The preamble must be consistent with the language of the regulation itself.[14]

Finally, as will be noted below, there exist certain critical questions regarding the technical reliability of WET testing.[15] These observations raise additional legal concerns if the biomonitoring results are to be part of a single test pass/fail enforcement program.[16] Technical decisions must meet certain minimal standards of rationality.[17] There must be an adequate accounting for various factors, such as analytical variability,[18] and there must be readily discernible and repeatable standards of performance.[19] There must exist notice of what action will result in a violation,[20] and arguably some consideration given to whether a standard or limit can reasonably be met given available technology.[21] Finally, if the test is found to lack adequate reliability, its use for purposes of violation prosecution, especially in the criminal arena, may be quite limited.[22] All of these judicial caveats must be factored into the equation when fashioning an appropriate biomonitoring program.

TECHNICAL ANALYSIS

Technical aspects of the Whole Effluent Toxicity (WET) test and its application in the Water Quality Standards and NPDES Permitting Programs have several components. These components include, but are not limited to, the variability of the test itself, the representativeness of WET test results to actual receiving water impacts, appropriateness and applicability of the WET test protocol, the proper test result interpretation techniques, and the technical approaches to responding to "positive" test results. This section briefly raises and summarizes some of these issues.

Variability of the WET Test

Dozens of research articles have been written over the last several years analyzing and evaluating the variability of the WET test, and in particular, the chronic toxicity test using fathead minnows and *Ceriodaphnia dubia*. Some researchers have found that the largest component of variability associated with the toxicity test measurements is interlaboratory differences between the measured endpoints, ranging from 0 to 100 percent for some test concentrations.[23] These researchers also found that intralaboratory variability was significant enough that multiple tests were necessary to establish a high degree of confidence. An intra- and interlaboratory study found that experienced laboratory personnel at 11 labs could complete only 56 percent of a given suit of 7-day *Ceriodaphnia dubia* tests, and that substantial variability occurred between the laboratories.[24]

Other researchers have documented the impacts of test organism health on variability found in toxicity tests, and found the variability in control survival to be greater than the variation in the toxicity tests, with reference toxicity test controls using *Daphnia* spp. having a standard deviation of 5 and 147 percent C.V.[25] Parental diet for cultured test organisms (*Ceriodaphnia dubia*) was found to have a profound effect on the susceptibility of newborn organisms to toxicity of certain pollutants.[26]

The whole effluent toxicity chronic toxicity test does not reliably distinguish the presence or absence of toxicity. As with all living organisms, the fathead minnow and *Ceriodaphnia dubia* will naturally grow and reproduce with considerable variability between individuals. Even lifespan varies. The level of background biological variability can confound the biomonitoring test. EPA recognized this and established cutoff criteria for control performance. At a minimum, controls must demonstrate 80 percent survival, minnows must weigh at least 0.25 grams, and *Ceriodaphnia* must produce at least 15 offspring. If the controls fail to meet these criteria, the test must be restarted.[27]

Based on analysis of more than 210 tests,[28] the fathead minnow procedure is likely to be aborted 10 percent of the time for failing to meet mortality criteria and 22 percent of the time for failing to meet growth criteria. Using results from 191 *Ceriodaphnia* tests, the procedure is likely to be aborted 11 percent of the time for failing to meet mortality criteria. The data from 103 *Ceriodaphnia* reproduction tests show the procedure itself fails nearly one-third of the time. While EPA has developed criteria for rejecting ill-performing controls, and thereby reduced the incidence of false negative results, no such adjustment is available when organisms assigned to the effluent breakers begin to exhibit impairment due to natural causes. All reductions in survival, growth, or reproduction are assumed to be due to toxicity in the water column.

Table 1. Performance of Biomonitoring Controls in Dilution Water Only.

Organism	No. of Cases[1]	Mean	Standard Deviation	99% Confidence Limits[2]	% Test Restart[3]	No. of Tests Required for Stability[4]
Fathead Minnow Mortality	210	9.0%	10.6%	0-30%	10%	5
Growth[5]	210	0.43 g	0.21 g	0-0.92 g	22%	95
Ceriodaphnia dubia Mortality	191	11.4%	21.9	0-62%	11%	24
Reproduction[6]	103	17.0	7.0	0-33	32%	68

Notes:
1. The number of biomonitoring tests used to calculate control performance.
2. The range of mortality, growth, or reproduction expected 99% of the time.
3. The number of test which failed to meet EPA's recommended acceptance criteria for control performance.
4. The number of repeated biomonitoring tests which would be required to assure that control performance was within 5% of the estimated average for the species.
5. Growth measured as dry weight grams/fish.
6. Reproduction measured as number of offspring per surviving parent.

Source: 1992 Risk Sciences, Colorado Springs, CO, and the Santa Ana Watershed Project Authority.

Table 1 presents the average performance of organisms exposed solely to dilution water. The average mortality rate for fathead minnows is 9 percent; for *Ceriodaphnia* it is 11.4 percent. The average weight for fathead minnows is 0.43 grams and the mean number of offspring for the *Ceriodaphnia* is 17. However, the average tells only half the story. When biological variability (standard deviation) is accounted for, it is clear that the test is incapable of distinguishing the presence or absence of toxicity. Ninety-nine percent of the time, fathead mortality ranges between zero and 30 percent. Fathead weight can range between 0 and 0.92 grams. *Ceriodaphnia* mortality can range between 0 and 62 percent, while reproduction varies between 0 and 33 offspring.

For the key sublethal effects, even findings of zero growth and/or zero reproduction are not statistically significantly different from population averages. A finding of statistically significant difference in the context of a single test is an artifact of the small sample sizes.

To compensate for normal biological variability, the biomonitoring test must significantly increase the number of replicates used. Another alternative would be to increase the number of tests used to make a determination on toxicity. If fathead minnow survival is the measured endpoint, five complete chronic toxicity tests would be required before one could be 95 percent certain that the controls performed within 5 percent of the known average lifespan for this species. Ninety-five tests would be required before one could attain the same confidence about the representativeness of controls with regard to growth.

Twenty-four complete chronic toxicity tests would be necessary before one could statistically confirm that the controls were within 5 percent of the average lifespan for the species population. And, it would be impossible to conclude that toxicity was adversely impacting *Ceriodaphnia* reproduction until 68 chronic tests were performed. Until the sample sizes are made considerably larger, there is considerable risk of mistaking normal biological variability among exposed organisms for effluent toxicity.

In an attempt to demonstrate that the variability of WET testing was essentially comparable to that of chemical analyses, the EPA conducted a Discharge Monitoring Report Quality Assurance Performance Evaluation (DMR-QA 11) in 1991. This report looked at analytical results nationwide for metals, conventional pollutants, nonconventional pollutants, and acute and chronic WET tests using fatheads and daphnia. Based on this report, CVs for various analytical methods were compared. As shown in the attached chart, Table 2, biomonitoring methods consistently had the highest CVs, ranging from 20 percent for the fathead acute LC50 procedure to 50 percent for daphnia chronic results. The CV was estimated from the 95 percent confidence intervals for the data, reported as warning limits in the attached Discharge Monitoring Report Quality Assurance (DMR-QA) Summary Report. The 95 percent confidence interval spans approximately 2 standard deviations on either side of the mean, and the equation below was used to estimate the CV. With the exception of biomonitoring methods, only CBOD and cyanide CVs equaled or exceeded 20 percent. (Data selected from DMR QA Study 11, prepared by City of Colorado Springs Wastewater Department.)

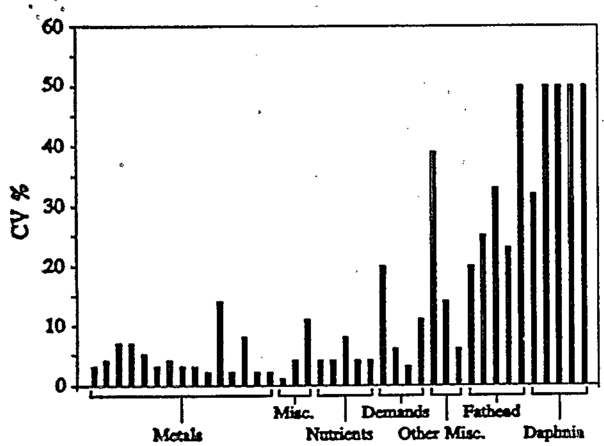
In general, the methods currently used to calculate WET limits for discharge permits have been found to overestimate the harm to aquatic communities, WET test variability is substantial and is not taken into account in permit limits, and site-specific factors that reduce toxic effects are generally ignored.[28]

Correlation of WET Test with Receiving Water Impacts

The fundamental assumption behind the EPA's use of WET testing as a water quality-based approach to toxics control is that the results of the WET test on effluent in the laboratory correlates directly to toxic impacts in the receiving waters. To demonstrate this relationship, EPA conducted eight studies as part of its Complex Effluent Toxicity Testing Program (CETTP). Closer examination of this effort revealed that (1) the CETTP was performed without

Table 2. Coefficients of Variation (CVs) for various NPDES analytical methods were compared using the data from the DMR-QA Performance Evaluation, conducted for EPA in 1991.

Analyte	CV est
ALUMINUM	3
ARSENIC	4
BERYLLIUM	7
CADMIUM	7
CHROMIUM	5
COBALT	3
COPPER	4
IRON	3
LEAD	3
MANGANESE	2
MERCURY	14
NICKEL	2
SELENIUM	8
VANADIUM	2
ZINC	2
pH	1
TSS	4
OIL AND GREASE	11
AMMONIA-NITROGEN	4
NITRATE NITROGEN	4
KJELDAHL NITROGEN	8
TOTAL PHOSPHORUS	4
ORTHOPHOSPHATE	4
CBOD	20
COD	6
TOC	3
BOD	11
CYANIDE	39
TOTAL PHENOL	14
CHLORINE, TR	6
FATHEAD, ACUTE LC50	20
FATHEAD, LETHAL NOEC	25
FATHEAD, CHRONIC IC25	33
FATHEAD, CHRONIC IC50	23
FATHEAD, CHRONIC NOEC	50
DAPHNIA, ACUTE LC50	32
DAPHNIA, LETHAL NOEC	50
DAPHNIA, CHRONIC IC25	50
DAPHNIA, CHRONIC IC50	50
DAPHNIA, CHRONIC NOEC	50



$$CV\ est = \frac{\left(\frac{UWL - LWL}{4}\right)}{TRUE\ VALUE} x\ 100$$

where:

UWL = Upper Warning Limit and
LWL = Lower Warning Limit

the benefit of a formal statistically based experimental design; (2) the studies focused on correlating only instream toxicity, not effluent toxicity to community effects; (3) that significant correlation occurred for 22 percent of the individual comparisons; (4) the site-specific factors confounded relationships among effluent toxicity, ambient toxicity, and community effects; and (5) the conditions examined in the studies were markedly different from those used as the basis for toxicity permit limits.[30] The review effort concluded that the additional studies were required to "strengthen the scientific basis for using--(WET)--to predict potential ecological effects." An evaluation of the statistical relationships between effluent toxicity and instream impacts developed by the CETTP showed relatively few correlations.[31]

Presently, the EPA biomonitoring protocols require, among other things, the use of nonrepresentative species. For example, *Daphnia* spp. live in quiescent conditions, and cannot survive the velocities of free-flowing rivers and streams. Yet discharges to such water bodies are analyzed for toxicity using daphnia. Also, test protocols require toxicity analyses to be conducted at water temperatures that do not exist in most receiving waters. Diet, food abundance, and the ability to move to less stressful locations as limited by the protocols do not represent receiving water conditions. The dilution water used during the test typically is synthetic laboratory water which does not reflect the character of the receiving water. These are some of the issues that bring into question any direct correlation of WET results with receiving water impacts.

A use attainability analysis on the Santa Ana River, that is presently being completed,[32] has indicated that the "corroborative evidence" of chemical analyses, biomonitoring, and ecological assessments is necessary to determine if there is an impact, and what the causative agent(s) may be.

Test Result Interpretation

Interpretations of test results can also be extremely difficult, erroneous, and meaningless. For example, without a demonstrated dose-response relationship, the test data are meaningless. An effluent may be tested at 12.5 percent, 25 percent, 62.5 percent, and 100 percent concentrations, and the respective survival results are 100 percent, 90 percent, 100 percent, and 100 percent, with control survival of 100 percent. The 90 percent survival at 25 percent effluent is statistically significant according to the applicable statistical technique. Yet this survival rate is above the allowable control mortality and higher effluent concentrations show no toxicity--there is no dose-response relationship. These test results are questionable and probably meaningless. Yet they will result in a permit violation. Is the violation due to real toxicity or to flawed statistical interpretation?

EPA's current standard WET analysis protocols consider only intra-laboratory variability. Inter-laboratory variability is excluded. Chemical data analysis considers both. Until toxicity protocols consider both, their results will be often misleading or meaningless.[33]

Current statistical analysis methods can lead to erroneous interpretations with respect to compliance with permit WET limits. These analyses compare the biological responses between exposed organisms and unexposed organisms. This hypothesis testing approach is subject to the statistical analysis upon which determinations of biological significance are made. The magnitude of any indicated adverse effect is heavily influenced by the design of the toxicity test and the natural variability between living organisms exposed to the same test conditions.[34] Therefore, WET test design, the test dilutions used, natural variability, and the choice and application of the statistical method, rather than actual toxicity, can have a greater influence on the "apparent" test results.

Additional Technical Considerations

Other factors must be considered in the use of biomonitoring, or WET, for compliance determination purposes.[35]

The health and well-being of the test organisms is critical. Diet and environmental factors must be optimized to prevent false indications of toxicity that are caused by poor health, poor diet, or the environmental conditions in which the organisms are cultured and tested. In one publicized case, apparent toxicity was due to daphnia infection by a bacterium living in the automatic sampler tube.[36]

Selection of dilution water is important. Synthetic laboratory water may not accurately reflect the character and mitigating effects of the receiving waters. Replacement of dilution water during the chronic test adds other variables and may create a shock stress on the organisms. On the other hand, use of upstream receiving water as dilution water also adds variables, and may be a source of toxicity. This was the case in a Wisconsin POTW situation where the higher the effluent concentration, the less mortality and greater fecundity and growth. The POTW effluent diluted the toxicity caused by nonpoint pesticides entering the upstream receiving waters which, per the permit, had to be used as dilution water.

The pH creep in the laboratory test situation, which does not occur in the real environment, can and does cause toxicity due to un-ionized ammonia concentrations artificially elevated by the laboratory conditions. This situation is especially of concern in small lagoon treatment systems that experience seasonal high pH levels as a result of algal growth.

Further, the effects of synergism between otherwise innocuous substances in POTW effluent or effluent/receiving water mixtures cannot be predicted or easily identified. POTW influents and effluents are continually changing in their makeup. Determining the causative agents of toxicity under such circumstances may be impossible with current technology. At the very least, the toxic agents must be consistently present--one cannot find that which no longer exists--and the opportunity to run multiple tests without facing liability for such investigative efforts must be available.

PUBLIC POLICY ARGUMENTS

Most, if not all, POTWs will acknowledge that WET testing is a useful tool in toxicity control, and that it should be a part of the Nation's water quality regulatory program. However, its misuse, including an insistence that each biomonitoring test failure be subject to the enforcement provisions of the Federal Act, could prove disastrous both financially and politically.

It is unfounded for the Agency to fear that if the same approach to effluent control which has worked tolerably well for the past 20 years for conventional, numerically measured pollutants, is modified, a precedent will be set which will open the flood gates to the incorporation of a "diligence approach" throughout the environmental regulatory program. Fundamental scientific principles and commonly accepted notions of due process simply demand that a different course be followed in this instance in order to reach the same commendable result, i.e., the control of toxic discharges and the protection of classified water uses as identified by the States. As noted in the recent report issued by the Council on California Competitiveness, in the area of regulatory management, **process cannot take precedence over rational policy-making.**[37]

In advocating adoption of the original Colorado biomonitoring regulation, Colorado POTWs identified a number of public policy concerns (in addition to the technical concerns) during the course of the debate. These remain relevant today, and include the following:

- By its very nature, WET testing is designed to catch the "unknown" pollutant; if the toxicant is known to exist, it will be regulated in the permit as a specific chemical numerical limit.

- It takes multiple biomonitoring tests, each with inherent variability, to track and identify the cause of the toxicity. Until the cause is determined, POTWs cannot take action to stop a WET violation, such as enhanced pretreatment regulation.

- There must exist a positive incentive to run <u>more</u> tests.

- WET test failures can be the result of toxicity sources which are difficult if not impossible to control. such as illegal dumps, synergism as a result of legal discharges, a disposal of household waste, or copper plumbing leaching.

- EPA's use of enforcement discretion in a single test pass/fail system may be closely circumscribed due to the possibility of citizen suits.[38]

- By virtue of judicial precedent, a single incident of toxicity may be the basis for 30 separate violations if monthly testing is in effect, or 90 violations if quarterly testing is adopted.[39]

- Even though enforcement discretion may be exercised and no fine imposed, adverse publicity may undermine citizens' support of, and confidence in, the utility system and its employees.

- A finding of violation could result in an inability to obtain bond financing, or at least bonds at the rate desired.

- An initial "violation" could be utilized in the future by EPA or the State in assessing and calculating future penalties under EPA or State penalty policies.

- An enforcement "policy" of leniency relative to initial violations may run the risk of modification due to political pressures, citizen concerns, changes in philosophy, or simple personnel shifts.

- EPA's insistence in its preamble to the 1989 changes to 40 C.F.R. §122.44 (1991), and in its biocriteria guidance,[40] on "independent applicability" repeals the long accepted notion of permit as a shield, and exposes POTWs to substantial enforcement risk.

Not emphasized in the above listing are the tremendous costs associated with ensuring that the sensitive test species, generally *Ceriodaphnia dubia* and fathead minnows, survive at a given rate in the wastewater effluent. Though EPA has at times indicated that indigenous species may be used for test compliance purposes, this has been with the caveat that it is "strongly discouraged."[41] If employed, species from the receiving water itself "should never be used," while use of the resident organism would require the development of complex EPA-approved protocols and quality assurance procedures.[42] In other words, protection of the current water quality is not acceptable. These costs are reflected in plant upgrade expenditures, additional pretreatment program measures, and testing expenses, including direct labor costs. In addition, there are expenditures associated with penalty enforcement proceedings, including attorney fees.

One must ask the question whether EPA's preferred single test pass/fail approach to WET control is a wise use of scarce resources. Wouldn't it be better to devote these resources to investigation and control under a "diligence" scenario? As stated in the Report of the California Council on Competitiveness referenced above, isn't it a worthwhile undertaking to require "that all proposed environmental legislation and regulations include an analysis of alternatives that would achieve the same or nearly the same benefits but with a more efficient use of resources."[43]

A recent article in Forbes magazine highlighted many of these same concerns.[44]

> One thing, however, is absolutely clear: The cost per life theoretically saved--as measured by the EPA itself, often under statutory requirement--is now verging on the fantastic. "I have never seen a single [proposed regulatory] rule where we weren't paying at least $100 million per life for some portion of the rule, or very few," says Yale Law Professor E. Donald Elliott, a Reilly ally and recent EPA general counsel. "I saw rules costing $30 billion."

John Goodman of the Dallas-based National Center for Policy Analysis reports a 1990 EPA regulation on wood preservatives that imposed costs at a rate of $5.7 trillion per life presumed saved. This implies a willingness to spend the entire GNP to avoid a single hypothetical premature death.

Similarly, there appears to be a willingness to expend vast sums to ensure the happiness, in a laboratory setting, of oftentimes nonindigenous test organisms. Mr. Elliott was later quoted in the article as stating:

> Everybody at EPA understands, and everyone who works in this business understands, that you could save many more lives if you took the same amount of money and devoted it to say, infant nutrition programs, or a whole range of public health services.

The article then concludes:

> As Elliott puts it, reflecting on prospective costs and benefits: **"I've come around to the view that you just can't get there from here using these kinds of techniques."** What Elliott means by "here" is known in the trade as "command-and-control" bureaucracy--prescribing detailed rules attempting to cover every possible circumstance. The EPA's pervasive rules, some observers say, amount to a national industrial policy . . . or land use act.

The above observations have a direct application to biomonitoring, as EPA attempts to prescribe the essence of State programs down to the last detail, rather than allowing the States to implement their narrative toxics standards, through WET controls, in a manner that efficiently and effectively achieves the goals of the Act, and in a manner which is consistent with Executive Order 12612 (on federalism) and Executive Order 12778 (on civil justice reform). A "command-and-control" approach not only is financially expensive but also leads to governmental in-fighting, which breeds delay.

To the extent EPA argues that its actions in this particular area are constrained by the very language of the CWA, POTWs have supported clarifying legislation which would allow States to adopt enforceable permit "conditions" to meet toxic control objectives rather than relying upon single test pass/fail limits.[45] The exact wording of the legislation, which is currently pending in Congress, is not magical in nature, and certainly could be modified as long as the underlying concept of performance-based enforcement is retained. One must produce a positive incentive for the productive use of biomonitoring testing, while ensuring that test nonperformance, malperformance, or failure to comply with a schedule of compliance, will remain susceptible to enforcement proceedings. Legislation which clearly endorses this approach could be the foundation for forging a partnership between local, State, and Federal government agencies in the control and eventual elimination of toxic discharges.

FOOTNOTES

1. 5 C.C.R. 1002-2, Section 6.9.7.

2. Pifher and Egan, Biomonitoring and Toxics Control: The POTW Perspective, Natural Resources and Environment, Volume 4, No. 1, Spring, 1989.

3. See, e.g., Objection to NPDES Permit No. CO-0039641, City of Delta, Colorado, February 15, 1989.

4. 40 C.F.R. §123.62(b) (1991).

5. See, e.g., Sections 301, 309 and 402 of the Clean Water Act; 40 C.F.R. §§122.4(a), 122.45(d), 123.27(a), 123.27(b), 122.45(d) (1991).

6. 40 C.F.R. §122.44(d).

7. See, e.g., Legal Opinions to Martha Rudolph, counsel for Water Quality Control Commission, from Mark T. Pifher dated November 20, 1990, and August 29, 1991; Comments of the City of Colorado Springs and the City of Delta for Public Hearing Upon the Colorado Biomonitoring Regulation as a Substantial Program Revision, April 19, 1991; In Re: Region VIII EPA Objections to the Issuance of Delta, Colorado, Permit, CO-0039641, Memorandum and Exhibits in Opposition to EPA Objection, January 17, 1990.

8. Correspondense from James Scherer, Regional Administrator, Region VIII EPA, to David Holm, Colorado Water Quality Control Division, January 9, 1991.

9. See NRDC v. EPA, 656 F.2d 768 (D.C. Cir. 1981); Virginia Electric and Power Company v. Costle, 566 F.2d 446 (4th Cir. 1977).

10. See Virginia Electric and Power Company, supra; Correspondence from Harry Seraydarian, Director, Water Management Division, Region IX, EPA, to Elizabeth Miller Jennings, State Water Resources Control Board, 1990.

11. See Exxon Corp. v. Train, 554 F.2d 1310 (5th Cir. 1977); E.I. duPont de Nemours and Co. v. Train, 430 U.S. 112 (1977).

12. See State of Alabama v. EPA, 557 F.2d 1101 (5th Cir. 1977), (EPA must object to adoption of state standards as compared to implementation provisions); In the Matter of Star-Kist Caribe, Inc., NPDES Appeal No. 88-5 (1990), order denying modification request, May 26, 1992 (Under 301(b)(1)(C), Congress intended the states, not EPA, to define appropriate compliance deadlines and the stringency of limitations).

13. Hoffman Homes v. EPA, 1992 WL 78009 (7th Cir. 1992); Fertilizer Institute v. EPA, 935 F.2d 1303 (D.C. Cir. 1991).

14. See Bowles v. Seminole Rock and Sand Co., 325 U.S. 410 (1945); Cf: National Recycling Coalition, Inc. v. Reilly, 884 F.2d 1431 (D.C. Cir. 1989).

15. See N.R.D.C. v. EPA, 859 F.2d 156 (D.C. Cir. 1988) (EPA can express technology-based or water-quality-based limits in terms of toxicity).

16. See Connecticut Fund for Enviro., Inc. v. Upjohn Co., 660 F.Supp. 1397 (D. Conn. 1987) (Congress did not intend for courts to determine adequacy of scientific measurements); Sierra Club v. Union Oil of Calif., 813 F.2d 1480 (9th Cir. 1987); N.R.D.C. v. Outboard Marine, 702 F.Supp. 690 (D.C. Ill. 1988) (test methods must be challenged at time of permit issuance).

17. American Paper Institute v. EPA, 660 F.2d 954 (4th Cir. 1981).

18. Chemical Manufacturer's Association v. EPA, 870 F.2d 177 (5th Cir. 1989); see also NRDC v. EPA, 863 F.2d 1420 (9th Cir. 1988).

19. See Kulender v. Lawson, 461 U.S. 352 (1983); Hercules, Inc. v. EPA, 598 F.2d 91 (D.C. Cir. 1978); Reynolds Metals Co. v. EPA, 760 F.2d 549 (4th Cir. 1985); Cf: Student Pub. Int. Res. Group v. P.D. Oil & Chemical, 627 F.Supp. 1074 (D. N.J. 1986) (cannot challenge accuracy of DMR's); PIRG of New Jersey v. Yates Industries, Inc., 33 ERC 1149 (D. N.J. 1991); Student Public Interest Group v. AT&T Bell Lab., 617 F.Supp 1190 (D.C. N.J. 1985).

20. See Grayned v. City of Rockford, 408 U.S. 104 (1972); United States v. Hutson, 843 F.2d 1232 (9th Cir. 1988).

21. See 48 Fed. Reg. 51408 (1983) (40 C.F.R. 131); 40 C.F.R. 131.10 (1991); Union Electric Co. v. EPA, 427 U.S. 246 (1976) (Clean Air Act); United States v. West Penn Power Co., 460 F.Supp. 1305 (1978); Cf: United States v. Earth Sciences, 599 F.2d 368 (10th Cir. 1979) (intent and good faith are irrelevant).

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31. Marcus, M.D. and MacDonald, L.L. 1991. Evaluating the Statistical Basis for Relating Receiving Water Impacts to Effluent and Ambient Toxicities. Accepted by Environmental Toxicology and Chemistry.

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35. Pifher and Egan, Biomonitoring and Toxics Control: The POTW Perspective, Natural Resources and Environment, Volume 4, No. 1, Spring, 1989.

36. French, R.D. and Humble, D.E. 1990. False-Positive Results May Plague Biomonitoring Tests. The Bench Sheet, Water Pollution Control Federation and American Water Works Association, Vol. 12, No. 2.

37. California's Jobs and Future: Council on California Competitiveness, April 23, 1992, Peter V. Ueberroth, Chairman.

38. See Sierra Club v. Chevron U.S.A., Inc., 834 F.2d 1517 (9th Cir. 1987); Atlantic States Legal Foundation, Inc. v. Koch Refining Co., 681 F.Supp. 609 (D. Minn. 1988).

39. See Gwaltney of Smithfield, Ltd. v. Chesapeake Bay Foundation, 791 F.2d 304 (4th Cir. 1986), vacated 108 S.Ct. 376 (1987).

40. EPA Biological Criteria; National Program Guidance on Surface Waters, April, 1990; EPA: Policy on the Use of Biological Assessments and Criteria in the Water Quality Program: May, 1991; Pifher, "Biocriteria: Just When You Thought It Was Safe To Go Back Into The Water," BNA Environment Reporter, August 30, 1991.

41. Correspondence from LuJuana Wilcher, Assistant Administrator EPA, to Honorable Jon Kyl, House of Representatives, March 5, 1991.

42. Id.

43. Report of Council on Competitiveness, supra at page 33.

44. "You Can't Get There From Here." Forbes, July 6, 1992.

45. See H.R. 735, POTW Biomonitoring Use Act.

THE STATUS OF THE SCIENCE RELATIVE TO THE USE OF WHOLE EFFLUENT TOXICITY TESTING IN WATER QUALITY STANDARDS

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INTRODUCTION

Whole effluent toxicity (WET) testing has been used for monitoring purposes since the early 1940s, and has been utilized for compliance monitoring in California since the late 1960s. The purpose of such monitoring was a recognition that chemical monitoring alone could not predict or measure biological effects in receiving water bodies. Early test development was targeted toward short-term exposures measuring lethality, and when coupled to an estimate of the field exposure, could be used to assess receiving water effects. However, early uses of toxicity testing were targeted toward technology to control effluent quality with little consideration for receiving water exposures. The adoption of water quality-based permitting in 1984 by the U.S. Environmental Protection Agency (U.S. EPA, 1984) was a major step forward in integrating chemical and biological monitoring to protecting receiving water quality. Integrating the concept of hazard assessment which coupled effects and exposure allowed effluent dischargers to estimate environmental effects of effluent quality (Bergman et al., 1986).

Water quality-based permitting applied to National Pollutant Discharge Elimination System (NPDES) permit monitoring, and compliance presented an opportunity to assess and control the discharge of "toxic substances in toxic amounts." However, considerable controversy arose regarding the technical basis for implementing this approach considering that unacceptably deemed toxicity test results could result in multimillion dollar engineering solutions for corrective action. There also continues to be a lack of standardization in the application of test methods or the results of WET (Glickman, 1991).

The use of WET for development of water quality standards may be made on a State-specific basis and may be either a numeric limit or narrative standard to protect the designated uses of the receiving system. EPA guidance has recommended that no receiving system should have acute toxicity at any time, although a chronic toxicity standard protective of the receiving water is appropriate. The development of that standard should incorporate the best available science to protect the biological population in the system, and should be site-specific to account for regional differences in biological community and water quality characteristics.

The test procedures for whole effluent testing have been developed for several freshwater and marine tests and are being utilized for many NPDES programs in the United States. These methods, for the most part, have not been promulgated as procedures as specified in the Clean Water Act section 304(c), but are being utilized. This paper addresses the science of WET for water quality standards.

The purpose of this discussion is to review the technical progress made toward the application of WET toward water quality standards and to outline some of the problems facing implementation. The existing science of WET as it is being applied to State and regional programs will be discussed and highlighted: (1) the expected variation in test results and exposures relative to a discharger's ability to meet a water quality standard; (2) selection of the appropriate test species for the specific site; and (3) application of site-specific WET methods for assessing receiving water impacts.

EXPECTED VARIATION IN TEST RESULTS

In anticipating WET testing for compliance to a water quality standard, several factors require attention to ensure that results are realistic with relationship to achieving the goal of receiving water protection. For illustrative purposes, Figure 1 shows several cases whereby there is considerable uncertainty in knowing whether WET limits are being achieved for receiving water body protection. This figure in essence captures all of the major issues surrounding WET testing for water quality standards. The top set of data shows WET results for acute and chronic toxicity such that the receiving water concentration is below the effect concentrations. However, superimposed on these data are areas of uncertainty (dashed lines) that delineate boundaries where the measurements vary, and one is not certain (or with a small probability) that WET standards are achieved. The second set of data shows the same information and includes the issues surrounding setting an exposure estimate of receiving water flow. The indicated line for the 7-day average low flow during a 10-year period (7Q10) is often used to set limits. The chronic toxicity data illustrate possible responses of three species (recommended in U.S. EPA, 1991) and their span of sensitivity and frequency of reflecting changing effluent conditions. The dilemma of these data is that one may *not* be in compliance because of uncertainties due to test precision, exposure, and site-specific variations. The following discussion illustrates these concerns, as applied to specific derivations of effluent toxicity and exposure.

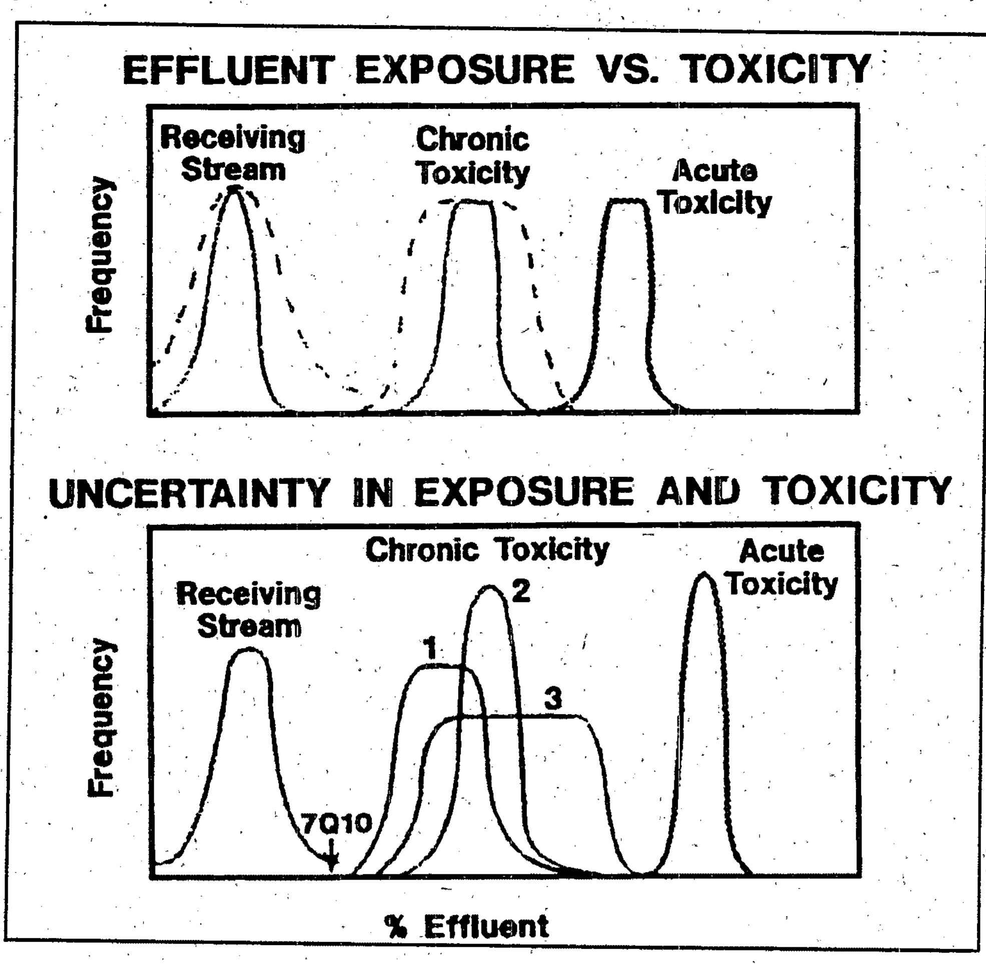

Figure 1. The conceptual application of Whole Effluent Toxicity (WET) testing to compliance with water quality standards (WQS). The top figure demonstrates the relationship between acute and chronic toxicity of an effluent compared to an instream effluent concentration determined by stream flow gaging data. The difference between the exposure and toxicity is the margin of safety, which is, however, confounded by the uncertainty in the measurements shown by dashed lines. The lower figure illustrates the uncertainty when multispecies testing is used and the relationship to instream exposures.

Test Precision Estimates

Few effluent toxicity test round robin exercises have been conducted to understand precision, but available results demonstrate that there is variation between laboratories. In some cases, there is so much variation that the ability to determine compliance to a toxicity requirement would be questionable. Numerous intralaboratory studies have shown that effluent toxicity tests, and toxicity tests, in general, are within "acceptable variability" relative to chemical analysis methods to be used in a regulatory framework. In the last few years, interlaboratory experiments have been conducted using NPDES compliance test methods for *Daphnia, Ceriodaphnia dubia, Pimephales promelas*, and *Mysidopsis bahia*. These programs have investigated interlaboratory response to reference toxicants in conjunction with effluent testing. Reference toxicants used include potassium dichromate, sodium chloride, and sodium pentachlorophenol. Effluents tested have been from electric generating utilities (DeGraeve et al., 1992; 1988), pulp and paper mills (DeGraeve et al., 1992), refineries (DeGraeve et al., 1988), chemical plants (Grothe and Kimerle, 1985), and drilling muds (Ray et al., 1989).

Table 1. Interlaboratory variability of fathead minnows and *Ceriodaphnia* exposed to reference toxicants and effluents. Mean data are 7-day LC50 for 10 laboratories. Sets 1 and 2 represent time independent testing periods. The coefficient of variation (CV) is shown in percent and derived as standard deviation/mean x 100.

	Ceriodaphnia				Fathead Minnow			
	Set 1		Set 2		Set 1		Set 3	
Test Sample	Mean	C.V.	Mean	C.V.	Mean	C.V.	Mean	C.V.
$K_2Cr_2O_7$ (µg/L)	29.6	70.8	49.6	37.7	2000	22.8	2000	23.6
NaCl (g/L)	1.77	6.7	1.33	49.9				
Utility Effluent (%)	3.7	80.6	100.0	0.0	3.7	36.9		
Pulp Effluent (%)			70.0	12.0				
Refinery 301 (%)					1.0 0.9	30.9 33.1		
Refinery 401 (%)					10.0 9.0	27.9 26.0		
NaPCP (µg/L)					228 288	54 43.5	293 285	40.3 44.7

Table 2. Intra- and inter-laboratory variation in effluent toxicity tests conducted. Number of species and effluents are indicated from all studies analyzed, toxicity is ratio of maximum/minimum values measured, and coefficients of variation (CV) are shown as mean and range. (Adapted from Parkhurst et al., 1992)

Intralaboratory	Species	Effluents	Mean max/min Toxicity	Mean CV	CV Range
Acute	5	13	3.2	17	0-135
Chronic	2	7	1.9	7	0-20
Interlaboratory					
Acute	4	13	7.4	34	0-166
Chronic	2	7	2.9	34	0-83

In studies to determine the interlaboratory variation of *Ceriodaphnia dubia* test methods, 10 laboratories participated and tested utility and paper mill effluents. Test variation (coefficient of variation) ranged from 12 to 80 percent, and variation using reference toxicant ranged from 6 to 70 percent. Similar results were obtained in a second study using the fathead minnow (Table 1). In a summary of acute and chronic round robin data (Parkhurst et al., 1992), the mean coefficient of variation was between 7 and 34 percent (Table 2).

There is a need to conduct interlaboratory precision exercises for other species utilized in NPDES WET testing before implementing compliance requirements for these species. After thorough testing, EPA should publish test methods according to Clean Water Act section 304 (c) criteria. Although all species utilized in State NPDES programs may not have been evaluated, some baseline species can be used.

TOXICITY TESTING FOR PERMIT COMPLIANCE

For screening purposes, effluent toxicity testing is a valuable tool, and can enable a discharger to determine the need for additional treatment, process changes, point source control, etc. However, effluent toxicity testing is routinely being used for compliance with requirements such that the determined toxicity, i.e., no observable effects concentrations (NOEC) such as NOEC >90 percent effluent, may be difficult to achieve. Although the interlaboratory precision of effluent toxicity testing has been shown to be approximately 30 percent variation, the variation has been calculated on lethal concentration (LC50) or inhibiting concentration (IC50) point estimates and not on specific variability in complying with a specific concentration, such as that the NOEC must be greater than a specific concentration. A summary of effluent performance characteristics and implications for regulatory testing were evaluated (Parkhurst et al., 1992;

Warren-Hicks et al., 1992), and were found to show higher variation in one concentration comparison which compared a point estimate such as LC50. Data analyzed by Warren-Hicks et al. (1992) from the fathead minnow round robin conducted by DeGraeve et al. (1988) illustrate the variation in response if the same concentration/mortality data from "refinery 301" are plotted for each laboratory compared to comparing LC50s (Figure 2). The figure shows that the variation in data from the 10 different laboratories would be inconclusive to determine compliance.

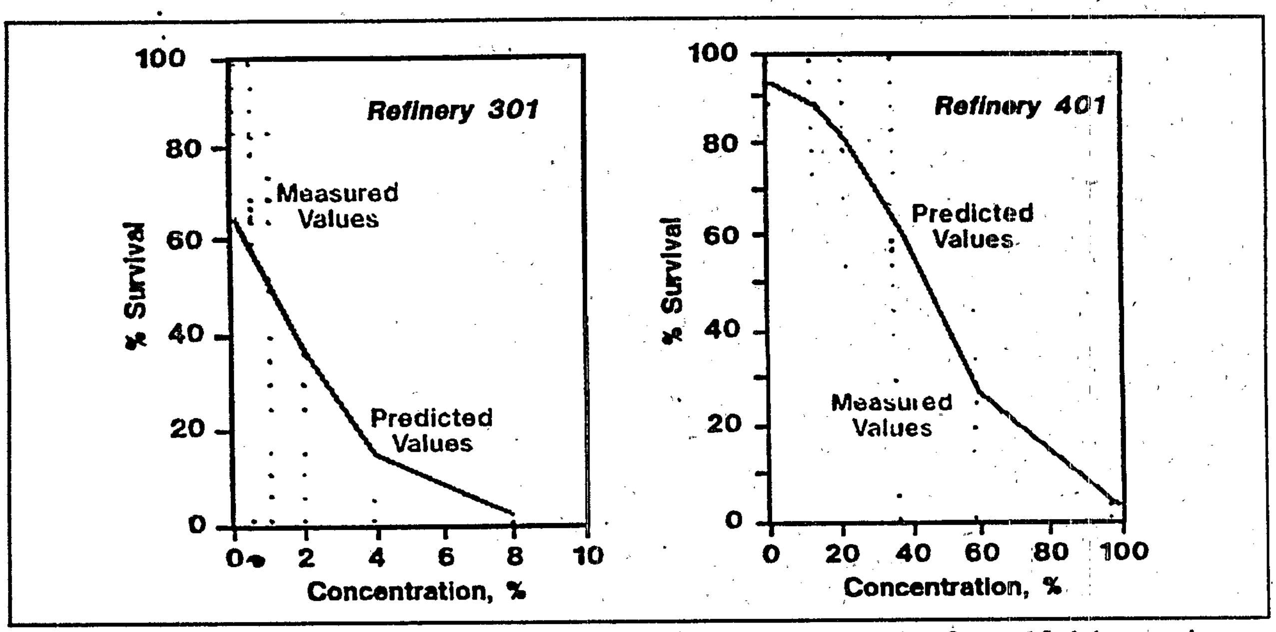

Figure 2. Chronic fathead minnow effluent toxicity test results from 10 laboratories on concentration-specific exposure to two refinery effluents. There is a wide range in interlaboratory sensitivity to each of these two effluents, which could result in uncertain decisions for NPDES compliance. Typical application would use the point estimates for a "critical" concentration compared to the control for compliance determinations. (Adapted from Warren-Hicks and Parkhurst, 1992.)

Although interlaboratory precision is acceptable for general research testing, permit compliance to specific limits may have greater variation than the discharger can accept. Unless the uncertainty of these results can be incorporated, dischargers may continuously face unnecessary toxicity identification evaluation studies. EPA should adopt the use of uncertainty to include inherent test variation in water quality-based permitting with WET. Precision estimates are based on studies with "well-qualified" laboratories, and are not necessarily indicative of all laboratories conducting NPDES testing.

A strong reference toxicant program should be required and considered in any compliance testing. Reference toxicant testing provides a baseline response to indicate to the laboratory and the client the quality of test organisms and their response to known challenges. A time course analysis of data portrayed as a statistical process control chart will show the performance of the laboratory organisms over time. Reference toxicants, in addition to WET controls, should be used to evaluate the performance of valid tests. When unacceptable reference toxicant test results are identified, WET compliance tests should be discarded.

SELECTION OF TEST SPECIES APPROPRIATE TO THE RECEIVING ENVIRONMENT

Selection of test species for effluent toxicity has been a subject of considerable debate. If the receiving water is to be protected, species selection should be consistent with that environment. Test species and protocols should also be carefully evaluated such that "interferences" are eliminated. If the effluent possesses higher total dissolved solids (TDS), different ionic composition, or salinity, test methods may have to be modified to incorporate potential toxic effects from effluent quality not associated with "toxics" (Dorn and Rogers, 1989). Measurement of "salinity" or "TDS" alone may not determine whether one species or another is a better choice for testing. If the ionic balance is markedly different than the environmental tolerance of the organism, toxicity may result (Figure 3). In this figure, the effect of effluent salinity is compared to effluent "toxicity," and the resulting interpretation is that the effluent ionic balance caused the toxicity. In actuality, the site is located in the arid West Texas environment and contributes to an otherwise ephemeral stream. The plant intake water contains the high ionic strength solution, and little additional constituents were added by the plant process.

If receiving water temperatures are lower than laboratory toxicity test conditions, such as 15°C in the field and 25°C in the laboratory, an effluent containing ammonia would test toxic in the laboratory test and not in the field. Cautions for these interferences must not be underestimated.

Test conditions should provide a tolerable environment for the test organisms, so the "toxics" in the effluent may be expressed independent of other sources of effect. EPA guidance recommends that control data be carefully evaluated by using positive and negative control data. The dilution water, as well as laboratory reference toxicity tests, should be used to determine organism health before decisions on effluent toxicity are made.

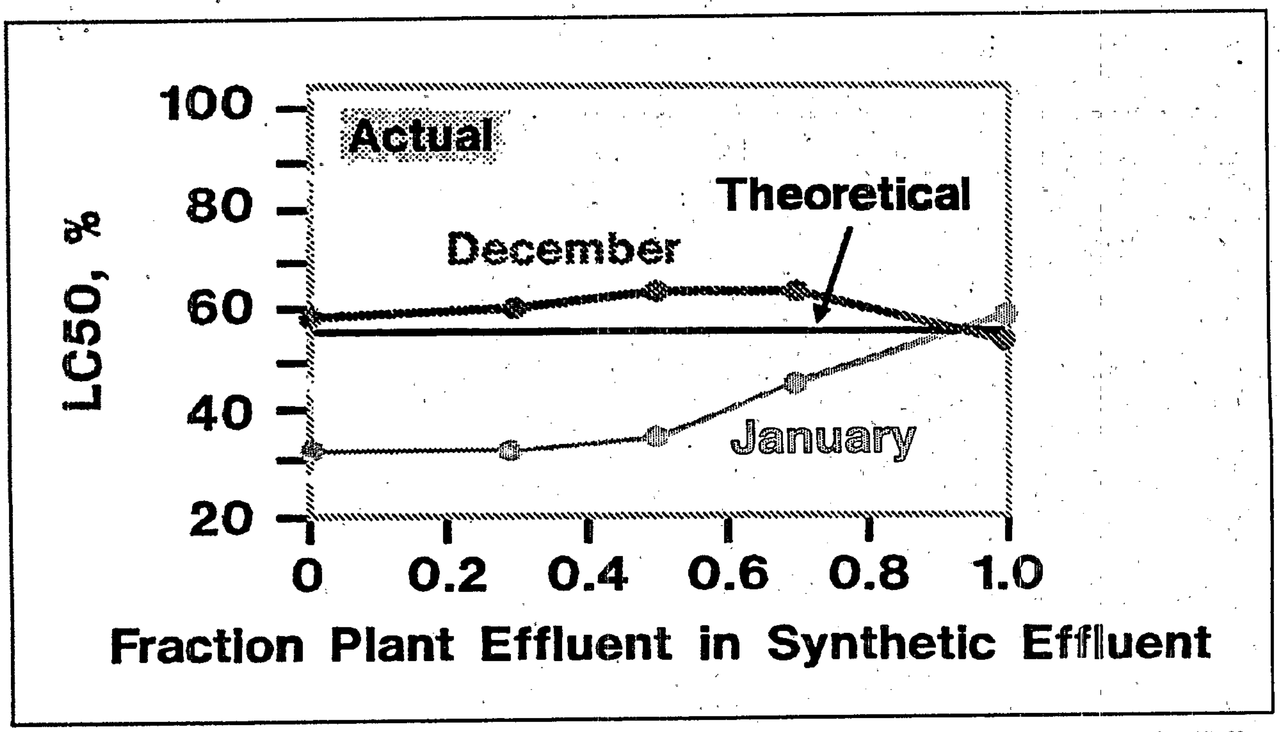

Figure 3. The effect of salinity on the toxicity of refinery effluent. The "theoretical" line indicates the LC50 that was found when the synthetic effluent was prepared by adding the exact composition of anions and cations to distilled water and measuring toxicity. The two data points for January and December show the results of mixtures of refinery effluent and synthetic effluent. The 1.0 point shows that the refinery toxicity duplicates the toxicity of the synthetic effluent.

EPA procedures for calculating a water quality criteria value for a toxic pollutant acknowledge that the criterion will be protective of 95 percent of the species in the population. The search for the most sensitive species should not be the focus of WET testing, and better estimates of variability in toxicity and exposure would produce better WET standards.

SITE-SPECIFIC WET METHODS FOR ASSESSING RECEIVING WATER QUALITY

Effluent toxicity may result in acceptable or unacceptable results depending upon the specific permit limits that have presumably taken exposure into account. Understanding effluent variability should be more important than evaluating one "toxic" result as a significant toxicity event. The presumption of receiving water effects from one or two WET results is not appropriate unless a significant "pattern of toxicity" can be established that would indicate a cause and effect relationship between laboratory toxicity tests and receiving water community effects. State and regional programs have utilized different methods for WET compliance, such as weekly acute flow-through tests using rainbow trout in San Francisco Bay, where the 90th percentile of 11 tests must be 90 percent or greater. Dischargers in the Bay also must not have survival in the lower 10th percentile less than 80 percent. In EPA Region 6, dischargers may be required to meet chronic toxicity limits for *Ceriodaphnia* and fathead minnows corresponding to the critical low flow and one-half of the critical low flow for the receiving water body. Region 6 stipulates that a test failure for mortality will require three retests in 45 days, and a failure to meet requirements at that point results in a Toxicity Identification Evaluation (TIE) study.

To eliminate diverse State and regional testing and compliance programs, EPA should develop guidance for criteria for establishing patterns of toxicity that could lead to remediation activities such as toxicity identification evaluations.

In development of WET water quality standards, site-specific factors must be included to assure that national approaches are compatible with specific sites. Through the use of constructed stream and pond enclosure *mesocosm* experiments, it has been demonstrated that laboratory toxicity test results are reasonable estimates of field predictions when site-specific conditions are maintained in test environments (Pontasch et al., 1989; Dorn et al., 1991; SETAC, 1992). Procedures for WET site-specific criteria similar to those allowed in modifying water quality criteria should be included (U.S. EPA, 1983).

SUMMARY

The science of WET methods for establishing water quality-based receiving standards is well developed, but has not been appropriately addressed for implementation into State programs and NPDES compliance testing.

WET methods have been well developed to present few technical challenges for laboratories. However, EPA should conduct interlaboratory comparisons of those methods and initiate promulgation according to the Clean Water Act section 304 (c) procedures.

Implementation of WET for water quality standards must address variability and uncertainty associated with the receiving water exposure, and measurement (calculation) of toxicity endpoints. The pattern of toxicity should be established for appropriate test species relating to receiving water effects before remediation activities are begun.

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Re-examining Independent Applicability

RE-EXAMINING INDEPENDENT APPLICABILITY: AGENCY POLICY AND CURRENT ISSUES

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EPA's Office of Water recommends the independent application of its full array of water quality measures (chemical-specific, whole-effluent, and bioassessment approaches) in State water quality programs. "Independent applicability" means that the validity of the results of any one of the approaches used to assess water quality does not depend on confirmation by one or both of the other methods. This policy is based on the unique attributes, limitations, and program applications of each of the three approaches. Each method alone provides valid and independently sufficient evidence of aquatic life use impairment, irrespective of any evidence, or lack of it, derived from the other two approaches. The failure of one method to confirm an impact identified by another method does not negate the results of the initial assessment. The policy, therefore, states appropriate action should be taken when any one of the three types of assessment determines that a standard is not attained.

The policy of Independent Applicability is discussed in the *Technical Support Document for Water Quality-Based Toxics Control* (U.S. EPA, 1991a), which was widely peer reviewed, and in policy guidance to the Regional Offices on the use of biological assessments and criteria in water quality programs (U.S. EPA, 1991b). The current policy largely evolved from a work group chaired by EPA that included representatives from EPA Headquarters offices, research laboratories, all 10 Regions, U.S. Fish and Wildlife Service, and U.S. Forest Service. New York and North Carolina provided technical assistance to the work group. Based on the recommendations from several areas within EPA's national water program, EPA asked the work group to address how to integrate biological assessment and criteria approaches with traditional chemical and physical methods. To do so, the work group had to first consider the scientific base for the three approaches.

Water chemistry methods are used to predict risks to human health, aquatic life, and wildlife, and to diagnose, model, and regulate water quality problems. Chemical-specific water quality criteria for the protection of aquatic life are toxicity-based and address the effects of single chemicals over a wide range of species. Whole-effluent toxicity tests measure the toxic effects of effluent samples that may consist of unknown or complex mixtures of chemicals. Biological assessments and criteria directly measure the aquatic community's response to any and all pollutants, including habitat degradation and loss. The distinct capabilities of each of these approaches to water quality assessment are the technical underpinnings of the policy on independent application. The work group concluded that a comprehensive picture of risk is possible from using all three together, and when used in a regulatory context, each measure also indicates risk and can be, and should be, applied independently. When one technique detects or predicts a water quality impairment, the results of another assessment technique should not be used to overrule that finding.

The policy clearly has a regulatory purpose, and at first reading, its application to water quality programs appears straightforward However, implementation of the policy has shown this not to be the case. Several States, municipalities, and industries question the policy and its application in water-quality based programs, including challenges to individual approaches. Examples include challenging the environmental significance of the chemical- specific water quality criteria or whole-effluent toxicity measures and giving precedence to biological assessments over those other two approaches. However, the central issue under discussion is: How are these different approaches, our basic program tools, most effectively applied in water quality and resource protection?

Central to the debate is the uncertainty about what biological criteria are and how these criteria will be applied in pollution control and abatement programs. Some of the issues under consideration are: What constitutes a sufficiently comprehensive biological assessment that accurately reflects critical conditions? How can biological assessments be used in evaluating cause-and-effect relationships? How will biological criteria derived from such information be used in regulatory programs? Some of the key policy issues surrounding independent application will be addressed as technical guidance on biological criteria is developed and implemented. The scientific foundation of biological criteria needs to be well established and tested in a wide range of situations before some aspects of policy implementation can be resolved.

Aside from questions about policy application, the environmental benefits of independently applying the three assessment tools in detecting and remedying receiving water impacts are not yet evident to many States, municipalities, or dischargers. One viewpoint holds that since a biological assessment is a direct measure of the health of an ecosystem, a visibly healthy biological community should be the deciding factor for determining whether or not a water body is impaired or whether exceedances of a permit limit are environmentally significant. This viewpoint gives precedence to biological assessments and criteria over toxicity-based chemical measures. The Agency's concern in using a hierarchical approach of biological assessments over chemical measures is based on the technical evaluation that each of these assessments measures different endpoints and each provides a valid assessment of nonattainment of standards. For example, a short-term assessment of a biological community would fail to detect long-term chronic and sublethal effects that would put the community at risk. In addition, the science supporting biological assessments and criteria, and indeed all methods, is evolving.

A related issue involves the use of long-term biological assessments rather than the Agency's recommended toxicity-based methodology to establish chemical-specific water quality criteria to protect aquatic life. Some within the Agency feel that this challenges the policy of independent applicability and could result in less protective criteria because information specific to each approach may not be considered. In fact, more stringent criteria could also be the result. Others argue that a thorough, long-term biological assessment is the most direct and realistic measure of the status of the resource that we want to protect. This question has arisen under provisions of the water quality standards regulation that authorizes States to develop water quality criteria based on "other scientifically defensible methods." The Agency has not yet issued guidance on the use of a biological assessment in the development of chemical-specific water quality criteria, and this issue is being addressed on a case-by-case basis without thoroughly evaluating potential ramifications to other parts of the water quality program.

An alternative to strict application of the policy is the weight-of-evidence approach. This approach entails the evaluation of all available information to make the most informed decision possible, and can take into account the strengths and weaknesses of each approach. Since sufficient uncertainty is associated with each of the three assessment methods, an integrated synthesis of all available information will make for the most sound and cost- effective decision making. Some would argue that a weight-of-evidence approach is appropriate and practical in all aspects of a water quality program, from assessing impairment of a water body to deriving permit limits and conditions. The Agency is concerned that this approach would be difficult to implement to protect water quality and to avoid one measure undermining another in a finding of nonattainment. For example, if a short-term biological assessment is used to override a chemical-specific permit limit violation, it may neither take into account the potential long-term chronic impact of the toxicant discharged at higher concentrations nor measure if there is a reasonable potential for a water quality impairment. However, the predictive chemical-specific and whole- effluent approaches will.

The discussion on independent applicability has two key aspects: the technical foundation of the policy and the logistics of policy implementation. First, from the Agency's point of view, sound scientific reasons support the basic premise of the policy: that together, each of the three measures (chemical-specific, biological assessment, and whole-effluent) provide unique and complementary information about water quality and the health of an ecosystem. Essentially, each approach tests a somewhat different hypothesis. The Agency recognizes the need to better articulate this point, and we plan to do this. Various aspects of the technical issues have been investigated. Additional technical evaluation of the complementary nature of these three measurements are being planned, including an examination of the strengths and weaknesses of each approach and further explanations and interpretations of situations when discrepancies between the results are found. Such a comprehensive evaluation will provide further technical basis for application of the policy, making full use of the strengths of the three approaches.

Second, the Agency's water quality-based program has evolved from relying on technology-based industry standards to including chemical-specific water quality standards and whole-effluent toxicity limits, which have proved to be successful in controlling the discharge of toxic pollution. In addition, the Agency is evaluating the application of sediment quality and wildlife criteria as well as developing fundamentally different approaches such as biological (instream response) and habitat criteria. This expanding base of water quality protection tools reflects advancements in science and technology and a more sophisticated understanding of the complexity of our natural world. The challenge to the Agency is to integrate all these tools in a practical and cost-effective manner. The driving question should be: What is the most effective application of our water quality tools in the protection of water quality and water resources? Successful implementation of the policy of independent applicability depends upon this integration as well as clear and comprehensive guidelines for its application.

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RE-EXAMINING INDEPENDENT APPLICABILITY: REGULATORY POLICY SHOULD REFLECT A WEIGHT-OF-EVIDENCE APPROACH

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INTRODUCTION

The protection of aquatic life is a basic mandate of our Nation's water pollution control efforts. This mandate has been pursued over the years by a variety of regulatory measures that have increased in sophistication and complexity to reflect the growth in understanding of the dynamics of aquatic ecosystems. Water pollution control programs have sequentially implemented these measures in a hierarchical progression: from the broad-brush approach of technology-based standards; adding the more narrow focus on chemical-specific, numeric permit limitations; followed by whole effluent toxicity testing; and now beginning to incorporate bioassessment and biocriteria.

Each successive regulatory measure for the protection of aquatic life is translated into permit requirements that are layered over the preceding ones, traditionally without regard to any redundancy in their technical foundations and informational values. The permit requirements are subsequently treated as independent, autonomous limitations that are separately evaluated for compliance and enforcement under the strict liability statute of the Clean Water Act (CWA).

This approach, endorsed by the U.S. Environmental Protection Agency's (EPA) policy of independent applicability, excludes much valuable information from the development of permit limitations and magnifies the liabilities associated with scientific uncertainties in each of the control measures during compliance evaluations. The results of this policy may be manifested in redundant and inefficient allocations of resources for the protection of aquatic life and contradictory conclusions from the multiple control measures about the health of the aquatic community. Independent applicability also perpetuates a rigid, mechanistic regulatory strategy that is inconsistent with the EPA's advocacy of risk-based environmental management.

A better approach to the protection of aquatic life would use the weight of all evidence provided by the various assessment techniques to determine appropriate water pollution control requirements. The weight-of-evidence approach acknowledges and accounts for the scientific uncertainties of each assessment technique, builds upon the techniques' informational strengths, emphasizes the value of site-specific data, and promotes the flexibility in the process necessary to facilitate the incorporation of new science (such as sediment toxicity assessment). Using the weight of evidence is technically defensible, and is consistent with risk-based environmental management.

BACKGROUND

Early efforts to develop regulatory control measures protective of aquatic life were severely hampered by a lack of understanding about the environmental fate and modes of toxic action of waterborne pollutants. The first attempt to use water quality standards and water quality-based permitting in a regulatory format failed because of the difficulties in linking cause and effect, and because of the tremendous resource requirements that had to be applied to each particular permit evaluation.

The need to arrest the continuing decline in water quality during the time that science and understanding caught up to regulatory demands for effective aquatic toxicity data led to the establishment of uniform national technology-based effluent standards. With the technology-based standards assuring a minimum level of water quality, research continued to develop the techniques and data needed to assess the potential for adverse impacts from water pollution and to identify effective control measures.

Initial research efforts focused on defining the toxicity of individual chemicals through the use of laboratory toxicity tests with multiple aquatic species. These data were used to generate national water quality criteria representing "safe" levels of exposure for aquatic life and providing for the calculation of chemical-specific, numeric limits in discharge permits. Development of whole effluent toxicity assessment in the second phase of research was driven by recognition that the chemical-by-chemical approach was very slow and did not address critical real-world exposure factors such as bioavailability and the possible additive, synergistic, or antagonistic effects of mixtures of toxicants. Whole effluent toxicity testing, although more useful for measuring bioavailability and the aggregate toxicity of a complex effluent, is still an indirect assessment of *in situ* effects and must be extrapolated to the elaborate community of indigenous aquatic organisms. This shortcoming is now being compensated for by the use of bioassessment techniques that can directly appraise the status of a water body's biological health under the dynamics of actual exposure.

Although the foregoing is an oversimplistic history of the development of aquatic toxicology, it does represent conceptually the continued increase in complexity and refinement of aquatic ecosystem assessment techniques. Each successive assessment technique incorporates the major elements of the preceding one. Therefore, whole effluent toxicity testing also measures the effects of individual toxicants, and bioassessment studies provide data on the response of aquatic communities to the aggregate toxicity of complex effluents. The progression of chemical-specific to whole effluent toxicity testing to bioassessment greatly increases the amount of information and knowledge provided by each technique, but at a loss of focus and of the ability to resolve the causative factors of any effect.

The interrelationship of aquatic toxicity assessments has been acknowledged in national regulatory policy. In the first detailed expression of the National Policy for the Development of Water Quality-Based Permit Limitations for Toxic Pollutants (U.S. Federal Register, 1984), the EPA states:

> There is now a general consensus that an evaluation of effluent toxicity, when adequately related to instream conditions, can provide a valid indication of receiving system impacts. This information can be useful in developing regulatory requirements to protect aquatic life, especially when data from toxicity testing are analyzed in conjunction with chemical and ecological data. (emphasis added)

Unfortunately, this acknowledgment has not carried over into the actual development of regulatory requirements. Control measures have been implemented in a step-wise procedure reflecting the availability of the successive assessment techniques. In this manner, permit requirements derived from each technique (i.e., chemical-specific numeric limits, whole effluent toxicity restrictions, and biocriteria) are being added on top of each other in an approach that ignores the broad overlaps of the assessment techniques and prevents the consideration of valuable information generated by each assessment.

The policy of independent application reinforces this approach by requiring that the most "protective" result [empirically equivalent to the finding of most significant potential adverse impact] from each assessment be used for effluent characterization while suppressing the comparison of data from other techniques where the data are contradictory (U.S. EPA, 1991).

DEFICIENCIES OF INDEPENDENT APPLICABILITY

It must be noted that there is no statutory requirement driving the policy of independent applicability. This policy has developed because of the severe limitations on resources essential to assess fully each specific discharge situation and the necessity of operating under the rigid format of the NPDES program. It is being administered as a regulatory expediency, to allow water pollution control measures to keep pace with advancing science without having to modify the existing permit program and without the need to justify or resolve discrepancies between the aquatic assessment techniques. Independent applicability simplifies the implementation of permit requirements for the protection of aquatic life by minimizing the need for best professional judgment and site-specific flexibility in the process, but at the loss of accuracy and effectiveness.

A basic conceptual failing of independent applicability is that it presumes that only negative findings, i.e., those that indicate adverse impacts, are valid data. The problems with this principle are twofold: First, it assumes that each assessment technique is unique and that its measurement endpoint is a perfect indicator of the adverse effects on aquatic life from exposure to the pollutant being evaluated. Second, it dismisses all positive data, i.e., the data indicating no adverse impacts, as valueless when these data are in contradiction to negative findings from any assessment.

Consider the following scenario as an illustration of the problems with independent applicability: A discharge permit is being developed for a single point source discharge to a freshwater receiving stream. Chemical analyses of the effluent demonstrate that all pollutants are below applicable water quality standards except for copper, which exceeds the criterion continuous concentration standard by 15 percent at the instream waste concentration. Short-term chronic toxicity tests of the whole effluent do not show any adverse effects. Instream bioassessments of fish and benthic macroinvertebrates indicate the existence of a healthy aquatic community.

In this scenario, if stringently applied, the policy of independent applicability would require that the chemical-specific data alone be used to justify the need for a permit limit for copper, resulting in either additional wastewater treatment for this element or in a permit violation for the discharger. Any value of the information provided by whole effluent toxicity testing and bioassessment would be excluded from consideration in the development of permit requirements, and the uncertainties with the chemical criteria results (such as bioavailability, and relevance to the local indigenous species) would be magnified in importance because of the substantial liabilities associated with violations of NPDES permit limitations.

Clearly, unanswered questions are raised by this scenario. Why is there a discrepancy between the chemical-specific data, which predict an adverse impact from the discharge, and the whole effluent toxicity data and bioassessment results, which do not show any such impact? What site-specific factors could be mitigating the effects of copper toxicity? Is a permit limit really necessary to protect the aquatic life of the receiving stream, in light of the actual bioassessment results? Under the policy of independent applicability these questions would remain unanswered, and permit writers would be discouraged from addressing them.

An evaluation of empirical results from the different assessment techniques indicates that contradictions can be expected a significant percentage of the time. A comparison of the use of chemical criteria and biocriteria to detect impairment of the aquatic community found that the two assessments disagreed 53.6 percent of the time (Yoder, 1991). Whole effluent/ambient toxicity assessments have been observed to be in contradiction to instream (bioassessment) findings from 10 to 19 percent of the time. [These values are derived by adding the percentages for those cases where impact was predicted but not observed, and where impact was not predicted but was observed, from a series of studies as reported in the Technical Support Document for Water Quality-Based Toxics Control (U.S. EPA, 1991).]

Such contradictions between the aquatic life assessment techniques arise because the techniques are not perfect measures of actual effects. Each technique has an inherent degree of uncertainty and can produce erroneous or inapplicable information. The potential for false conclusions was noted in an EPA study of environmental indicators in the surface water programs:

> The utility of biological community monitoring derives from its direct nature. One is monitoring the feature of the environment that water quality regulations seek to protect, so that one cannot be fooled into falsely believing the ecological protection goal of the CWA has been met, as can occur when physical and chemical measures are used (U.S. EPA, 1990).

The relative strengths and weaknesses of each technique, and their comparative evaluations, are addressed in several publications (Courtemach, 1989; Parkhurst et al., 1990; Parkhurst and Mount, 1991; U.S. EPA, 1991), and the reader is referred to these documents for further details.

BENEFITS OF THE WEIGHT-OF-EVIDENCE APPROACH

In contrast to independent applicability, the weight-of-evidence approach does not establish an *a priori* presumption about the validity of any information generated by the various assessment methods (Miner and Borton, 1991). This approach encourages the consideration of all information relevant to the assessment of potential impacts on the aquatic community. In cases where the data are contradictory, attempts are made to resolve the contradictions by evaluating assumptions or simplifications in the assessment methods, accounting for site-specific factors that would influence the findings, and using best professional judgment in "weighing" all of the evidence available to determine what, if any, control measures are needed to protect aquatic life.

Weight of evidence acknowledges and accounts for the weaknesses in each of the assessment techniques. It allows the strengths of each method to be used to complement and support, not isolate, the others. This approach is based upon the scientific manner of inquiry, in which a hypothesis is proposed and data are collected and evaluated to test the hypothesis. Furthermore, it promotes and advances the use of site-specific data in the development of control strategies.

The presence of contradictory information from the aquatic assessment techniques emphasizes the importance of evaluating the data within the site-specific conditions of the discharge. Ranking the techniques in the hierarchical order of chemical-specific criteria < whole effluent toxicity testing < bioassessment represents a continuum toward increasing value of site-specific data. With respect to the previously described scenario, the weight-of- evidence approach encourages the use of detailed site-specific information generated during whole effluent toxicity testing and bioassessments to judge the applicability of the national water quality criterion for copper to the discharge site, and to decide if site-specific adjustments of the criterion are justified. [See Brungs et al. (1992) and U.S. EPA (1992) for a specific discussion about the problems of correlating impacts predicted by water quality criteria for metals to actual *in situ* bioavailability and ecological effects.] In this regard, the weight-of-evidence approach is fully compatible with, and can be considered an expansion of, the site-specific criteria development policies of the EPA (U.S. EPA, 1983).

Using the weight of evidence will also serve to drive a holistic perspective to the evaluation of all factors influencing water quality and aquatic life. In the process of investigating contradictory findings and integrating the various assessment techniques rather than employing them piecemeal, evaluators will be motivated to address all sources of water quality impacts, including nonpoint sources. Weight of evidence will help to expand the focus of regulatory programs and will provide the evaluations and knowledge needed to target aquatic life protection programs for the greatest effective return. It will also help to realize the currently hollow promise of use attainability analyses and site-specific water quality criteria in practical and effective elements of the process.

Finally, this approach permits new assessment techniques and advancing scientific knowledge to be phased into the water pollution control program. New initiatives such as sediment toxicity assessment can be utilized to produce a more complete evaluation of potential impacts of a discharge on aquatic life, while at the same time facilitating the validation process for the new assessment technique by providing comparative site-specific data and an interpretive framework. This can be accomplished without automatically placing the results of the new technique under the strict liability rule of the NPDES program, since the information will be considered as part of the whole evaluation and not as an independent finding.

RECOMMENDATIONS

Implementation of the preferred approach of using the weight of evidence in regulatory decision making for aquatic life protection will require several changes in the current system:

The EPA must discontinue the policy of independent applicability, which is inconsistent with the weight-of-evidence approach.

Permit writers must be adequately trained and supported with sufficient resources to effectively use their best professional judgment with the data for aquatic life protection. They must be actively encouraged to collect and evaluate all site-specific information necessary and appropriate to assess the potential of a discharge to have adverse impacts on aquatic life.

Permit writers should be discouraged from "layering" limitations with similar endpoints (such as a chemical-specific aquatic toxicity number and a whole effluent toxicity limit) simply for regulatory convenience and without sound technical justification.

Implementation of the provisions under 40 CFR 122.44(d)(1) *et seq.* relating to the determination of "reasonable potential" for a discharge to cause an instream excursion of a water quality standard must emphasize the use of site-specific data under the weight-of- evidence approach. Overly conservative assumptions and the use of multiple safety factors should be avoided in this determination unless adequately justified by the preponderance of local data.

The NPDES permit program, as established under section 402 of the CWA and in subsequent Federal regulations, must be modified to incorporate additional flexibility in how permit limits are expressed and compliance with limits is assessed. Provisions must be included to allow for the consideration of all available data in the evaluation of whether the designated uses of the receiving water bodies are being maintained in the presence of any particular discharge.

The use of special permit conditions should be promoted and expanded to account for unique local water quality and aquatic life characteristics and interactions. The NPDES enforcement strategy must be updated to enable consideration of all permit information to be included in determinations of appropriate enforcement actions, rather than responding to each permit limitation as an autonomous, definitive, and irrefutable endpoint.

Criteria to determine Significant Noncompliance (SNC) and Violation Review Action Criteria (VRAC) should be revised to reflect both the degree of uncertainty in a compliance assessment technique and the environmental significance of the compliance endpoint. [Note that enforcement discretion should not be used to cover for technical or conceptual deficiencies in the assessment methods, but to resolve any site-specific anomalies that arise in their application.]

CONCLUSIONS

The policy of independent applicability suffers from significant conceptual and scientific deficiencies. This policy enhances a disjointed approach to aquatic ecosystem assessment, magnifies the uncertainties in the assessment methods in the regulatory process, and fosters the development of extraneous permit limitations that in turn divert scarce resources and attention from more significant problems. Furthermore, the policy excludes valuable information about the aquatic community. It discourages permit writers from using their best professional judgment in deciding appropriate control measures, and can leave them with unresolved contradictions in the assessment results. Independent applicability sustains a rigid regulatory process that treats the aquatic assessment techniques in an isolated, compartmentalized approach that is antagonistic to the desired strategy of watershed level, risk-based water quality management.

In contrast, the weight-of-evidence process makes maximum use of all data generated in aquatic ecosystem assessments. It emphasizes site-specific information, encourages resolution of contradictions, and motivates permit writers to use their best professional judgment. Using the weight of evidence builds upon the strengths of the various assessment methods. It accounts for their weaknesses and integrates the information to enable a full deductive evaluation. The weight-of-evidence approach is fully consistent with the policy of risk-based water quality management and provides a process that will advance the consolidation of water pollution control within watersheds.

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RE-EXAMINING INDEPENDENT APPLICABILITY

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BIOLOGICAL CRITERIA ARE THE BEST MEASURE OF THE INTEGRITY OF A WATER BODY AND SHOULD CONTROL WHEN THERE IS A CONFLICT

Biological criteria have as their most promising attribute the ability to detect and quantify a wide range of effects upon the aquatic ecosystem. The effects of habitat disturbances on stream communities constitute a form of pollution that is often undetectable with chemical criteria and toxicity measurements. Pollution from traditional chemical pollutants is also accurately assessed because responses in the biological criteria reflect the frequency and duration of stress caused by the pollutants. These factors make biological criteria the preferred method for judging use attainment, reporting impaired waters, and prioritizing watersheds for point and nonpoint control strategies. However, the user must recognize important limitations; for example, biological criteria will not adequately address problems related to bioaccumulative toxicant effects on wildlife and humans.

The role of biological criteria in the permitting and compliance program has been a major concern to regulators, industries, municipalities, and environmental groups. How can biological criteria be effectively employed without upsetting the more established chemical-specific and whole-effluent toxicity methods? Initially, we must recognize the existence of a hierarchy of bioassessment methods that vary in their abilities to both assess water body condition and contribute to the permitting process. This paper will present examples of situations facing water resource managers as we attempt to fit biological criteria into water body assessment tasks and permitting tasks.

Finally, Ohio's 13 years of experience with biological monitoring will be drawn upon to address several of the technical questions posed by the organizers of the session.

- Are we confident enough in the accuracy of the newer measures to allow them to override the well-established chemical criteria?

- Is the laboratory development of the chemical criteria so unrepresentative of the real world that we should abandon them where conflicts arise?

- Do we have the expertise available now to routinely resolve conflicts between the measures in a thoughtful way?

INTRODUCTION

I want to express my appreciation for the invitation to be here today. Because Ohio has been at the forefront in developing and using biological criteria, I feel we can significantly contribute to the resolution of this issue.

Yesterday, we heard Tudor Davies identify the importance of using good science and the need to include all data in decision making. EPA has encouraged comparative risk projects that focus on the most important issues with the bottom line being environmental results.

The challenge we face as water resource managers is to effectively transfer the broad policy statements about good science and comparative risk management into specific program policies. We think this can be accomplished through integrating biological criteria into many program areas that are designed to protect aquatic life. I urge EPA to work toward a good science framework for integrating the various water quality criteria disciplines into a workable policy that achieves what we all want--environmental results.

What I'd like to do in the next few minutes is explore how Ohio is using biological criteria to achieve environmental results. We'll look at a couple of case examples: one in permitting, the other in water body assessment and reporting. In keeping with our panel's objective, we will need to examine whether data are best evaluated using a weight-of-evidence approach or whether EPA's policy of independent application should be followed.

Finally, I will take just a minute or two to use Ohio's experience to answer the questions posed by the organizers of this session.

SUMMARY OF OHIO'S BIOLOGICAL METHODS

I will begin with a short overview of Ohio's biological criteria. Between 1981 and 1984, the Ohio EPA worked on a cooperative research project with EPA's Corvallis Lab. Nationally, this was some of the early work on defining aquatic ecoregions and, in Ohio, it has led to a regional reference site approach for biological criteria. Standardized methods were developed for collection and assessment of fish and macroinvertebrates. More than 300 "least impacted" reference sites in 5 ecoregions were sampled in the 1980s to develop our biological community expectations for fish and macroinvertebrates. Three separate multimetric indices or criteria are employed: two using fish, one using macroinvertebrates. These indices have proven to be very reliable in describing the health of aquatic communities. In 1990, these biological criteria became part of the State's WQS rules.

One very crucial point that policy makers must recognize is that there exists a hierarchy of bioassessment methods, which vary in their ability to accurately measure biological performance. EPA has encouraged the use of biological assessments of all types ranging from volunteer monitoring through a series of Rapid Bioassessment Protocols to more advanced ecoregion-based reference site methods such as those employed in Ohio. However, EPA's policy on the use of biological assessments and criteria does not account for the very strong technical differences along this hierarchy of assessment methods. This must change to promote the greater use of biological criteria.

On the screen, you can see our recommendation for a better system that will promote the use of biological criteria. States with more advanced biological survey methods, and subsequently stronger biological criteria, should be given modest policy flexibility in certain program areas to use these powerful tools. I will provide some examples as I describe Ohio's program. Bioassessment programs provide EPA, Congress, and the public with a much more accurate and complete assessment of the Nation's water resource quality. Most importantly, the environment benefits because problems are identified and addressed.

Our experience in Ohio offers clear evidence that the identification of pollution impacts and sources cannot be done with chemical testing and toxicity testing programs alone. In many locations, the major threat to resource integrity comes from periodic discharges at unregulated sites, habitat destruction, nutrient enrichment, or flow diversions.

Biocriteria offer new avenues to address these problems. If we want to be good stewards of our total water resource, if we truly want to protect our water ecosystems, we must find ways to encourage all States to adopt and use biological criteria.

OHIO'S USE OF BIOLOGICAL CRITERIA

The potential use of biological criteria, especially in the NPDES permit program, has become a controversial issue. An EPA newsletter discussed this conflict.

Fortunately, I can report to you that this "conflict" is really a misunderstanding of the language in Ohio's standards rather than an ideological difference about independent application. Ohio EPA and regional EPA staff will clarify the language as a part of the next triennial review.

A case example illustrates how we can use the biological criteria in permitting. This plot presents biological survey results of the Maumee River at Defiance, Ohio. The data reveal that the biological performance of the river meets our expectations or biocriteria set for the designated use. No significant impact is caused by the Defiance WWTP.

The next chart adds information regarding the ammonia effluent quality. The open bar depicts an existing quality of 20 mg/L. The dark bar represents a proposed effluent limit of 5 mg/L derived using the ammonia WQS criterion and the usual steady-state model. It is not always appropriate to use the river's present biological conditions under an existing effluent quality to draw conclusions about the expected biological condition under future conditions. In this situation, however, it is appropriate because it is not anticipated that the existing WWTP flow will change. Only the concentration is proposed to be reduced. Since current biological conditions meet the criteria, the results serve as the cue to re-examine the assumptions behind the proposed permit limit. The biological assessment criteria alone are not justification to withhold the ammonia limit in this case, but they are sufficient reason to re-examine the chemical-specific criteria and modeling assumptions before a permitting decision is made and expensive treatment upgrades are mandated. In fact, EPA's criteria support documents contain similar precautionary statements.

Given this information, what should be done with the Defiance permit? Ideally, the permit would wait until further study is done. In the present system, however, deadlines for major permit re-issuance seldom wait for good science to catch up.

Here is an opportunity for EPA to provide some policy flexibility for State programs that use advanced biological assessment methods. The incentives for States and permit holders could be as simple as extended compliance schedules to meet the initial limits while additional water quality studies are performed. That is what we did with Defiance. Another alternative could be a short-term extension of the previous permit. I want to stress that such options are appropriate only in situations where advanced biological assessment methods are employed and results show little risk to aquatic life. We believe such policy flexibility would accelerate the use of bioassessments and biocriteria, encourage site-specific assessments, and promote the use of good science in decision making.

Finally, was this an example of weight-of-evidence or independent application? To us, using biological criteria as a feedback mechanism for triggering the next level of good science in a permitting decision is simply an example of integrating the strengths and weaknesses of each discipline as called for by EPA's policy on independent application.

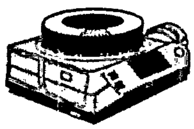
What about weight of evidence? You've probably heard that Ohio operates using a weight-of-evidence approach. Well, this is true, but only in the context of water body assessment tasks; that is, the work required under section 305(b) of the Clean Water Act. The purpose of the 305(b) report is to provide the most accurate picture of the conditions of the Nation's waters. It serves to prioritize where program attention or changes are needed, to correct programmatic problems, and to direct many site-specific tasks on the State level. On the screen, you see some of the attributes that make biological criteria a strong tool for assessing aquatic life conditions in a water body. It is important to recognize that biological assessment does not address bioaccumulative affects of some chemicals or wildlife and human health. Separate criteria and assessment methods are needed here.

Given this recognized strength of biological criteria, let's examine some data from the Ohio River. Slide 9 depicts the biological performance of the river in 1991. As you can see, the Ohio River, once quite polluted, is now supporting a full array of sport fish and nongame species, and is rated in good to excellent condition by our biologists. Monthly monitoring for chemical parameters is conducted at several locations along the river. These results have indicated a fairly consistent exceedence of the total copper criteria. If one uses the EPA guidelines regarding the frequency and magnitude of these exceedences, the entire length of the Ohio River is either partially attaining, or not attaining, the "fishable" goal of the Clean Water Act. Furthermore, the policy of independent application states that the failure of one measure to detect a problem should not discredit another finding.

In this example, independent application sets in motion a series of events aimed at identifying and regulating copper inputs into the entire Ohio River system. This will be done with the purpose of achieving the copper standard, but we know beforehand that these efforts will achieve little aquatic life improvement. Greater environmental improvement would result if we had focused on control efforts where the biological criteria indicated a problem exists.

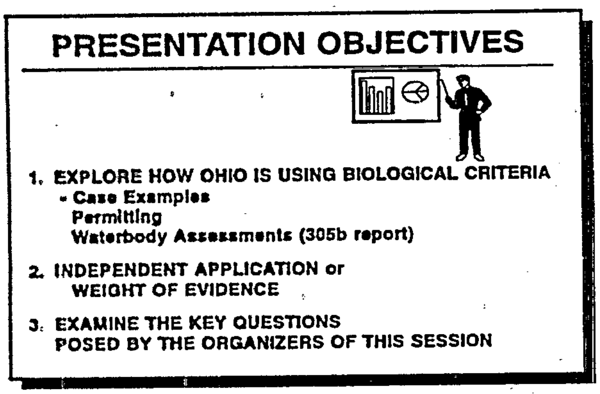
The recommendation here is to include some policy flexibility for States with advanced biological assessment methods. States should be given the option of using a weight-of-evidence approach when assessing and prioritizing water quality and water resource problems. States will get more done, and the environment will realize greater improvements in aquatic life protection, if biological criteria are used as the measure of aquatic life use impairment in the 305(b) report process. Ohio has more than 3,000 miles of degraded stream segments to address. We need to concentrate our limited resources where we will get environmental results. Conversely, we should be able to rank as low the risk posed by copper violations along 450 miles of the Ohio River if we know the river supports a balanced aquatic life and attains the biological criteria.

In summary, to manage for environmental results, we should not let "independent" application direct our attention to insignificant issues. Biological assessment used with a weight-of-evidence approach is very much a comparative risk project that can successfully direct our efforts to protect and enhance our water resources.



Slide Presentation

Slide 1



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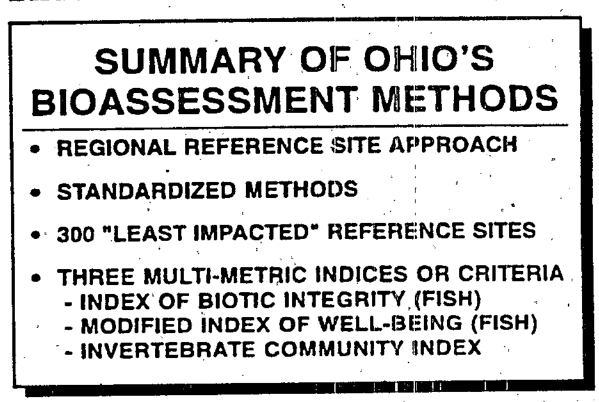

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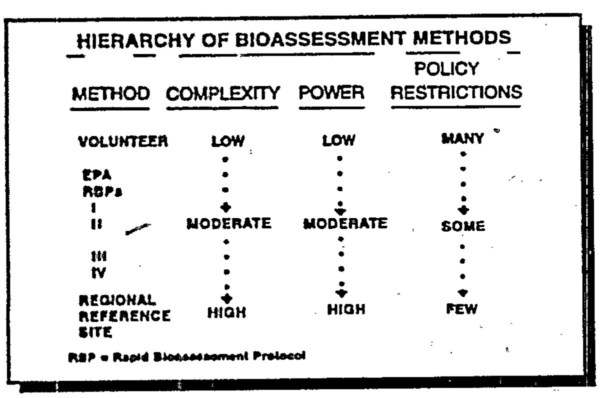

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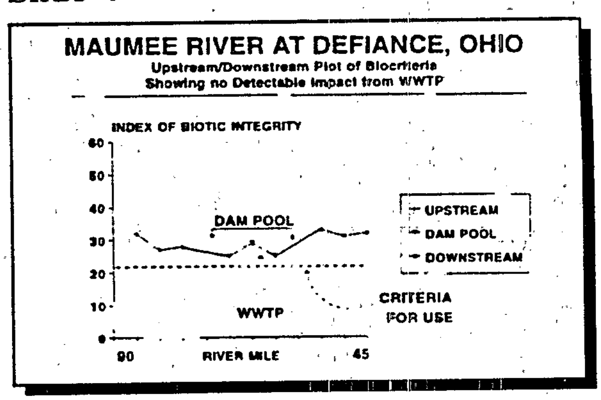
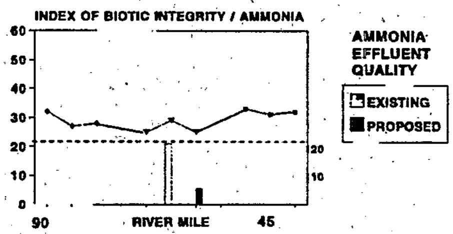


Slide 5

MAUMEE RIVER AT DEFIANCE, OHIO
Biocriteria as a CUE to
Re-examine Criteria Application in Permit



Ammonia expressed as effluent concentration, mg/l

Slide 6

LIMITATIONS OF CRITERIA
AMMONIA AS AN EXAMPLE
PRECAUTIONARY STATEMENTS FOUND IN USEPA 1985 (1)

- "There is limited data on the effect of temperature on chronic toxicity."
- "...additional site-specific information should be developed before these criteria are used in wasteload modeling."
- "Dynamic models are preferred for the application of these criteria."

AMBIENT AQUATIC LIFE WATER QUALITY CRITERIA FOR [illegible]

Slide 7

DEFIANCE SITUATION REQUIRES
POLICY FLEXIBILITY

- EXTENDED COMPLIANCE SCHEDULE
- SHORT TERM EXTENSION OF PREVIOUS PERMIT
- BIOLOGICAL CRITERIA ARE THE FEEDBACK MECHANISM TO TRIGGER NEXT LEVEL OF ANALYSIS
- THIS INTEGRATION IS CONSISTENT WITH INDEPENDENT APPLICATION

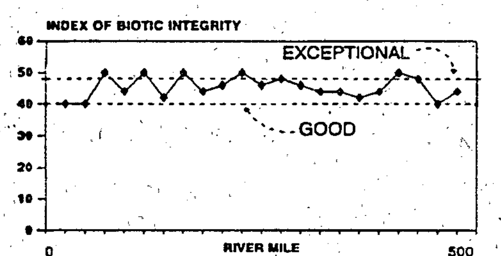
Slide 8

STRENGTHS OF BIOLOGICAL ASSESSMENTS

- BIOTA ARE RESPONSIVE TO WIDE RANGE OF IMPACTS
  - HABITAT
  - ENERGY OR FOODCHAIN IMBALANCES
  - FLOW ALTERATIONS
  - CHEMICAL POLLUTANTS
- BIOTA CAN ACCOUNT FOR THE REAL WORLD FREQUENCY AND DURATION OF STRESSES CAUSED BY POLLUTANTS
- THERE ARE IMPORTANT LIMITATIONS
  - BIOACCUMULATIVE TOXICANTS NOT FULLY ADDRESSED
- CONCENSUS OPINION AT RECENT NATIONAL 305(b) WORKSHOP

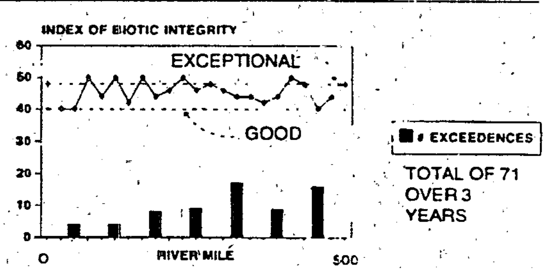
Slide 9

BIOLOGICAL CONDITIONS
OF THE OHIO RIVER

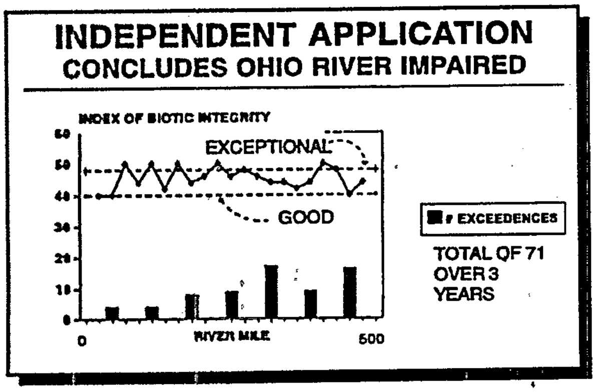


Slide 10

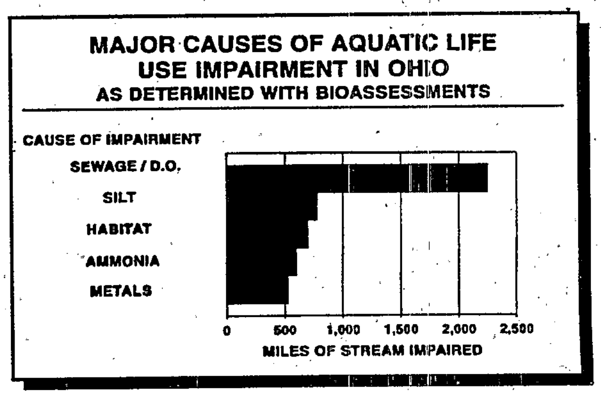
AMBIENT EXCEEDENCES OF
COPPER CRITERIA - OHIO RIVER



Slide 11



Slide 12



Slide 13

QUESTIONS POSED BY USEPA FOR THIS PANEL

Are we confident in the accuracy of biocriteria?
Allow them to override other criteria?

- CONFIDENCE DEPENDS UPON THE BIOASSESSMENT METHOD.
  EPA POLICY SHOULD ACKNOWLEDGE THE HIERARCHY
  OF METHODS WITH GRADUATED POLICY FLEXIBILITY.
  ADVANCED METHODS = GREATER FLEXIBILITY
- WHETHER TO "OVERRIDE" OTHER CRITERIA DEPENDS UPON TASK:
  - WEIGHT OF EVIDENCE IS APPROPRIATE FOR WATERBODY ASSESSMENT TASKS
  - INDEPENDENT APPLICATION WITH BIOCRITERIA AS FEEDBACK MECHANISM IS APPROPRIATE FOR PERMITTING

Slide 14

SUMMARY

- BIOLOGICAL ASSESSMENTS ARE VITAL TO PROTECTING THE WATER RESOURCE
- THEY CAN BE INTREGRATED INTO EXISTING PROGRAMS
  - WATERBODY ASSESSEMENTS
  - PERMITTING
  - STANDARDS AND CRITERIA
- THEY DON'T REPLACE EXISTING METHODS
- THEY ENHANCE OUR USE OF GOOD SCIENCE AND MANAGING FOR ENVIRONMENTAL RESULTS

WATER QUALITY PROTECTION REQUIRES INDEPENDENT APPLICATION OF CRITERIA

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The National Wildlife Federation supports broader use of biological criteria. It is an important step toward realizing our vision, which lives in the Clean Water Act: "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."

But we oppose allowing biological criteria to trump chemical criteria or whole effluent toxicity testing--the so-called weight-of-evidence approach. Given our limited ecological understanding and the predictive limits of biomonitoring, it is foolish to discard any assessment indicating potential for impairment. I will focus on three arguments in support of our position.

1. We remain ignorant of ecological consequences. No assessment methods have proven adequate in the past to prevent or accurately predict impairment; all are evolving rapidly, including biomonitoring. With so few States even using biological criteria, it is premature, at best, to consider discarding EPA's integrated policy of independent application.

2. New evidence of impairment warrants a conservative approach. There is emerging scientific consensus regarding reproductive and developmental effects from trace levels of certain environmental contaminants. Wildlife is being seriously affected, yet no national wildlife criteria exist and few States have adopted their own. Under these circumstances, prudence dictates that the most stringent water quality criterion available should govern.

3. Reliance on biological criteria ultimately conflicts with national clean water goals. No one has an inherent right to use common resources to dilute poisonous wastes. Biological criteria are valuable as a tool, but too easily can be turned into a final measure to justify how much pollution is "OK."

History, law, ethics, and humility lead us to this conclusion: an absence of evidence of environmental damage is not necessarily evidence of the absence of environmental damage.

If you need proof, look to the Great Lakes. Here, the best efforts to manage this ecosystem have fallen short.

Biomonitoring may show an absence of environmental damage in the vicinity of a discharge. But downstream, where the Great Lakes provide a sink for the cumulation of their tributary loads, there's unmistakable environmental damage. Bald eagles and mink can't successfully reproduce near the coast. Fish aren't safe to eat for wildlife or people.

Last year a group of scientists from around the world, who have been looking at some of the more insidious effects of pollution, met at Wingspread Center in Racine, Wisconsin. They synthesized the body of evidence regarding widespread disruption of endocrine systems in fish, wildlife, and humans from certain environmental contaminants. These effects, including male and female sexual dysfunctions, are in evidence in the Great Lakes and elsewhere, due to long-term contributions of pollutants to the environment.

In their "Wingspread Consensus Statement" (Colborn and Clement, 1992) the scientists noted well-documented impairments:

> The impacts include thyroid dysfunction in birds and fish; decreased fertility in birds, fish, shellfish, and mammals; decreased hatching success in birds, fish, and turtles; gross birth deformities in birds, fish, and turtles; metabolic abnormalities in birds, fish, and mammals; behavioral abnormalities in birds; demasculinization and feminization of male fish, birds and mammals; defeminization and masculinization of female fish and birds; and compromised immune systems in birds and mammals.

Most troubling, the experts estimated "with confidence" that:

> Unless the environmental load of synthetic hormone disruptors is abated and controlled, large scale dysfunction at the population level is possible. The scope and potential hazard to wildlife and humans are great because of the probability of repeated and/or constant exposure to numerous synthetic chemicals that are known to be endocrine disruptors.

How many of us would have predicted such effects 10 years ago, even 5 years ago? What biomonitoring criteria predict endocrine disruption in the second generation of eagles (see Gilbertson, 1991)? What additional revelations are in store for us in the 21st century?

This is one reason we shouldn't pretend we can craft nature's most efficient wastewater assimilation systems. New and improved dilution zones, mixing zones, and proposals to discard independent application suggest we can.

We can't and we shouldn't. Our encompassing task is to maintain a cadence toward halting the toxic pollution to our Nation's waters. This is the wisdom of the Clean Water Act (Hair, 1989).

Recent initiatives in the Great Lakes can provide a national model and a valuable backdrop for this debate over independent applicability.

The Great Lakes Water Quality Agreement took the Clean Water Act's goal and turned it into a concrete mandate for the Great Lakes ecosystem--zero discharge of any persistent toxic substances.

This 1978 agreement between the United States and Canada implicitly recognizes the reality of the ecosystem it aims to restore. Contaminated sediments and atmospheric fallout will continue to impact the system; therefore, <u>any</u> additional inputs from controllable sources of persistent toxic substances should be banned.

I recommend to you the fifth and sixth biennial reports to the U.S. and Canadian governments in 1990 and 1992 by the International Joint Commission (IJC)--the body charged with overseeing implementation of the Great Lakes Water Quality Agreement. These reports anticipate issues that will frame the agenda for water quality management in the 21st Century.

The IJC encapsulated the moral and scientific power of our environmental conundrum--those stubborn issues mandating the goal of zero discharge. Its 1990 report singled out persistent chemicals widely found in the Great Lakes Basin Ecosystem, including PCBs, dioxin, furan, hexachlorobenzene, DDT, dieldrin, lead, and mercury.

> When available data on fish, birds, reptiles and small mammals are considered along with . . . human research, the Commission must conclude that there is a threat to the health of our children emanating from our exposure to persistent toxic substances, even at very low ambient levels. The mounting evidence cannot be denied . . . These chemicals appear to be causing serious and fundamental physiological and other impacts on animal populations in the Great Lakes basin, and undoubtedly elsewhere. The dangers posed to the ecosystem, including humans, by the continuing use and release of persistent toxic contaminants are severe (International Joint Commission, 1990).

This year the IJC singled out synthetic chlorinated organic substances as a class of compounds that should be subject to zero discharge. The Commission recommended that the Federal Government,

> in consultation with industry and other affected interests, develop timetables to sunset the use of chlorine and chlorine-containing compounds as industrial feedstocks and that the means of reducing or eliminating other uses be examined (International Joint Commission, 1992).

One major, albeit imperfect, step to implement this mandate of zero discharge of persistent toxic substances to the Great Lakes is under way now. In 1990, Congress passed the Great Lakes Critical Programs Act (P.L. 101-596). This neat little law codifies the ecosystem approach. It requires EPA to develop guidance for minimum water quality standards, antidegradation policies, and implementation procedures consistent with the Great Lakes Water Quality Agreement that will apply in all eight Great Lakes States. This draft guidance is the "Great Lakes Water Quality Initiative."

The Initiative's approach attempts to start from the needs of the ecosystem, then projects criteria limits back upstream. Wildlife criteria are included. Mixing zones for bioaccumulative chemicals will be banned after 2004.

The Great Lakes Initiative does not include biological criteria. Nevertheless, as its measures are implemented, we expect biological criteria to be an increasingly important component of tracking progress toward our ultimate goal of healthy ecosystems.

But we are cautious about reliance on biological criteria. For example, the experience in Ohio is often cited to demonstrate that biological assessments frequently pick up impairment missed by chemical evaluation (U.S. EPA, 1990). That is hardly comforting; Ohio is viewed widely as having the most lenient chemical criteria among the eight Great Lakes States (Indiana Department of Environmental Management, 1990; Foran, 1991).

During debate on the issue of independent applicability at this conference 2 years ago, one speaker argued for use of judgment based on the "weight-of-the-evidence" when faced with contradictory chemical, toxicological, and biological assessments (Miner and Borton, 1990).

The fatal flaw in this logic, it seems to me, is the presumption of what he called "irrefutable in-stream data document[ing] the presence of healthy and abundant populations..." and "copious unimpeachable studies involving the most sensitive organisms in the water quality criteria database..."

How convincing is the use of so-called unimpaired reference sites, on which comparative studies are based, particularly in a State like Ohio that historically has been subjected to wholesale landscape modification?

> In the Great Lakes basin the injury has been so extensive and for such a long period of time, that most people, even trained biologists, barely know what happened nor what they are trying to restore (Gilbertson, 1992).

Are biological assessments today capable of demonstrating the absence of developmental and reproductive effects from any chemical? Which chemicals should we worry about? Are there interactive--additive or synergistic--effects occurring in the stream, or far downstream?

The U.S. General Accounting Office (1991) concluded last year that we don't have good answers to these questions:

> Because there is no accepted federal list of reproductive and developmental toxins, such as that generated by law for carcinogens, federal agencies have had no index of whether they have regulated the most important hazards to reproduction and development . . . The protection against reproductive and developmental toxicity afforded the public by current regulation is uncertain at best.

There are lots of things going on out there in the environment that we don't recognize or understand.

CONCLUSIONS

First, our history in the Great Lakes suggests it would be foolhardy to dismiss any chemical, toxicological, or biological indicators of impairment from pollutants. There is strength in each approach; even when results differ, we don't know enough to assume contradictions exist. Independent applicability is grounded in law and common sense.

The National Wildlife Federation and other environmental groups opposed Ohio's recent proposal to allow biological criteria to trump other criteria in its revision of State water quality standards. We would oppose any similar nationwide proposal.

Second, until zero discharge of persistent toxic substances is achieved, however imperfect the use of biological indicators, they are an essential tool in attempting to predict insidious effects of combinations of pollutants.

Rather than continue to debate the established policy of independent applicability, EPA needs to direct States to adopt and use biological criteria. Leadership from EPA Headquarters is needed to establish consistency among and within Regions. The draft Great Lakes Water Quality Initiative can be a national model for progressive guidance and inter-state consistency.

Third, national wildlife criteria must be developed quickly. The Clean Water Act calls for more than a seemingly healthy aquatic system; it also requires health of terrestrial species that rely on the aquatic food chain--eagles, terns, kingfishers, mink, people.

Fourth, water quality criteria must include protection against the spectrum of potential adverse effects, including second generation reproductive and developmental impairment. Counting water bugs under rocks will not suffice--which brings us back to the need for national wildlife criteria that effectively protect the babies of eagles that eat the gulls that eat the fish that eat the little fish that eat the water bugs under the rocks.

Fifth, the term "weight of evidence" has been abused. In fact, we agree on the need for regulators to make judgment calls, to incorporate real-world field data into the process of setting permit limits.

However, weight of evidence does not mean selection of criteria most convenient to dischargers. It does not mean innocent until proven guilty. It does mean a conservative assessment of all indications of impairment, in context of our meager ecological ken. It means coming down on the side of environmental health, when there are inconsistencies among data.

Finally, we seek restoration goals superior to the status quo. Should we have set our sights in the 1960s, for example, on the best water quality Lake Erie or its tributaries then had to offer? Certainly, it would have been hard to justify the 1 mg/L phosphorus limit based on biological impairment in the vicinity of wastewater treatment plants, such as Detroit and Cleveland. But the dreams were for restoring a Lake Erie capable of sustaining a world class fishery. It is a dream coming true.

Our hopes and aspirations for water quality, which were detailed in our own "A Prescription for Healthy Great Lakes: Report of the Program for Zero Discharge" (National Wildlife Federation and Canadian Institute for Environmental Law and Policy, 1991), are set by three affirmative goals:

- Whether women can eat fish from the waters without affecting the development of their babies;
- Whether wildlife that eat fish and other aquatic life from the waters can thrive; and

- Whether people can eat fish from the waters without increasing their risk of getting cancer.

Independent application of water quality criteria is just one tool necessary today to move us in that direction.

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Human Health Risk Management: Who Should We Protect?

HUMAN HEALTH RISK MANAGEMENT: WHO SHOULD WE PROTECT? WHAT IS AN ADEQUATE LEVEL OF PROTECTION?

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Chief
Fish Contamination Section
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EPA's Water Quality Criteria (WQC) for Human Health are designed to protect against the risk of adverse health effects associated with the ambient concentration of a pollutant. The human health criteria are based primarily on two endpoints: (1) carcinogenicity, and (2) toxicity with the principal routes of exposure being the consumption of contaminated surface water and the ingestion of fish contaminated from polluted water.

For many pollutants, human health criteria are limiting factors for the establishment of effluent discharge restrictions. But, although EPA issues criteria guidance documents, it is primarily the responsibility of the States to give these criteria regulatory force through the adoption of water quality standards (WQS).

Human health criteria and water quality standards are derived using a calculation encompassing many exposure, risk assessment, and risk management parameters. For example, the existing EPA methodology assumes an average exposure scenario based upon a fish consumption rate of 6.5 grams per day (i.e., approximately one 7-ounce serving per month). Most States use this rate in setting their WQS. Also, most States adopt an incremental cancer risk level of 1 in 1 million, although a significant number of States have chosen a risk level of 1 in 100,000. The combination of these factors has recently lead to questions being raised about exposure and risk management aspects of the criteria and standards.

- As States have adopted WQS for toxic pollutants, dischargers and other interested parties have challenged the fish consumption exposure and risk level assumptions underlying the standards. Issues relate to the adequacy of the data, the degree of conservativeness in the methodology, the appropriateness of the target population being protected, etc.

- During the process, many have questioned the statuary provisions and risk management policies that allow for diversity among States in the level of human health risk protection provided their citizens.

- In February 1992, EPA Deputy Administrator Henry Habicht issued *Guidance on Risk Characterization*. The document established principles to promote greater consistency and comparability in risk assessments and risk management decisions across Agency programs. Implementation of this policy should produce more realistic risk characterizations and encourage more accurate risk communication. Applying this policy to the Clean Water Act (CWA) WQS could result in important changes.

- Over the past few months, the issue of "environmental equity" has received increased public and EPA attention. The Agency has been petitioned by the Alabama Attorney General to address these equity issues. In the WQC/WQS program, this takes the form of issues concerning the adequacy of protection of populations that are more highly exposed to the risk of consumption of chemically contaminated fish. These exposure patterns may be based on economic status, religion, racial or ethnic background, or geography. Questions arise about what populations and individuals the WQC/WQS should protect, whether the State or EPA should make that decision, what constitutes sufficient data upon which to base these risk management decisions, etc. Others counter that the existing methodology provides adequate protection to even highly exposed populations because of the generally conservative nature of the methodology.

EPA has initiated a review of its CWA risk assessment methodology for WQC and related risk management issues. A major aspect of this review will focus on exposure through the consumption of chemically contaminated fish. This triggers a number of specific questions on which EPA is seeking input.

- How should EPA achieve balance in its risk assessment methodology between being sufficiently protective given continuing scientific uncertainty and not so overprotective as to divert limited pollution control resources to address *de minimis* risk?

- Which exposure scenario for fish consumption should be reflected in EPA's criteria development and approval or disapproval of State WQS actions? Should this parameter be dealt with in isolation from the other factors in the risk assessment methodology?

- Should States be given more or less flexibility in risk assessment and risk management decisions? Are the existing mechanisms for developing site specific criteria adequate to address concerns about protecting highly exposed populations?

- Are the data for rates of fish consumption of sufficient quality to justify changing the assumed rate of 6.5 grams per person per day?

- Is a statutory change necessary or desirable, and if so, what form should it take?

Your input is important. We look forward to a free-ranging exchange of ideas during the panel discussion and the question and comment period to follow.

"FISH CONSUMPTION" AND NATIONAL WATER QUALITY CRITERIA

Daniel C. Picard
Director
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Lapnai, Idaho

"Environmental Equity"--a very appropriate term used by the Administrator of the U.S. Environmental Protection Agency, William K. Reilly, to describe a work group convened by the EPA to assess evidence that racial minorities and low-income communities bear a substantially higher environmental risk burden than the general U.S. population. In terms of "environmental risk," the general findings of the work group were of no real surprise to minority races, groups, and communities, but did well to raise this important issue in the eyes of both the general American public and the EPA itself. This work group intimated the idea that the Agency should indeed increase the priority that it gives to the issue of "environmental equity."

The obvious question then becomes "Why should the EPA increase the priority it gives to environmental equity, and further, how would EPA accomplish this task?" The initial answer is also obvious: EPA has a responsibility, as the Nation's environmental and environmentally related human health "protector," to see that the Nation's citizenry is thus protected adequately. This, of course, would also mean an "equal" protection for all citizens. A protection of the "majority" of the Nation's citizens is not adequate, and in fact is not the mandate under which the EPA operates. As outlined in countless volumes of statutory law, the EPA has, as its general purpose, the protection and enhancement of both the environment and human health.

With this in mind then, let us move on to a more specific application of these ideas. For some time now, it has been argued that perhaps certain criteria by which the EPA attempts to fulfill its role as the human health protector are not adequate when applied to specific populations. This, I would submit, holds especially true for the Native American tribes of the Northwest, with the Nez Perce Tribe being no exception.

As most are no doubt aware, the Agency bases its pollution effluent limitations on certain baseline assumptions, with the idea of protecting human health. The EPA has developed this baseline human health criterion using a combination of exposure and risk management parameters. And, of course, most are no doubt aware that the baseline "fish consumption" rate is presently at an estimated 6.5 grams per day, or an average of 7 ounces per month. This also is the baseline "standard" that most States have used in the development of their individual water quality standards. The focus of my remarks is to bring to light that this fish consumption baseline assumption is not adequate in terms of protecting the Tribes of the Northwest; this may also hold true when speaking of other minority groups who may consume an above-average amount of pollution- contaminated fish.

The Nez Perce, along with a number of Tribes in the Northwest (and more specifically, the Columbia River Basin), have for time immemorial accessed the fisheries of the Columbia River Basin, but in only recent times have been subjected to threats to their health for exercising this custom, right, and subsistence need. With the coming of the European and continual growth in science and technology, we stand today with industry and various other pollution sources on the banks of that same river system. The Nez Perce Tribe is highly dependent upon fishery resources, just as in the past, and in fact, the fishery resource is a vital component of tribal subsistence and cultural preservation. The protection and enhancement of the water quality throughout the Columbia Basin is, therefore, also of vital importance to the Tribe. It is the Tribe's position that the fishery resources within the Columbia Basin are in need of heightened protection. There is increasing evidence of toxic contamination in the river system, which leads both to health effects on the fish themselves and to a threat to the health of the tribal members consuming those contaminated fish.

To ascertain whether EPA water quality criteria, and the underlying "fish consumption" assumption numbers, actually protect human health from the possible effects of toxic chemicals in the Columbia system, the Nez Perce Tribe, along with the other member tribes of the Columbia River Intertribal Fish Commission (Yakima, Umatilla, and Warm Springs), conducted a fish consumption survey. This survey determined the dietary rates, habits, and patterns of tribal members. The survey was funded under a grant from the EPA and was completed under the direction of a technical panel consisting of representatives from the EPA, the Seattle Indian Health Service, and the Centers for Disease Control.

The most significant finding of the Nez Perce portion of that survey was confirmation that the current EPA water quality criteria do not adequately protect tribal members consuming a significantly higher amount of fish than the general public. In comparison to the EPA water quality fish consumption assumption level of 6.5 grams per day, the survey indicated that the average Nez Perce tribal member consumes 79.7 grams per day, 2.35 fish meals per week, and an average of 8.37 ounces at each meal! Further, 10 percent of the Nez Perce interviewees indicated that fish is still relied upon as a primary source of subsistence, and these members ingest fish at a rate of 12.69 meals per week, at an average of 8.46 ounces per meal. This then averages out to approximately 434.79 grams of fish per day, a frightening 67 times the EPA assumption estimates!

The Nez Perce members involved in the survey were age 18 years or older, but by including questions regarding the rate of fish consumption by children within their households, the survey also garnered important information. The average weekly consumption for children identified as fish eaters was 1.18 meals per week, 4.12 ounces per meal, or 19.7 grams per day. Therefore, Nez Perce children typically consume three times the EPA estimate!

The risk of exposure to toxic chemicals by members of the Nez Perce Tribe is heightened even more because the majority of the fish consumed by Tribe members is obtained from the Columbia system, which today stands in a generally high degree of degradation. The threat of health effects in Nez Perce children from dioxin and other toxic pollutants is again increased because a significant number of Nez Perce mothers breast feed, or have breast fed, their children. Nez Perce children also were shown, at a rate of 30.3 percent, to begin eating fish by the age of 7 months while continuing to breast feed. They thus have a threat of double exposure!

Finally, the threat is again heightened because Tribe members are exposed to the threats of toxic pollutants not only at home but also at nearly every tribal cultural or social function. Nearly every function that occurs on the Reservation generally includes the use and consumption of fish.

The survey illustrates that, because fish consumption plays an essential role in tribal religion and culture as well as to subsistence and other uses, and because Tribe members are thus more highly exposed to toxic pollutants, the EPA criteria are obviously inadequate in terms of protecting the tribal "human health."

It is obvious, then, why this particular issue concerns the Nez Perce and other Tribes in the Northwest. It is also obvious why the Tribe would consider the present EPA criterion, with an assumption level at 6.5 grams of fish per day, inadequate. The Tribe is especially concerned with the amounts of dioxin that may enter the water systems, as a result of this faulty standard, on and surrounding the reservations and in places where the Tribe members may access the fisheries. The EPA water quality standard for dioxin also concerns the Tribe because the criterion controlling this pollutant not only is based upon a faulty fish consumption average but also does not account for other harmful effects of dioxin. Recent information on the health effects of toxic pollution show that serious reproductive, hormonal, and other problems result from exposure to much lower levels of dioxin than the levels that may cause cancer (Colborn, 1991; U.S. News and World Report, 1992).

The Nez Perce also believe that the Federal Government's responsibility to protect the public from toxic contamination resulting from industrial waste is even more critical in the case of Indian treaty fishing rights. In 1855, the Nez Perce signed a treaty with the United States that secured to them a reserved right to hunt and fish in "all usual and accustomed places." As part of the treaty right, and to allow the Tribes to take advantage of the right to harvest fish in the

Northwest, Federal courts have expressly recognized a duty of the Federal Government to protect Indians and their fisheries, as demonstrated in *Kittitas Reclamation District v. Sunnyside Valley Irrigation District*, 763 F. 2d 1032 (9th Cir., 1985). This "trust responsibility" is much more than that of an ordinary trustee in that the government has a moral obligation to exercise the highest degree of responsibility, care, and skill in protecting tribal members and the trust property from loss or damage. [See *Seminole Nation v. Georgia*, 30 U.S. (5 Pet.) 1, 17 (1831).] By failing to protect tribal people and the fishery resources upon which they rely, in the Columbia Basin or otherwise, the limitations on toxic chemical discharges may thus violate Federal treaty rights. Federal agencies are obligated to safeguard the treaty tribal members, as well as the subject matter of those treaties. This "trust responsibility" also includes actions taken off reservation by the Federal Government, which may uniquely impact tribal members or their property, as demonstrated in *Northern Cheyenne Tribe v. Hodel*, 12 Indian L. Rep. 3065, 3070-71 (D. Mont., 1985). It is thus argued that the EPA must, therefore, revise the limitations on toxic chemicals based upon faulty fish consumption information to adequately protect tribal treaty rights and to safeguard the health of Tribe members in the Columbia Basin.

The findings and recommendations of EPA's Environmental Equity Work Group stated "there is a general lack of data on environmental health effects by race and income," and also, "Native Americans are a unique racial group with a special relationship with the Federal Government and distinct environmental problems . . . EPA should establish and maintain information which provides an objective basis for assessing risks by income and race . . . . "Finally, the findings stated: "The Agency should incorporate considerations of environmental equity into the risk assessment process. It should revise its risk assessment procedures to ensure, where practical and relevant, better characterization of risk across populations, communities, or geographic areas. In some cases it may be important to know whether there are any population groups at disproportionately high risk" (U.S. EPA, 1992).

It would be the opinion of the Nez Perce Tribe that the recommendations outlined by EPA's Environmental Equity Work Group should be implemented. The group also suggested that "the Agency should expand and improve its communications with racial minority and low-income communities and should increase efforts to involve them in environmental policy making." The Nez Perce emphatically agree. Especially with regard to Indian Tribes, who stand in a unique relationship with the Federal Government, EPA has an obligation to do just that. The Indian Tribes have long asked for such a coordinated effort, and although somewhat late in coming, it is with great optimism that they review the recommendations of EPA's Environmental Equity Work Group.

In the spirit of those same recommendations, the Tribes of the Columbia River Intertribal Fish Commission are hopeful that the data collected for their recently completed fish consumption survey will be put to appropriate use by the Agency. The data collected illustrate that the tribes of the Columbia Basin (more specifically, the Nez Perce, Yakima, Umatilla, and Warm Springs) are disproportionately affected with relationship to the limitations on dioxin and other toxins, especially regarding fish consumption levels. Approximately 15 to 20 previous studies in the United States have addressed fish consumption rates of U.S. citizens. Few of these surveys have addressed fish consumption rates of ethnic groups, and none comprehensively reviewed the fish consumption habits of Native Americans. Therefore, the Columbia River Basin survey is unique because there is little or no other information focusing exclusively on subsistence and ceremonial use of fish by Native Americans. We now have that information, and we again would expect the Agency to use that information and take whatever actions are necessary to ensure the protection of this category of citizens. EPA has noted (as mentioned in the report of the EPA Environmental Equity Group), that there is a "general lack of data on environmental health effects by race and income." The Tribes are optimistic that the recently completed fish consumption survey will help to lay the groundwork for a future of working together to ensure that human health is being adequately protected by the EPA, State environmental agencies and groups, and also tribal environmental protection entities.

It is our hope, then, that when contemplating the change of water quality standards and regulations for dioxin and other toxic contaminants, the EPA would recognize their responsibility to protect the "human health" of all its citizens, and would further recognize their unique "trust responsibility" with regard to the protection of the Native American Tribes. Dioxin and other toxic pollutants seriously threaten almost every aspect of the lives of the Columbia River Basin Tribes, and we believe that water quality standards should pay particular interest to those individuals who stand to be harmed most by the effects of water pollution.

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U.S. News and World Report. 1992. Puzzling over a poison, pp. 60-61; April 6.

Sediment Management Policy Decisions

EPA'S CONTAMINATED SEDIMENT MANAGEMENT STRATEGY

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In the 1980s, EPA documented the extent and severity of contaminated sediment problems at sites throughout the United States. Concerned with the mounting evidence of ecological and human health effects, EPA's Office of Water organized a Sediment Steering Committee chaired by the Assistant Administrator of Water and composed of senior managers in all the EPA offices with authority to handle contaminated sediments and EPA's 10 regional offices.

Over the past 2 years, this committee has been preparing an Agency-wide Contaminated Sediment Management Strategy to coordinate and focus EPA's resources on contaminated sediment problems. A draft outline of this strategy was released to the public this year to serve as a proposal for discussion in three national forums scheduled for April, May, and June. The draft strategy is designed around three major principles:

1. In-place sediment should be protected from contamination to ensure that the beneficial uses of the Nation's surface waters are maintained for future generations;

2. Protection of in-place sediment should be achieved through pollution prevention and source controls;

3. Natural recovery is the preferred remedial technique. In-place sediment remediation will be limited to high-risk sites where national recovery will not occur in an acceptable time period and where the cleanup process will not cause greater problems than leaving the site alone.

The draft strategy includes several component strategies: assessment, prevention, remediation, dredged material management, research, and outreach. A brief summary of each of these elements follows.

In the assessment strategy, EPA is committing to develop a national inventory of contaminated sediment sites and a pilot inventory of potential sources of sediment contamination, based on existing data. The two types of inventories will be complementary because the source database can be used to predict where sediments are contaminated in unsampled areas. The inventories will be designed so that EPA's prevention and remediation programs can use them to focus their resources on cleaning up the top priority sites and sources. Another key element of the assessment strategy is the commitment to develop a consistent, tiered testing strategy that will include a minimum set of sediment chemical criteria, bioassays, and bioaccumulation tests that all programs will agree to use in determining if sediments are contaminated.

The prevention strategy includes a variety of pollution prevention measures and source controls. The scale of contamination will guide the choice of a particular set of these measures. If a sediment contaminant is causing harm or risk at numerous sites nationwide, it may be relatively inefficient to deal with the problem on a site-by-site basis. Instead, the strategy discusses nationally applicable responses, such as prohibitions or use restrictions under TSCA or FIFRA, technology-based effluent limitations for industrial dischargers, or a national initiative to revise water quality-based limits in NPDES permits. If atmospheric deposition appears to be a primary source of contamination, responses under the Clean Air Act will be considered. Where sediment contamination is a concern at particular sites, but not on a national scale, case-by-case assessments and response actions are recommended. Based on narrative and chemical-specific criteria and standards, EPA or a State can develop NPDES permit limits for discharges from industrial sources, municipal sewage treatment plants, stormwater outfalls, and combined sewer overflows. States that have nonpoint source control programs can take actions to reduce the contributions of these sources to sediment contamination.

EPA may remediate sediments under CERCLA, RCRA, CWA, and TSCA. The remediation programs will use the national inventory to assist in selecting sites for cleanup and the consistent tiered testing to assist in identifying contaminated areas and establishing cleanup goals. The remediation strategy emphasizes that sources of contamination should be controlled prior to remediation efforts unless the contaminated sediments pose a sufficiently great environmental hazard. In making remediation decisions, the strategy also points out that it is important to consider whether contaminated sediments at a site can be transported to downstream or offshore areas if left in place, thereby increasing the size of the contaminated area and making future remediation efforts much more difficult. Other factors to consider include the timeframe for natural recovery, the potential for contaminant mobilization during remediation, and the feasibility and cost of various treatment and removal options.

The maintenance of our Nation's waterways for navigation requires the dredging and disposal of 250 to 450 million cubic yards of material each year. Dredged material testing manuals prepared jointly by EPA and the Corps of Engineers recommend the chemical and biological tests that should be conducted to determine if the material is contaminated and must be disposed of using special procedures. The tests selected for the Agency-wide contaminated sediment strategy will be included in these dredged material testing manuals. The strategy also outlines additional guidance that will be developed by EPA and the Corps to improve the management of these materials.

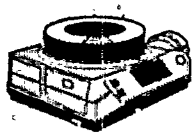
The research strategy outlines all the work that EPA's Office of Research and Development (ORD) has planned on sediment chemical criteria, sediment bioassay and bioaccumulation tests, fate and transport models, and remedial techniques. ORD is establishing a Resource Center to provide EPA offices with centralized technical assistance in evaluating sediment contamination and will also sponsor workshops and training sessions throughout the country.

The outreach strategy describes how EPA will work with other Federal agencies and State agencies to coordinate EPA's contaminated sediment activities with their efforts. EPA will strive to ensure that these agencies share sediment-related research findings and innovative technologies. In addition, EPA is proposing a two-way public awareness program that will disseminate contaminated sediment information to the public and also incorporate information from the public into EPA activities.

The purpose of this panel is to debate key issues involved in the strategy. The fundamental question is whether the relative human health and environmental risks of contaminated sediments merit the increased attention and resources EPA is proposing to commit to this area. The second key issue is whether we need any statutory changes to address contaminated sediment problems more effectively. The current strategy is based on existing authorities and requires no new legislation. If it is decided we need to focus more attention on this problem, the next issue of importance is how EPA should prioritize its activities. Should the primary focus be on criteria development, policy guidance, data gathering, NPS controls, or developing remedial technologies?

There are two key implementation issues which also must be debated. First, how should sediment quality criteria be used in the prevention, remediation, and dredged material management programs? Second, do the States have the resources and knowledge base to effectively implement the prevention, remediation, and dredged material management programs?

I look forward to a lively discussion of all these issues and invite everyone to take part in our debate.



Slide Presentation

Slide 1

EPA'S CONTAMINATED SEDIMENT STRATEGY:

A PROPOSAL FOR DISCUSSION

Slide 2

MAGNITUDE OF THE PROBLEM

- Extent of Contamination May Be Large
  - 1985 and 1987 OW Surveys
    - PCBs, Pesticides, PAHs, Metals
    - Potentially Hundreds of Sites
- Potential for Far-Reaching Effects
  - 1989 National Academy of Sciences Report

Slide 3

CASE STUDIES ON HUMAN HEALTH

- Quincy Bay, Massachusetts: Cancer Risk from Consuming Lobster Tomalley
- Los Angeles-Long Beach Harbor: Up to 10^{-3} to 10^{-4} Cancer Risk from Consuming White Croaker
- Puget Sound: As Much as 2×10^{-4} Cancer Risk for Moderate Seafood Consumers and 4×10^{-3} Risk for High-Quantity Consumers

Slide 4

CASE STUDIES OF ECOLOGICAL EFFECTS

- Elizabeth River, Virginia: Severe Fin and Gill Erosion, Tumors, Mortality
- Black River, Ohio: Fish Tumors
- Great Lakes: Reproductive Problems in Forster's Tern, Reproductive Failures and Mortality in Mink
- Commencement Bay, Washington: Mortality in Amphipods and Oyster Larvae

Slide 5

GOALS OF OUR STRATEGY

- Prevent Future Contamination of Sediments
- Manage Existing Sediment Contamination Using:
  - Pollution Prevention
  - Source Controls
  - Natural Recovery Where Appropriate

Slide 6

GOALS (Cont.)

- Remediate High-Risk Sites Where Natural Recovery Is Not Acceptable
- Ensure Environmentally Sound Management of Sediment Dredging and the Disposal of Dredged Materials

Slide 7

ELEMENTS OF OUR STRATEGY

I. Assessment
- A. National Inventory
- B. Consistent Tiered Testing
- C. Monitoring

II. Research
- A. Sediment Chemical Criteria
- B. Bioassay/Bioaccumulation Methods
- C. Fate and Effects Models
- D. Remedial Technology Development/Demonstration
- E. Technology Transfer

Slide 8

ELEMENTS (Cont.)

III. Prevention
- A. Effluent Guidelines
- B. Point Source Controls, Including CSOs and Stormwater
- C. Nonpoint Source Controls
- D. Review of Pesticides
- E. Review of Toxic Chemicals
- F. Additional Pollution Prevention Activities

Slide 9

ELEMENTS (Cont.)

IV. Remediation
- A. Enforcement-Based Remediation
- B. Superfund Cleanups
- C. RCRA Corrective Action
- D. PCB Cleanup Requirements
- E. CWA/Corps Remediation

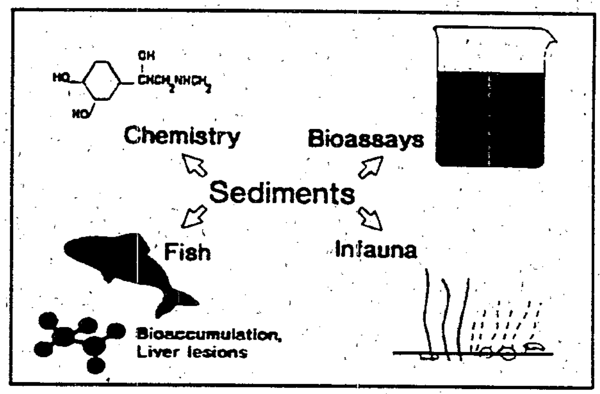
V. Managing Dredged Materials
- A. Improved Testing and Management
- B. Applying Sediment Criteria
- C. Applying RCRA Criteria
- D. PCB Disposal Requirements

WATER QUALITY STANDARDS IN THE 21st CENTURY: 181-190

REGULATORY USES OF SEDIMENT QUALITY CRITERIA IN WASHINGTON STATE

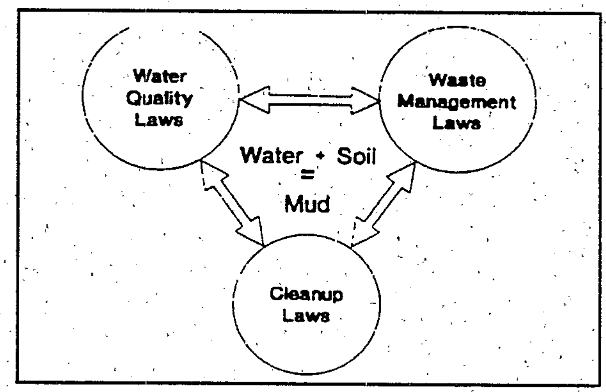
Keith Phillips
Washington Department of Ecology
Sediment Management Unit
Olympia, Washington

ENVIRONMENTAL EFFECTS OF CONTAMINATED SEDIMENTS



- Sediments with elevated concentrations of chemical contaminants.
- Adverse effects to laboratory test animals.
- Fewer animals living on and in contaminated sediments.
- Bottomfish fin rot, gill lesions, reproductive failure and liver tumors.
- Local health department fishery advisories warning against human consumption.

INSTITUTIONAL CHALLENGES OF SEDIMENT MANAGEMENT



- Like water, sediments are an environmental medium and are subject to aquatic protection laws.

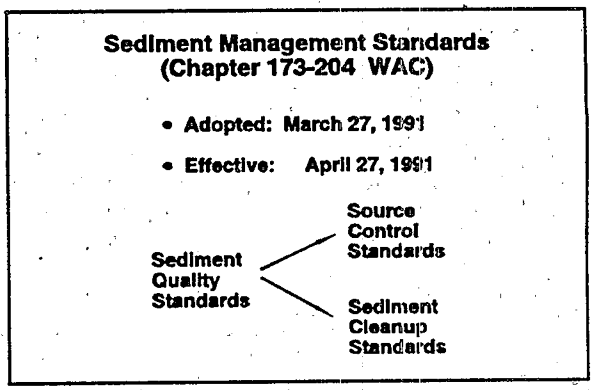
- Unlike water, if sediments are picked up, they are similar to any other solid waste material.

- Contaminated sediments result in cleanup liabilities to the discharger, the waterfront developer, and the landowner.

- Underlying institutional challenge: Ensure that all government programs that affect the quality of sediments (source control, dredging and cleanup) are integrated and work toward the same quality goals.

- Sediment management requires an innovative blend of legal mandates and procedures to effectively integrate water quality, dredging, and cleanup programs.

SEDIMENT MANAGEMENT STANDARDS



- Washington recently adopted a new rule known as the Sediment Management Standards, Chapter 173-204 of the Washington Administrative Code.

- The rule established a set of narrative chemical and biological criteria as "sediment quality standards."

- The rule applies sediment quality standards in existing source control programs designed to control the discharge of contaminants (e.g., discharge permits).

- The rule applies sediment quality standards in a sediment cleanup decision process and as sediment cleanup standards.

- The rule was recently approved by EPA as part of the State's "water quality standards" pursuant to section 303 of the Clean Water Act.

SEDIMENT RULES IN WASHINGTON STATE

Washington Sediment Rules

- **Sediment Management Standards**
  - **adopted 1991**
- **Dredged Material Management Standards**
  - **adopt late 1993?**

- In response to environmental problems, institutional challenges, and legal mandates associated with sediments, the State of Washington has been working on two new sediment rules.
- The first sediment rule is known as the Sediment Management Standards and was adopted in 1991.
- The other sediment rule is known as the Dredged Material Management Standards and is currently scheduled to be drafted by 1993.

SEDIMENT QUALITY STANDARDS: CHEMICAL TESTS/CRITERIA

Sediment Chemical Criteria

- **47 Chemicals of concern**
  - **8 metals**
  - **39 organics**
- **Criteria - - highest reliability**
  - **Apparent Effects Threshold**
  - **Equilibrium Partitioning**
- **"other deleterious substances"**

- The rule lists 47 chemical-specific concentration criteria for Puget Sound marine sediments.
- These criteria were developed using the Apparent Effects Threshold and Equilibrium Partitioning methods because the combination was more reliable in predicting adverse biological effects.
- The rule also provides for addressing "other deleterious substances in or on sediments" which cause adverse biological effects, with methods and criteria to be established on a case-by-case basis.

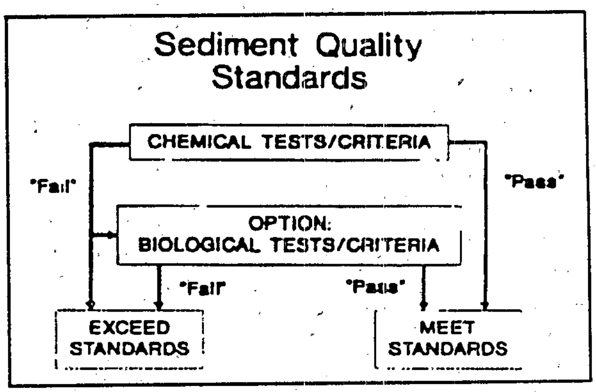
SEDIMENT QUALITY STANDARDS: BIOLOGICAL TESTS/CRITERIA

Sediment Biological Criteria

- **Acute Effects: Do 2 tests –**
  - **amphipod**
  - **larval (bivalve/echinoderm)**
- **Chronic Effects: Do 1 of 3 tests –**
  - **benthic infaunal abundance**
  - **polychaete biomass**
  - **Microtox**

- The rule establishes a set of routine biological tests for assessing sediment quality.
- When biological testing is conducted, a minimum of three tests is required--two to address "acute effects" and one to address "chronic effects."
- To address "acute effects," the rule requires that a 10-day amphipod mortality test and a 48- to 96-hour sediment larval (oyster, mussel, or echinoderm) test be conducted.
- To address "chronic effects," the rule requires that a bacterial bioluminescence test, a polychaete worm growth test, or a field benthic infaunal abundance assessment be conducted.
- Biological test interpretation criteria are contained in the rule.

SEDIMENT TESTING MODEL

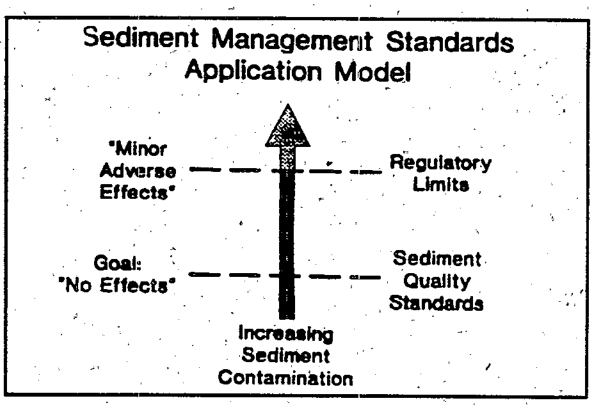


- The Sediment Management Standards relies on a tiered testing model to evaluate sediment quality.
- The first tier is sediment chemistry, where sediment chemical test results are compared to chemical criteria. If all chemicals of concern are below criteria, the sediment is assumed to not cause adverse biological effects.
- If any of the chemicals of concern are above the chemical criteria, the sediment is assumed to cause adverse biological effects pending results of biological testing.

- If biological tests are performed, the biological test interpretation criteria will govern the final decision regarding the quality of the sediments.

- This technical approach is used for all sediment quality decisions contained in the rule.

REGULATORY APPLICATION MODEL



- Sediment quality standards represent a "no effects" goal.

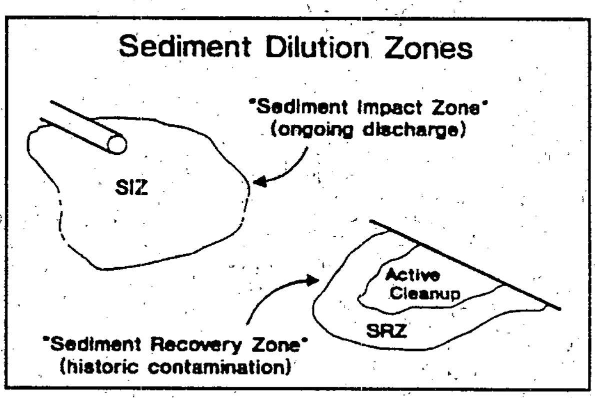
- Exceeding the sediment quality standard does not mean terminate discharge or start active cleanup.

- "No effects" standard was established solely using scientific information--not engineering feasibility or cost factors that are part of regulatory decisions.

- A second sediment standard, the "minor adverse effects level," acts as a upper bound or ceiling on regulatory decisions.

- Between these two standards, source control and cleanup decisions are made in consideration of net environmental effects and cost/feasibility tradeoffs.

SEDIMENT DILUTION ZONES

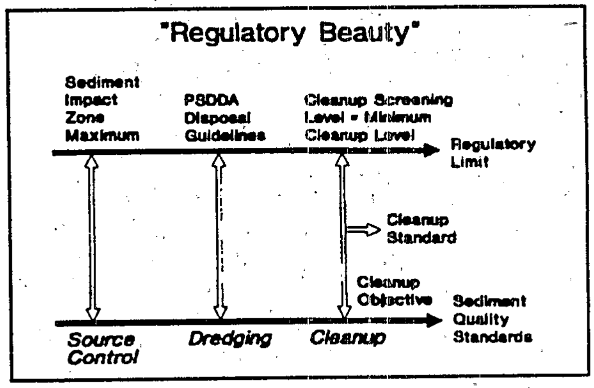


- The rule uses "sediment dilution zones" as the vehicle for authorizing adverse effects over the "no effects" sediment quality standards.

- For ongoing discharges, the State can authorize an area outside the discharge known as a "sediment impact zone" within which the discharge can exceed the lower "no effects" standard, but not the higher "minor effects" standard.

- For historic contamination subject to cleanup, the State can define contamination above the "no effects" standard and below the "minor effects" standard that does not need to be cleaned up--leaving a "sediment recovery zone."

CROSS-PROGRAM IMPLICATIONS



- The same standards of quality are established for all regulatory programs, ensuring that government programs affecting sediment quality work in harmony.

- We do not want permitted discharge sediment impact zones that will result in increased disposal costs and liabilities to navigation dredgers.

- For cleanup programs, the upper standard is a cleanup trigger ("cleanup screening level") above which we will list a site for active cleanup, below which we will not list a site for active cleanup.

- This arrangement ensures that we will not be permitting discharges or creating dredged material disposal sites that will later become future cleanup sites.

SEDIMENT SOURCE CONTROL PROCESS

Sediment Source Control (1 of 2)

- **A) Evaluate potential sediment impact**
- **B) Require SIZ application**
- **C) Verify technology requirements (e.g., BAT)**
- **D) Verify sediment impact**
- **E) SIZmax exceedance?**

- The rule describes the process for controlling sediment quality effects of discharges to the aquatic environment, beginning with evaluating the potential effects prior to discharge permitting.

- If adverse effects are possible, the rule outlines discharger information to be supplied with the permit application.

- Sediment impact zones are authorized only for discharges that are applying all federal and state technology requirements.

- Discharge sediment effects are verified by empirical and modeling information.

- Rule prohibits a discharge from exceeding the upper standard of "minor adverse effects"--the sediment impact zone maximum contamination (SIZmax) standard. (Sediment quality-based effluent limits can be required.)

- The rule contains narrative criteria for locations where SIZs are to be avoided if possible.

- Authorized SIZs are to be as small as practicable, with the least degree of contamination possible, i.e., the SIZ may not be allowed to reach the upper standard of contamination.

Sediment Source Control
(2 of 2)

F) SIZ locational criteria

G) Small/least contaminated as practicable

H) Public/landowner review

I) Permit issued with accountability:
- monitoring/maintenance/closure

J) Reduce/eliminate —> renewals/modifications

- Public and landowner review of the proposed SIZ is required prior to permit issuance.

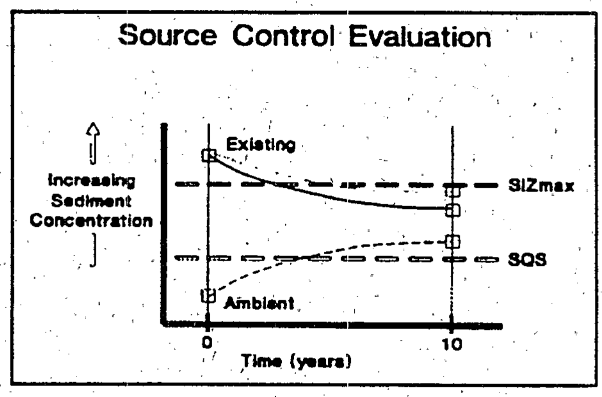
- Key intent: Rule ascribes accountability to the discharger through the permit, including monitoring, maintenance, and closure requirements for authorized SIZs.

- Key policy: To eventually reduce and eliminate all SIZs through the permit renewal process.

EVALUATING POTENTIAL SEDIMENT EFFECTS OF A DISCHARGE

- Unlike water, sediment effects can build up over years of discharge.

- The rule requires evaluation of the discharge for a period of 10 years (about two 5-year permit cycles).



- From "ambient" conditions (natural/background sediment quality, absent any other ongoing or historic contamination), the lower curve shows that the discharge may eventually result in exceedance of the sediment quality standards--requiring a SIZ authorization at the time of permit issuance.

- From the "existing" conditions (current sediment quality), the middle curve shows that most sediments are undergoing a natural recovery process due to regulatory efforts over the last decade.

- The upper curve indicates that an increased discharge would typically delay that recovery process.

- SIZs can be established in areas that are already contaminated above the SIZmax line, and are more like permitted loads than observable field conditions.

- Cleanup of historic contamination within an authorized SIZ is also possible.

DISCHARGE AND SEDIMENT LIABILITIES

Sediment/Discharge Liability

Regulatory Control?	- or -	Trespass and Taking?

- No landowner approval or indemnification
- Rule avoids proprietary implications
- Align standards/provide accountability
- Integrate regulatory and proprietary

- Unresolved legal issue: Whether a regulatory discharge permit that restricts, yet allows sediment contamination on someone else's land constitutes an action subject to proprietary laws.

- Landowner approval over regulatory permits could result in the landowner holding the discharger hostage. And there are legal questions about Ecology delegating regulatory powers to the landowner.

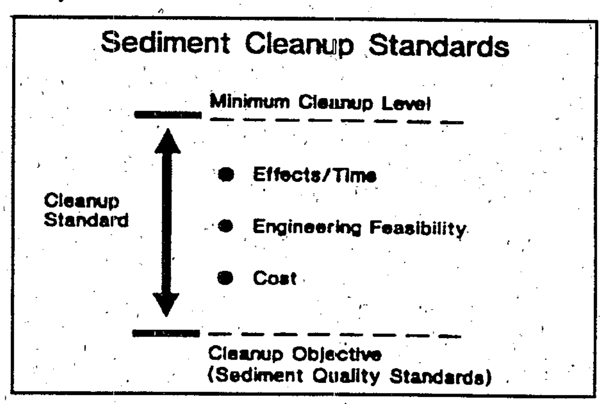
- Indemnifying the landowner for contamination that Ecology permits to be placed on their land would illegally rewrite legislated liability standards.

- Rule states that regulatory action does not address any proprietary requirements.

- Rule aligns the sediment standards so that discharges do not create new cleanup sites.

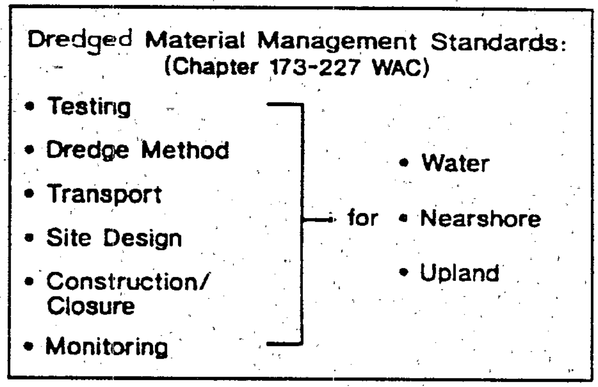
- Rule establishes accountability to the discharger for sediment effects.
- State agencies are integrating regulatory and proprietary interests.

SEDIMENT CLEANUP STANDARDS



- Key rule feature: Defines sediment cleanup standards.
- Cleanup standard is defined on a site-specific basis, as close as practicable to the sediment quality standards (the "cleanup objective"), not to exceed the "minimum cleanup level."
- In defining practicability, net environmental effects, natural recovery rates, engineering feasibility, and cost are all factors that are considered when determining the site cleanup standards.

DREDGED MATERIAL DISPOSAL STANDARDS



- The State is developing a second sediment rule addressing dredging and disposal of sediments derived from navigation and cleanup projects.
- Dredged Material Management Standards, Chapter 173-227 WAC, will specify technical and procedural requirements for all dredging and dredged material disposal actions.
- Rule will codify key features of existing federal/state program for unconfined, open-water disposal of dredged material (Puget Sound Dredged Disposal Analysis).

- Rule will provide "minimum functional standards" for disposal of sediments in upland disposal sites.

- Rule will be linked to the State's hazardous waste rules to address hazardous waste and contaminated sediment interface.

- Draft guidance manual due by late 1992; draft rule scheduled for 1993.

ONGOING DEVELOPMENT OF SEDIMENT CRITERIA

- Though the adopted Sediment Management Standards contain policies, procedures, and narrative criteria that are applicable state wide, numerical chemical and biological criteria contained in the adopted version of the rule are solely applicable to Puget Sound marine sediments.

Ongoing Criteria Development

- **Human health sediment criteria**
- **Freshwater sediment criteria**
- **Benthic infaunal criteria**
- **Antidegradation**

- Ecology is continuing work to fill in the "reserved" portions of the rule.

- Human health sediment criteria are being developed jointly by Ecology and the Washington Department of Health, with technical work scheduled for completion in 1993. Freshwater sediment criteria are also being developed by Ecology.

- Ecology will convene a meeting of benthic infauna experts to evaluate improved ways for interpretation of benthic community data.

- Ecology has agreed to include sediment quality issues during development of the antidegradation implementation plan for water quality standards.

SEDIMENT CRITERIA: NEEDS AND USES

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First, I'd like to say that I'm sure I speak for thousands of environmentalists around the country when I say that I'm pleased that EPA has focused so much energy and attention over the past several years toward the development of sediment criteria and a national contaminated sediment management strategy.

WHY BE CONCERNED ABOUT SEDIMENT CONTAMINATION?

In the Great Lakes, we're used to being the miners' canaries that spot problems first, probably because there are so many of us out there watching all the time. For more than 6 years, contaminated sediment in our Great Lakes tributaries and harbors has been recognized as one of the biggest contributors of persistent, bioaccumulative contaminants to our sport fish and fish eaters. Lack of agreement on safe disposal options for contaminated dredged material has also been the thorniest problem for keeping recreational and commercial harbors operating at full capacity.

I surely don't need to tell this group that contaminated sediment is now thought to come close to or to possibly even equal the atmosphere as a source of persistent contaminants to the Great Lakes. It certainly exceeds (currently active) point source contributions by a long shot; we don't have good data on surface runoff.

When we look, therefore, at human and environmental effects of toxic chemicals in the Great Lakes, at fish tumors and other carcinomas, at reproductive failure and behavioral abnormalities of fish and of fish-eating birds and people, we are increasingly confident that sediment has been a major exposure route. Several specific caged-fish studies, notably in Detroit River sediment, have corroborated this. So has the continued predominance of PCBs in fish flesh, because PCBs have long since been banned from production, leaving sediment as the biggest source of these compounds.

Numerical vs. "Effects-Based" Criteria: What Are We Really Arguing About?

Sediment quality criteria, as our "national contaminated sediment working group" of environmentalists sees them, are measures of the levels of contamination in sediment that pose risks of adverse effects to human health or the environment. (Many of the points I will address here today are taken from a report our group prepared in March, with Rich Cohn-Lee and Jessica Landman of the National Resources Defense Council as principal authors and collators of our views.) We believe that sediment criteria must:

- Protect the most sensitive species in a given habitat <u>plus</u> an extra safety margin;
- Take into account the fact that many organisms absorb contaminants directly from sediment and not through the water column; and
- Be designed to protect against chronic, bioaccumulative effects, dynamic changes in bioavailability, food chain exposure--and reproductive and behavioral effects as well as cancer.

Some people have expressed concern that it would not be scientifically possible to come up with one simple number (such as 1 μg/kg for cadmium) that defines what level of contamination is safe or "clean" in all locations or circumstances. This concern is based on what we perceive as an incomplete understanding of EPA's proposed criteria process.

Sediment quality criteria need not consist of one simple number applicable in all waters. It is likely that criteria will vary depending on a number of factors that might affect toxicity or exposure, such as salinity, organic carbon content, or sediment grain size. A sediment quality criterion could consist of a matrix that includes these or other relevant factors, and that enables the decision maker to calculate a concentration appropriate for a given site. Many of the water quality criteria now in existence are written this way.

Furthermore, sediment quality criteria need not be only a "number." Sediment quality criteria and standards should be allowed to consist of an array of tests. EPA may not be able to derive numbers that define the safe concentration of a chemical in sediments with a high degree of confidence for more than a small subset of chemicals.

In summary, the concept of sediment quality criteria is broad enough to encompass a combination of single-chemical criteria (such as those developed by the Equilibrium Partitioning approach or the Apparent Effects Threshold), toxicity bioassays, and *in situ* measurements of benthic health. Single-chemical numbers by themselves will not meet the "sensitive species" or "margin of safety" criteria. Toxicity bioassays should be able to define chronic effects and sublethal endpoints. Owing to gaps in the understanding of sediment chemistry and bioavailability, sediment quality criteria must incorporate this full suite of testing to be accurate and protective.

We believe this approach will be more protective and accurate than the "effects based" approach, which develops an action level in a specific location, based on toxicity of a chemical in a single chemical dilution without regard to synergistic or antagonistic effects, and without acknowledging the direct sediment to organism pathway for pollutants.

How Do Sediment Quality Criteria Fit into the Federal/State Relationship?

Sediment quality criteria, as I see it, are fully compatible with the existing Federal and State regulatory framework.

Under section 303(c) of the Clean Water Act, States are required to adopt water quality standards that "serve the purposes of the Act," as spelled out in section 101(a). Such standards must include criteria that protect water body uses such as fishing, swimming, and for fresh water bodies, drinking.

Furthermore, Federal regulations provide that State standards must be based on Federal criteria (EPA's section 304(a) guidance), the EPA guidance modified to reflect site-specific conditions, or other scientifically defensible methods.

Once EPA develops sediment quality criteria, this same principle would apply to State adoption. That is, Federal 304(a) guidance will form the basis for State standards, unless the State develops site-specific standards or uses some other scientifically defensible method for deriving standards; the burden of demonstrating defensibility will rest with the State.

Over the past decade, the States have been extremely slow to adopt water column standards for toxic pollutants, despite a specific requirement in the 1987 Amendments to the Clean Water Act that they do so within 3 years. This inactivity has resulted in a delay in protecting our waters. For this reason, a successful national sediment quality criteria program must include strong incentives for States to promptly adopt and implement standards. If sediment quality criteria are developed by the EPA, the States should be given 2 years to adopt their own standards. If they do not adopt standards at least as protective as EPA's within the deadline, EPA's criteria should automatically become applicable State standards.

In waters where State criteria do not apply, such as the open ocean, federally adopted sediment quality criteria should be used. In interstate waters such as the Great Lakes or Chesapeake Bay, a mechanism, such as that currently being offered through the Great Lakes Water Quality Initiative, is needed to ensure adoption of consistent, protective standards. If States wish to apply more stringent provisions, they should be provided authority to do so.

How Should Sediment Quality Criteria Be Applied?

There are a number of obvious applications for sediment quality criteria. More are sure to emerge once these criteria are established.

NPDES Permitting, Limits Derivation

Industries and sewerage treatment plants that discharge effluent into U.S. waters are required to have permits that establish limits on the quantity of pollutants they can release. Today, those limits are derived to protect water quality, i.e., the chemical content of the water column. Permit writers use State standards, plus information on effluent concentration, flow (the "dilution" of the waste stream that will occur once it hits the water), and patterns of mixing to back-calculate the level of a pollutant that is permissible in the effluent (U.S. EPA, 1991a).

However, it is known that, even if pollutants are present in low concentrations in the water, they can settle out into sediment and, over time, accumulate in high concentrations.

Once sediment quality standards are available, they can be used in a manner similar to water quality criteria to back-calculate the level of pollutant discharges that can safely be made without exceeding sediment criteria (U.S. EPA, 1991b). Permits limits then can be modified to protect both water and sediment quality.

For many waters, multiple dischargers often exist for a toxic contaminant of concern. In such cases, single-facility discharges cannot be analyzed in isolation. A Total Maximum Daily [sediment] Load (TMDL), or the maximum daily amount of a certain pollutant that the sediment bottom can safely receive, must be calculated. Once the TMDL for sediment is determined, that load must be allocated among all dischargers and pollutant sources (both point and nonpoint sources). **I say all this with the caveat that environmentalists do not favor mixing zones and dilution allowances for the handful of persistent bioaccumulative toxic compounds that have produced clear adverse health effects. We also see approaches such as TMDLs as interim tactics on the way to achieving zero discharge for these same compounds.**

During the time that the load allocation calculations are taking place, an interim approach would be to require a staged cutback or freeze at current levels of discharges if a sediment standard for a pollutant is exceeded. The freeze or reduction would remain in effect until an acceptable wasteload allocation could be developed.

Once the load allocation is established, pollution prevention strategies on several levels should be implemented to reduce and ultimately end the discharge of pollutants to the water and sediment. Although individual strategies may vary depending on site-specific factors, a TMDL should typically include the reduction of pollutants from discrete industrial, commercial, and municipal discharges, and the prevention of more diffuse sources such as contaminated stormwater runoff from urban, agricultural, and harvested forest areas. Some pollution prevention strategies include the elimination of harmful chemicals from industrial and commercial processes, and the retention of naturally vegetated "buffer zones" to reduce the magnitude and contamination of runoff flows during rainfall.

Protection of Pristine Areas

Clean sites that do not yet have contaminated sediments also need to be protected. To effectively protect sites that are cleaner than the sediment standards would require, the antidegradation policy of the Clean Water Act, which states that clean waters must remain uncontaminated, should be amended so that it clarifies that sediment quality criteria, as well as water quality criteria, can trigger its application.

Evaluation of Materials for Dredging and Disposal, and Better Management of Contaminated Materials

Every year, between 350 and 450 million cubic yards of materials, enough to fill a football field-sized pit 6,000 miles deep, are dredged and disposed of to keep shipping channels and harbors open in this country. A growing percentage of these materials is contaminated by toxic substances. Sediment quality criteria and standards will enable us to test these materials, to see which ones are "clean" and which may have adverse effects on the environment.

Once the distinction can be made between clean and contaminated dredged materials, we can focus on beneficially reusing the clean materials. The comprehensive pollution prevention strategies we support will help by halting their continuing contamination. We also support elimination of the open water disposal of contaminated materials, a practice already in effect over most of the Great Lakes. Elsewhere, as we move toward achieving that elimination, more effective sediment control and management strategies are needed to minimize damage to the environment.

The Marine Protection, Research, and Sanctuaries Act (MPRSA), or Ocean Dumping Act, should incorporate sediment quality criteria as a screening tool to determine the quality (i.e., clean, partially contaminated, contaminated) of sediments at a site where dredging is planned. Since the MPRSA forbids the ocean dumping of dredged materials that would endanger human health, the aquatic ecosystem, or the economic potential of an area, sediments that fail the sediment quality criteria should not be approved for ocean dumping. In emergency situations where there is no feasible alterative to ocean disposal, our group has proposed that a waiver request could be submitted to the EPA. If the Agency determines that the dumping will not result in "unacceptably adverse impact" on a water body, a waiver will be granted that permits ocean dumping of contaminated material (33 USC Section 1413(d)).

Site management plans should be developed for designated ocean sites that receive both clean and contaminated dredge materials. These plans should include periodic monitoring using sediment quality criteria as a measurement tool and a plan for closing the site or modifying its use if impacts are discovered.

Consistent Standards for Monitoring and Ecological Evaluation

For many years, people have been debating the scope and degree of sediment contamination. A number of efforts have been made to evaluate the problem on a national basis, by such institutions as the National Academy of Sciences.

Thus far, all the evaluators have had to develop their own yardsticks for contamination, which has made it difficult to reach definitive answers. National sediment quality criteria (either EPA guidance adopted by the States or national criteria adopted by EPA for U.S. waters) will give us one yardstick that everyone can use. We will be far more able to set up monitoring programs, both for still uncontaminated sites, to protect them, and for contaminated sites, to measure our progress in cleaning them up, once criteria are in place.

Standards for Site Cleanup/Restoration

For sediments that are already contaminated and need to be cleaned up, a mechanism is needed to determine what triggers a cleanup. Sediment quality standards would serve as a critical component of a set of criteria used to trigger the cleanup and remediation of a contaminated site. Little agreement or understanding currently exists regarding the extent to which sediments must be cleaned up to consider a site "remediated." Of course, cleanup can mean many things. It can mean implementation of pollution prevention strategies to halt further contamination and allow natural processes to take their course--although this solution is unlikely to be applicable to Great Lakes tributaries, which regularly, during storm events, wash great quantities of contaminated sediments downstream to disperse beyond recovery in the lakes. In many cases, it will mean dredging a river bed or hot spots within it and treating the contaminated dredge spoils. Each site will need to be evaluated individually. Used in conjunction with other factors or criteria, sediment standards can serve to trigger remediation.

Does EPA Have Legal Authority To Develop Sediment Quality Criteria?

Yes. EPA does have authority to develop and implement sediment quality criteria. Section 101(a) of the Clean Water Act establishes a national objective of restoring and maintaining the "chemical, physical and biological integrity" of our Nation's waters. In addition, section 304(a)(1) directs the Administrator to develop and publish criteria for water quality reflecting the latest scientific knowledge on (1) the kind and extent of <u>all</u> <u>identifiable</u>

effects on plankton, fish, shellfish, and wildlife that may be expected from the presence of pollutants in any body of water, including ground water, and (2) the effects of pollutants on biological community diversity, productivity, and stability.

Section 304(a)(2) directs the Administrator to develop and publish information on the factors necessary for the protection and propagation of shellfish, fish, and wildlife for classes and categories of receiving waters.

EPA has developed water column criteria pursuant to its authority under section 304(a). These numerical criteria are intended to protect the chemical integrity of the aquatic resource, but, standing alone, are not adequate to protect physical and biological integrity as required by section 304(a). It is our view that it is in the context of recognizing this deficiency that EPA has begun developing both biological criteria (criteria based on biological assessments of natural ecosystems) and sediment criteria to complement its water column criteria. Once water column, sediment, and biological criteria are in place, we will have a better mechanism for restoring and protecting our waters as mandated under sections 101(a) and 304(a) of the Clean Water Act.

Why Do We Need Legislation?

Since EPA already has authority to set sediment quality criteria if it wants, why is legislation needed? There are two main reasons: timing and applicability.

Timing

While the law clearly allows, even requires, EPA to develop sediment quality criteria, the Agency's job would be done more quickly if Congress provided more express authorization and clearer instructions to convey priority. Despite its existing mandate, in 20 years EPA has yet to promulgate a single sediment quality criterion (although four have now been presented for approval). The Clean Water Act should be amended to specify how quickly EPA must move in developing sediment quality criteria; the law could also specify a priority for persistent, bioaccumulative compounds.

Applicability

Sediment quality criteria will protect the environment only if they are used as a basis for making regulatory decisions. The Clean Water Act and Marine Protection, Research and Sanctuaries Act should be amended to clarify that, once developed, these criteria will form the basis for decisions about permitting for the disposal of dredged materials (what may be dumped and where) and the discharge of pollutants. Further, we believe that the law should be amended to ensure that EPA's sediment quality criteria are applicable in ocean and shared coastal waters. Ideally, the Clean Water Act should be amended to establish national sediment quality criteria as well as national water quality criteria. These amendments would lay to rest once and for all the issue of "pollution shopping" by industries and would be a far more efficient and effective way to begin the national assessment and cleanup process. Of course, the law would continue to provide for the establishment of site-specific standards where scientific evidence demonstrates that such standards are appropriate.

Thank you.

(Members of the National Contaminated Sediment Working Group who participated in developing the positions summarized in this paper include Dery Bennett of The American Littoral Society, Topher Hablett of Save the Bay, Sarah Clark of the Environmental Defense Fund, Glenda Daniel of the Lake Michigan Federation, Brett Hulsey of the Sierra Club, Jessica Landman and Rich Cohn-Lee of the Natural Resources Defense Council, Boyce Thorne-Miller of Friends of the Earth, Beth Millemann of the Coast Alliance, David Miller of National Audubon Society, Kathleen Van Velsor of Coastal Advocates, Philip Weller of Great Lakes United, and Cindy Zipf of Clean Ocean Action. An additional 135 organizations have endorsed the general goals embodied in this statement through a Citizens Charter for Contaminated Sediment, published in 1987.)

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APPROACHES TO MANAGING CONTAMINATED SEDIMENTS WITHOUT SEDIMENT QUALITY CRITERIA

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INTRODUCTION

Near many industrial centers, the sediments in rivers, estuaries, and harbors contain elevated concentrations of toxic chemicals relative to sediments from "pristine areas." The concentration of toxic chemicals in many of these locations are great enough to have a reasonable potential to cause adverse effects to human health and the environment. The Environmental Protection Agency (EPA) is currently developing a management strategy to assess, control, protect, and remediate these contaminated sediments (U.S. EPA, 1992).

The management of contaminated sediments can be separated into two major functions: (1) controlling and protecting existing and future sediment quality, and (2) assessing and remediating sediments contaminated from ongoing and historic discharges. Recent EPA presentations before EPA's Science Advisory Board make it clear that EPA plans to rely heavily on sediment quality criteria (SQC) to provide the basis for their control and remediation strategies. In the draft contaminated sediment management strategy, EPA proposes to derive NPDES permit limits based on SQC to control and protect sediment quality (U.S. EPA, 1992). To accomplish this goal, EPA plans to release a draft guidance manual for deriving permit limits and conditions to protect sediment quality in Fiscal Year 1992 (U.S. EPA, 1992). Also in the draft strategy, EPA proposes to use existing CERCLA and RCRA regulations to manage the assessment and remediation of contaminated sediments (U.S. EPA, 1992). SQC will potentially be used as a pass/fail trigger to assess whether a sediment is contaminated and will form the basis for determining cleanup levels necessary to remediate contaminated sediments.

However, EPA does not necessarily need to develop SQC to manage contaminated sediments. Rather than relying on SQC, EPA can utilize existing water quality-based controls to control and protect sediment quality from current discharges and use a tiered, effects-based approach to assess and remediate sediments from historic discharges. Current water quality-based controls (e.g., water quality criteria, whole effluent toxicity limits) are likely protective of both water and sediment quality, thus eliminating the need for the development of a new control approach and the concomitant research, validation, and regulations needed to put the SQC approach into place. A tiered, effects-based approach similar to the one proposed by Adams et al. (1991; 1992) will more accurately assess sediment quality and provide a better basis for selecting between different remediation options than SQC.

CONTROLLING AND PROTECTING SEDIMENT QUALITY

Sources of sediment contaminants need to be controlled before successful remediation of contaminated sediments can occur. Otherwise, freshly remediated sediments will become re-contaminated from the uncontrolled sources. Rather than develop a new control strategy, EPA should first assess the integrative effectiveness of existing water quality-based controls for protecting sediment quality and controlling sources of sediment contaminants. If existing water quality-based regulations are adequate, then EPA can proceed with implementation of their remediation strategy. The development of any new control strategy, such as SQC, will certainly delay the remediation of contaminated sediments at many sites.

The perception that the presence of contaminated sediments means that water quality-based controls are not protective of sediment quality is not necessarily correct. In many cases, severely contaminated sediments sites were contaminated prior to the implementation of NPDES regulations and even the most basic NPDES discharge limits (i.e., effluent guidelines and conventional pollution control). Contaminated sediment sites such as Los Angeles County Wastewater Treatment Outfall, California (DDT, PCB), Hudson River, New York (PCB), Detroit River, Michigan (metals), Duwamish Waterway, Washington (metals, PCB, PAH) were contaminated as a result of discharges in the 1960s and early 1970s. In fact, EPA has concluded that "It is clear that many of the worst cases of sediment contamination are associated with sources that have ceased discharge" (U.S. EPA, 1987).

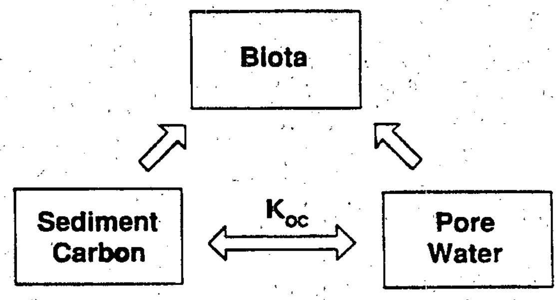
It is also clear that water quality-based controls, and the wastewater treatment technology needed to meet them, are reducing sediment contamination from point source discharges and, thereby, protecting sediment quality. In many contaminated sediment sites, the deeper sediments are more contaminated than surficial sediments. EPA readily acknowledges that in many locations the older polluted sediments have been covered by recent deposits of cleaner material (U.S. EPA, 1987). For example, in contaminated Detroit River sediments the maximum toxicity is presently at depths 10-15 cm below the surface, while the surficial sediments are not toxic (Rosiu et al., 1989). This improvement in sediment quality resulted from water quality-based controls, not from any sediment quality criteria or management approaches.

Current water quality criteria for many common sediment contaminants are stringent enough to prevent sediment contamination. For example, the water quality criteria for protection of human health for DDT (0.59 ng/L), PAHs (2.8 ng/L), and PCBs (0.044 ng/L) should preclude sediment concentrations that could adversely affect benthic organisms. Marine chronic criteria for metals, such as copper (2.9 μg/L), nickel (8.3 μg/L) and mercury (0.025 μg/L), should also prevent sediment contamination. Theoretically, even equilibrium partitioning (EqP), the basis for EPA's SQC, supports the contention that water quality criteria will likely be protective of sediment quality (Adams et al., 1991). For non-ionic compounds, EqP assumes that a chemical's concentration in the sediment will be in equilibrium with its concentration in the water. Because benthic organisms are not more sensitive than water column organisms (Di Toro et al., 1991), the EqP theory would predict that when a non-ionic compound's concentration is less than its water quality criteria, that adverse effects should not occur in the water column and sediments that are in equilibrium. Water quality criteria should be fully protective of both the water column and benthic communities, especially for non-ionic compounds, thereby eliminating the need for SQC development specific to the protection of benthic organisms.

EPA Water Quality Criteria

PAHs	2.8 ng/L
PCBs	0.044 ng/L
DDT	0.59 ng/L
Dieldrin	0.14 ng/L
Mercury	1.2 ng/L
Cadmium	1.1 μg/L

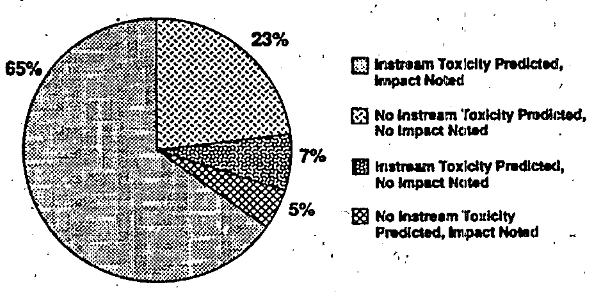
Equilibrium Partitioning Theory



It is not correct that SQC are necessary because there are many sediment contaminants for which water quality criteria have not yet been developed. Wastewater treatment technologies are not chemical-specific; they remove classes of compounds. For example, activated sludge technology removes all types of biodegradable compounds, not just chemicals for which there are permit limits. Dischargers need the necessary wastewater treatment technology to meet <u>all</u> of their water quality-based and technology-based control limits. Thus, the treatment technology necessary to meet a phenanthrene water quality standard of 2.8 ng/L will certainly remove acenaphthene and fluoranthene to similar levels even though their water quality standards would be much greater. Even when water quality-based controls do not specifically regulate chemicals that are considered potential sediment contaminants, the level of treatment that is required should be sufficient to also reduce the discharge of these chemicals.

Water quality criteria are only one component of water quality-based controls. The other major element, whole effluent toxicity, will also protect sediment quality. The whole effluent toxicity approach was field-validated by investigating the correlation between ambient and effluent toxicity as predicted by toxicity tests and biological impacts in the receiving water communities (U.S. EPA, 1991). Benthic invertebrate community measures were included in the biological indicators used to validate the whole effluent toxicity control approach in EPA's Complex Effluent Toxicity Testing Program (CETTP) (U.S. EPA, 1991). In addition, a study conducted by the North Carolina Division of Environmental Management indicated that whole effluent chronic toxicity tests using *Ceriodaphnia dubia* accurately predicted receiving water impacts on the benthic macroinvertebrate community in freshwater streams (as cited in U.S. EPA, 1991). Similar results were observed in a comparative time series study on the Trinity River in Texas (as cited in U.S. EPA, 1991). Whole effluent toxicity limits are expected to be fully protective of both water column and benthic communities as evident from the results of the CETTP and other studies.

Whole Effluent Toxicity Validation

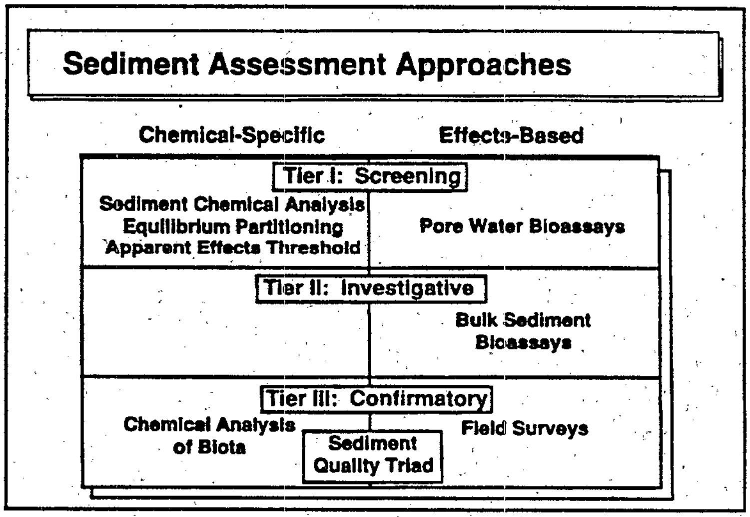


Comparison of Effluent Toxicity of Receiving Water Impact Using *Ceriodaphnia* Chronic Toxicity Tests and Freshwater Receiving Stream Benthic Invertabrates at 43 Point Source Discharging Sites in North Carolina (EPA, 1991)

Before proceeding with the development of new control strategies, EPA should first assess the integrative effectiveness of all water quality-based controls to protect sediment quality. States are already having difficulty implementing all of the existing water quality-based controls, and for this reason, EPA needs to critically evaluate whether the States will be able to take on a new control strategy to protect sediment quality. A new control strategy that cannot be implemented will not be effective. Rather than using limited resources to develop SQC and its related control and implementation strategies, EPA may find that it is more cost-effective to control and protect sediment quality by assisting States in implementing existing water quality-based controls.

ASSESSING AND REMEDIATING CONTAMINATED SEDIMENTS

Even after all sources of sediment contamination have been controlled, there will still be a need to assess and potentially remediate sediments contaminated from historic discharges. EPA's potential use of SQC as a pass/fail trigger for determining whether a sediment is contaminated ignores the wealth of experience that indicates that a tiered, effects-based approach (Adams et al., 1991; 1992), similar those used to assess the hazards posed by dredged materials, pesticides, and other toxic chemicals, will be more cost effective and scientifically sound. Because the factors controlling the fate, concentration, and bioavailability of chemicals in sediments are only now being investigated and understood, the use of a single value, such as SQC, to assess sediment quality and derive cleanup levels is overly simplistic and highly questionable. However, a tiered, effects-based approach which integrates biological, toxicological, and chemical data on a site-specific basis to evaluate the significance of sediment contamination will allow contaminated sediment sites to be prioritized and remediation options to be selected based on the risk to human health and the environment.



In a tiered approach, the methods increase in complexity and cost as the assessment progresses, and at each tier a decision is made to stop if adequate safety is demonstrated or the hazard is well characterized, or to continue to the next tier if significant uncertainties remain. The methods being proposed to develop SQC, such as EqP for non-ionic chemicals and acid volatile sulfide normalization for metals, could be incorporated into a tiered approach as sediment assessment values that would be used for screening sediments to determine whether additional toxicological and chemical investigations are needed (Adams et al., 1991; 1992). If sediments passed this screening tier, they would be considered "not contaminated" and the assessment would stop. If a sediment assessment value was exceeded, the assessment would proceed to the next tier, which would include laboratory sediment toxicity tests to determine if the chemicals present are bioavailable and present in toxic amounts (Adams et al., 1991; 1992). The last tier would involve confirming the laboratory results by performing a detailed field investigation of the sediment site. This confirmatory tier would include *in situ* toxicity tests, benthic invertebrate surveys, bioaccumulation tests (to investigate food-chain effects), and toxicity identification evaluations (Adams et al., 1991; 1992).

EPA should not approach sediment quality assessments any differently then they have approached hazard assessments in other programs (CWA, FIFRA, TSCA, CERCLA). These other programs all utilize a tiered, effects-based approach where higher tiers represent increasing degrees of complexity, resolution, costs, and predictive confidence. EPA should abandon the concept of using SQC as pass/fail triggers to determine if a sediment is contaminated and focus their efforts on developing standardized sediment quality assessment methodologies that will be useful in a tiered assessment approach. It is important to remember that the objective of any sediment assessment strategy is to determine if remediation is necessary to reduce the risks posed by the contaminants in the sediments to an acceptable level. The use of chemical-specific SQC will address neither the integrative effects from multiple contaminants nor all of the complex factors which govern bioavailability. Only by using a tiered, effects-based approach can the public have confidence that sediment sites will be remediated based on their actual risks to human health and the environment.

EPA'S NEXT STEPS

The risks posed by contaminated sediment have not been sufficiently characterized to justify EPA's haste in developing a comprehensive contaminant sediment management strategy. Although contaminated sediment sites are found nationwide, the actual areal extent of contaminated sediments is quite small. Corps of Engineers experience has shown that about 0.75-3 percent of the sediments that are dredged from waterways typically require special handling or treatment because of potential toxicity, even though areas that are dredged typically are near large population centers and high industrial activity locations (Lee, 1992). EPA should compile and maintain an up-to-date national contaminated sediment inventory so they can accurately assess the extent and severity of the contaminated sediment problem. The most recent inventory (U.S. EPA, 1987) is not altogether comprehensive because few of the identified contaminated sediment sites were assessed to determine if the chemicals present were actually causing adverse effects to human health or to the environment.

EPA should assess the significance of all potential existing sources of sediment contaminants, and structure its strategy accordingly. The heavy focus on controlling point source discharges in the draft strategy (U.S. EPA, 1992) may not be warranted. The impact of nonpoint sources of sediment contaminants will be difficult to assess, but it must be considered during the development of the strategy. EPA should not rely on SQC to manage contaminated sediments. Before continuing with SQC development, EPA should assess the integrative effectiveness of existing water quality-based controls for controlling and protecting sediment quality. EPA should continue its research into developing standardized sediment quality assessment methods which can then be incorporated into a tiered, effects-based assessment approach.

Most States will have neither the expertise nor the resources to implement new control and remediation strategies to protect sediment quality. Rather than developing strategies that the already overloaded States will be unable to implement, EPA should act as a technical clearinghouse and resource to the States. EPA should focus on providing research, training, and assistance to the States so the States can develop sediment strategies that recognize the priority that contaminated sediments pose locally and the resources they have available to effectively manage contaminated sediments.

CONCLUSIONS

It is likely that contaminated sediments will still be an issue far into the 21st century. The complexities in assessing, controlling, protecting, and remediating contaminated sediments will prevent any easy solutions to this problem. This assertation has been acknowledged by EPA when they stated in the draft strategy that "no action" (natural remediation) will in many cases be the preferred sediment management option. EPA should utilize all available technical expertise within both the Federal Government and State governments as well as in the private sector and academia, to continue their development of a comprehensive, scientifically sound contaminated sediment management strategy.

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EFFECTS-BASED TESTING AND SEDIMENT QUALITY CRITERIA FOR DREDGED MATERIAL

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INTRODUCTION

Approximately 450 million cubic meters of material are dredged each year from navigable waterways. Where open-water disposal is proposed for the material, the Corps of Engineers (CE) evaluates the material for suitability under the Clean Water Act (CWA, P.L. 92-500, as amended) or the Marine Protection, Research, and Sanctuaries Act (MPRSA, P.L. 92-532, as amended). If the material does not meet the CWA guidelines or the MPRSA criteria, the CE cannot approve unrestricted disposal of the material in open water. The CWA guidelines and MPRSA criteria are promulgated by the Environmental Protection Agency (EPA) and it exercises oversight on CE decisions regarding disposal. Further, CWA disposal requires State certification that it will not violate State water quality standards (Wright and Saunders, 1990).

The CWA guidelines (40 CFR, Part 230) for the evaluation of dredged material were first issued in 1975 and revised in 1980. These guidelines allow a comparison of contaminants in the dredged material with those at the disposal site and allow open-water disposal where contaminants at the two sites are "substantially similar" or where it can be shown that unacceptable concentrations of contaminants will not be transported beyond the boundaries of the disposal site. In addition, the guidelines provide that where there is such a large number of contaminants as to preclude identification of all of them by chemical analyses, or where chemical-biological interactive effects may occur, effects-based tests which measure organism responses may be used in lieu of chemical tests. In response to these guidelines, the CE issued an implementation manual (CE, 1976) which described the effects-based procedures. This manual is currently being revised.

The MPRSA criteria (40 CFR Parts 220-228) for the evaluation of dredged material were issued in 1973 and revised in 1977. These criteria are clearly effects based. At 40 CFR 227.6, certain constituents (organohalogen compounds, mercury and mercury compounds, cadmium and cadmium compounds, and oil of any kind or in any form) are prohibited from disposal other than as "trace contaminants." No numerical limits are given for these contaminants. Rather, the results of biological tests to evaluate persistence, toxicity, and bioavailability are to be used to determine whether or not the prohibited constituents are present in greater than trace amounts. In response to the 1977 criteria, the EPA and the CE issued a joint implementation manual (EPA/CE, 1977), which described the bioassay procedures. A revision of this manual was issued in 1991 (EPA/CE, 1991). In general, the revision focused on refinements of the 1977 procedures and retained the effects-based approach (Wright, 1992).

It is important to understand that dredged material is a highly complex substance composed of natural soil constituents that may or may not be contaminated (Engler et al., 1991a,b). Both the MPRSA and the CWA make this distinction and provide evaluatory procedures for dredged material that are different from those used for other materials. In the case of new dredging projects, the excavated material is usually "virgin," that is, it is sediment which has been exposed to few, if any, anthropogenic contaminants. Material excavated as a maintenance operation may come from a variety of sources, such as littoral drift, riverine input, and sheet erosion adjacent to the project. Such material may have been contaminated at its source or may become contaminated during transport or deposition at the project. Because the initial source of the material is soil or existing sediments, it will contain all of the elements in the periodic table as well as both natural and anthropogenic compounds. Insofar as many of these are classified as "contaminants," virtually all dredged material could be considered to be contaminated. In actual practice, the mere presence of a contaminant or its concentration in dredged material can rarely be used to predict whether or not it will have adverse effects upon biota (Engler, 1980), and the effects-based approach described below appears to be environmentally conservative (Jones and Lee, 1988; Lee and Jones, 1987).

EFFECTS-BASED TESTING

Effects-based testing whereby organism responses are used to determine the contaminant status of sediment is regulatorily mandated and has been in use for many years. Evidence of its effectiveness in environmental protection is provided by the observation that despite intensive monitoring of many disposal sites, there is no documentation of adverse effects from contaminants from material evaluated under these procedures. Effects-based testing is a holistic approach recognizing that there are potentially thousands of contaminants in sediments, and that many of these are biologically innocuous despite their concentration, whereas others may be biologically active at concentrations that cannot be measured with current analytical chemistry techniques.

The current evaluatory approach used in determining the suitability of dredged material for open-water disposal uses acute biological toxicity, bioaccumulation, and water quality criteria or standards. The effects-based results do not distinguish which contaminant or combination of contaminants is responsible for an observed effect and, for regulatory purposes, this is not important. It does, however, take into account possible interactive effects and is a direct measure of the bioavailability of all of the contaminants present (Wright and Saunders, 1990). Further, the evaluation includes an estimation for bioaccumulation of contaminants. The latter is not addressed by any proposed sediment quality criteria.

SEDIMENT QUALITY CRITERIA

Attempts to establish cause-and-effect relationships between the concentration of a particular contaminant and a biological effect in natural sediments have proved futile (Lee and Jones, 1992). Results from regulatory testing of sediments proposed for open-water disposal and broad field studies during the past decade which have yielded vast databases, such as the Status and Trends Program, have failed to demonstrate clear relationships between sediment contaminants and biological effects (O'Connor, 1990).

Despite the lack of cause-and-effect relationships, sediment quality criteria have been developed and applied. Among the first were the so-called Jensen criteria promulgated by the EPA in 1971 for dredged material evaluations. These appear to have had little, if any, technical validity and, in some cases, the criteria were well below the average crustal abundance for several contaminants (Engler, 1980) and did not take into account natural background concentrations (Wright, 1974). Naturally occurring levels of chemicals in sediments, particularly metals, vary greatly with the physical and mineralogical character of soils in the watershed. Within the Great Lakes, for example, background levels of lead, copper, and chromium in bottom sediments from Lake Superior (generally considered the "cleanest" of the Lakes), are 2-6 times those of the other four lakes (International Joint Commission, 1982). More recently, criteria were developed for use in Puget Sound (CE/State of Washington Natural Resources, 1988). These were developed using an approach known as the apparent effects threshold (AET). Although originally applied to exclude or allow open-water disposal (sediments which were not clearly excluded or allowed would be biologically tested to determine their status for disposal), the current use of these criteria is as a screening tool. When the criteria are exceeded, biological testing provides a possible override. Hence, decisions on disposal of the material are made on the basis of the biological tests rather than the criteria.

In the development of sediment quality criteria, it is extremely important that the activity to which they will be applied is taken into account. In the case of navigation dredging, it is a given that the material will be removed, and the question to be addressed concerns potential contaminant effects at the disposal site. For remediation, dredging concerns are the effects of in-place sediments, the benefits of removal, and potential effects at the disposal site. Several of the approaches proposed for the development of criteria, specifically the AET (PTI, 1988) and the sediment quality triad (Chapman, 1986, 1989) have failed to make this distinction. The AET and the triad incorporate benthic community structure at the excavation site as a component, thereby raising serious questions regarding their applicability to navigation dredging. The benthic community structure at the excavation site is not a particularly useful indicator of sediment effects, since the community is subject to a variety of influences other than the sediment. These include dredging, navigation traffic, degradation of water quality from outfalls, thermal discharges, surface runoff, the effects of droughts and floods, and other perturbations. The AET and the triad may be useful tools in evaluating the overall health of an aquatic environment but should not be used in the determination of the suitability of dredged material for open-water disposal. Unfortunately, this seems to have been overlooked in a recent controversy over the applicability of the threshold and triad (Spies, 1989; Chapman et al., 1991).

Most recently, criteria have been developed using the equilibrium partitioning (EqP) approach, whereby a nonpolar organic contaminant is normalized to organic carbon. This approach uses chronic water quality criteria to derive sediment quality criteria. The approach has some merit in explaining why certain sediment contaminants are not toxic or bioavailable. However, it has very limited utility in predicting whether or not a sediment will be toxic (Lee and Jones, 1992). Reviews of the various approaches used to derive sediment quality criteria are found in Brannon et al. (1990) and Marcus (1991). The EqP approach for sediment quality criteria is currently under review by the EPA Science Advisory Board.

COMPARISON OF EFFECTS-BASED TESTING AND EqP SEDIMENT QUALITY CRITERIA

In an effort to evaluate the relative effectiveness of the two testing approaches, preliminary EqP criteria for acenaphthene, fluoranthrene, and phenanthrene (Hais, 1991, personal communication) were compared to effects-based acute toxicity tests from Puget Sound, Washington. Of 152 samples, the criteria were exceeded and acute toxicity was observed in 5; there was no toxicity nor were the criteria exceeded in 116. One criterion was slightly exceeded in one sample but there was no acute toxicity. Of primary interest is that there were 31 samples which exhibited acute toxicity but which did not exceed criteria. The conclusions are that in 31 samples the organisms were responding to contaminants other than those of the criteria, and in five out of six samples acute toxicity and the criteria agreed.

It is commonly stated that chronic tests are more conservative than acute tests, that is, an effect is more likely to be observed with the former. This was clearly not the case in Puget

Sound and is probably related to the fact that there is no field or laboratory validation for the criteria nor is there any validation for the chronic effects of contaminated sediments. This casts significant doubt as whether or not the EqP criteria evaluate chronic effects.

From a pragmatic point of view, the only way to have detected the single marginal criterion exceedance would have been, as was done, to conduct sediment chemistry on all 152 samples. This is expensive and time-consuming, and one must question whether the environmental benefits of the detection of one marginal exceedance justifies the cost (Wright, 1974).

APPLICATION OF SEDIMENT QUALITY CRITERIA

Within the extant regulatory framework for dredged material there is no provision for sediment quality criteria or standards. Notwithstanding their underlying technical deficiencies, this leads to the question of how they will be applied in the effects-based testing protocol. Will they be pass-fail? Will they serve as a screen or trigger for effects-based testing? To date, no information has been put forth to address this issue. In a regulatory environment this is a crucial need. For example, if the Puget Sound data are representative (and there is no reason to believe that they are not), no additional environmental protection would have been gained from the application of the EqP criteria. Additionally, a number of samples could not be evaluated by the criteria because organic carbon was below the minimum required.

In the Puget Sound comparison, we used 0.5 percent organic carbon as the minimum level for which the criteria are valid. This excluded 21 percent of the samples. However, in various EPA documents regarding EqP sediment quality criteria, one finds 0.5 percent, 0.2 percent, and 0.1 percent as lower limits for organic carbon. There is no technical documentation for values <0.5 percent. In a recent national survey paper, Suedel and Rodgers (1991) found that the median organic carbon was 0.57 percent and 0.24 percent in freshwater and marine sediments, respectively. This suggests that the EqP criteria cannot be used for many sediments because of organic carbon constraints.

An additional concern is that dredged material effects-based testing compares the results of organism response to a reference sediment (EPA/CE, 1991). This procedure is eminently logical because it answers the question, "How will the dredged material behave with regard to the reference?" There are potential circumstances where the reference might not meet the EqP criteria. Would this mean that the reference might require remediation? If the dredged sediment proposed for disposal meets the criteria and the reference does not, does this constitute license for disposal? It could be argued that dredged material disposal would be a beneficial use under such circumstances.

A particularly thorny problem to be faced is whether to apply sediment quality criteria "across the board." This is an EPA problem. From an environmentally protective position, there should be no distinction in application. If a sediment "fails," the applicable statute regulating the material should make no difference. This would apply to RCRA, Superfund, etc. From the perspective of the States, who will presumably adopt the criteria as standards, the problem is even more vexing. As previously noted, both the CWA and the MPRSA have specific provisions concerning the procedures used to evaluate material dredged for navigation purposes. At the very least, the EPA should clearly and publicly provide guidance on the applicability of the proposed EqP criteria and how they relate to the current procedures used in various programs.

The utility of any sediment quality criteria to dredged material disposal decisionmaking is conceptually possible if there are numerical criteria for every possible contaminant and some kind of mechanism or formula to quantify the magnitude of interactive effects for all possible combinations of contaminants. Without a complete set of these tools, sediment quality criteria can only provide information incidental to regulatory decisionmaking. Further, if we accept that effects-based testing provides the most direct laboratory indication of contaminant mobility and impact, it should remain the preferred tool for regulatory decisionmaking in dredged material disposal.

SUBSTANTIATING RESEARCH

Between 1973 and 1978, the CE conducted a major $33 million program on dredged material disposal. This program consisted of over 250 individual studies and, in contrast to previous largely site-specific project investigations, the studies were generic in nature so as to have the widest applicability. A specific goal was to define the biological and water quality effects of open-water, wetland, and upland disposal. A major finding was that no single disposal option is presumptively suitable for a geographic region or group of projects. What may be desirable for one project may be completely unsuitable for another; consequently, each project must be evaluated on a case-by-case basis (Saucier et al., 1978). An additional finding was that open-water disposal resulted only in physical, rather than contaminant, effects on biota at the disposal site, and that biotal recovery was rapid following the cessation of disposal (Wright, 1978).

A further effort was initiated as a cooperative program between the CE and the EPA. This $7 million program was designed to compare new evaluatory techniques with those in use and to investigate the effects of the disposal of material from a single site in three different environments (open-water, wetland, and upland). Of the various new biological techniques examined to determine the suitability of material for open-water disposal, only a few showed significant potential as evaluatory tools and these were not suitable for regulatory application without additional research and development. None appeared to predict the effects of open-water disposal better than the acute toxicity and bioaccumulation techniques which are still in use; field investigations following the laboratory tests verified the predictive ability of the tests (Gentile et al., 1988). Upland disposal produced the greatest and most persistent effects, including the release of metals and extreme toxicity, whereas open-water disposal showed relatively minor and nonpersistent effects; effects from wetland disposal were intermediate between upland and open-water disposal (Peddicord, 1988). In addition to these broad investigations, an estimated $70 million has been expended by the CE on other studies over the past two decades.

CONCLUSIONS

The open-water disposal of dredged material is currently regulated under the CWA and MPRSA. The applicable regulations provide for an effects-based evaluation. Various alternative procedures to evaluate the material have been proposed. Of these, it is felt that the sediment quality triad and the AET are inappropriate for dredged material. Sediment quality criteria developed through equilibrium partitioning suffer from a number of technical defects. Further, no information is available as to how the equilibrium partitioning criteria might be applied.

Experience with effects-based evaluations has clearly indicated that the approach is environmentally conservative. The imposition of sediment quality criteria will increase testing costs without a concomitant increase in environmental benefits. As noted by Kagan (1991), this may well represent "administrative fragmentation and adversarial legalism."

ACKNOWLEDGMENTS

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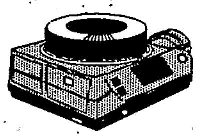

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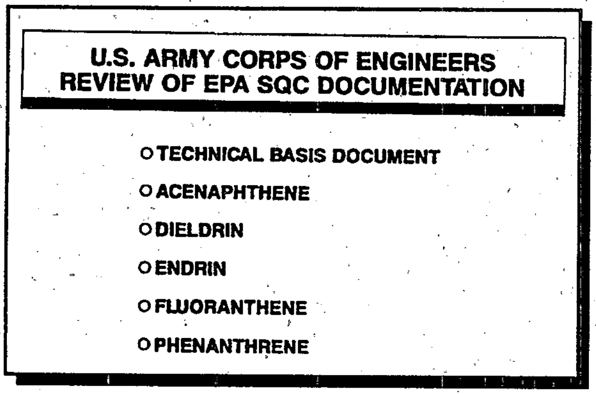

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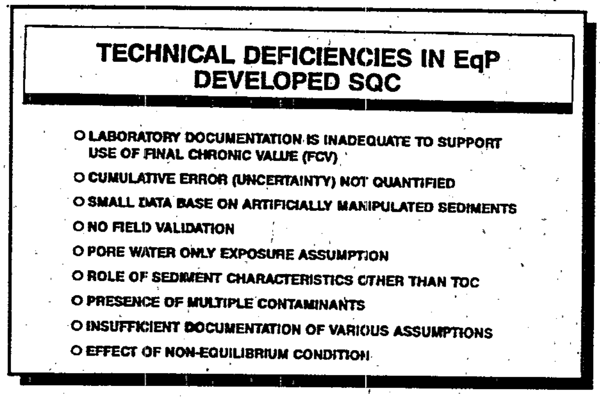

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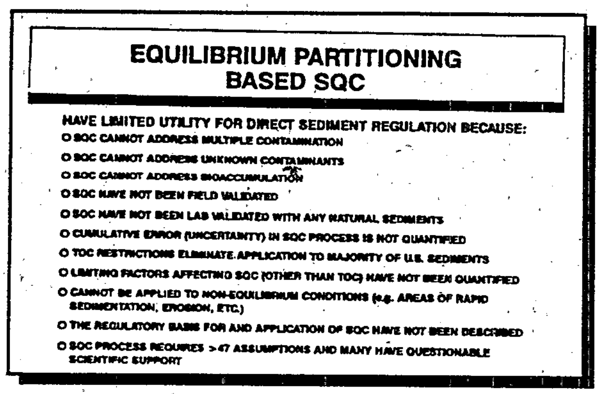

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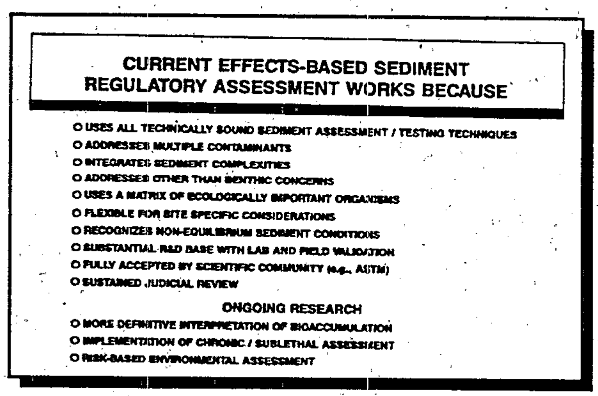

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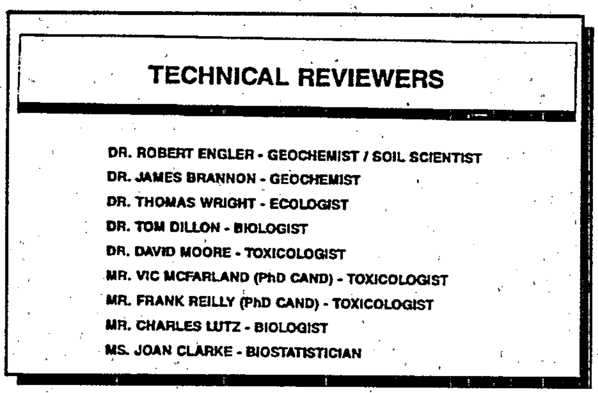

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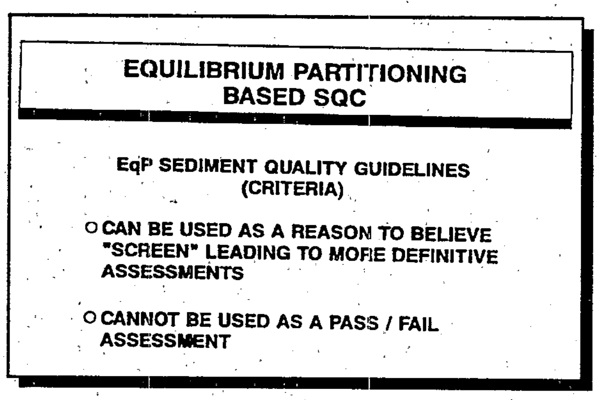

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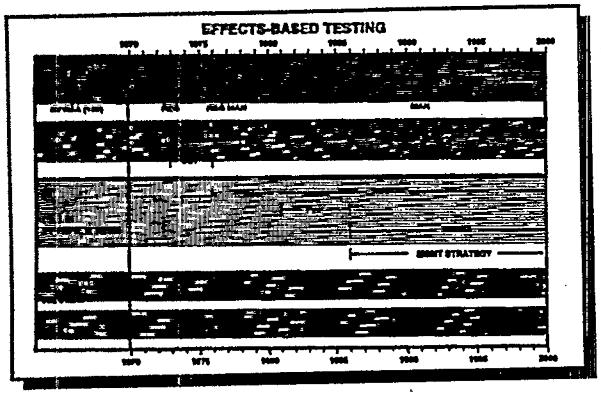

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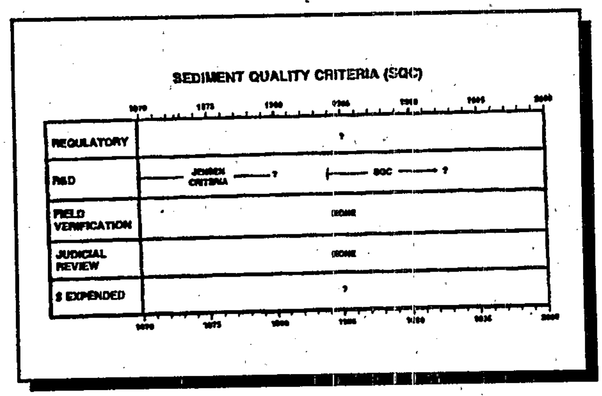


Advocates Forum

ADVOCATES FORUM: RESPONSE TO GENERAL QUESTIONS

Allan Stokes
Panelist

WHAT SHOULD EPA DO MORE OF OR IMPROVE?

U.S. EPA should proceed as rapidly as possible, consistent with sound scientific principles, to develop additional water quality criteria. Criteria developed must include an implementation component that provides clear guidance for States to use in translating the criteria into State water quality standards and establishing appropriate permit limits. First, emphasis should be placed on developing criteria and guidance relative to nonpoint sources.

WHAT SHOULD EPA INITIATE THAT IT HASN'T DONE IN THE PAST?

U.S. EPA should initiate a formal, orderly, and routine process for reviewing, and updating or revising, water quality criteria and technology-based standards/guidance, including categorical and pretreatment standards, and better definition of what constitutes Best Available Treatment Economically Achievable. This should include an initial review fairly soon after adoption to evaluate implementation difficulties and problems, and regularly scheduled reevaluations on a periodic basis thereafter. The evaluative process should include the States, who are the primary agents for using and implementing these criteria and standards.

WHAT SHOULD EPA DEFINITELY NOT GET INVOLVED IN?

U.S. EPA should not get involved in water quantity issues of water use or water rights allocation. Water quality criteria- and/or technology-based standards development should not be used as a means to insert Federal involvement in water quantity and allocation decisions.

WHAT IS THE SINGLE MOST IMPORTANT CHANGE YOU WOULD LIKE TO SEE IN THE CWA REAUTHORIZATION?

A realistic matching of resources to expectations relative to Clean Water Act implementation. Funding of U.S. EPA and State water quality programs must be increased to provide adequate resources to meet all of the expectations set forth in the Act. In the alternative, the Act could be amended to alter some of the expectations, eliminate duplicative and costly administrative requirements of little direct benefit to the environment, and provide greater flexibility for implementing creative solutions to water quality problems.

ADVOCATES FORUM RESPONSES

Robert Berger
Aquatic Toxicologist
East Bay Municipal Utility District
Oakland, California

WHAT SHOULD EPA DO MORE OF OR IMPROVE?

Criteria are the scientific basis for the Nation's environmental quality. They help establish the specification or standard to which both regulatory agencies and regulated parties are held. Developing technically valid new criteria and routinely reevaluating existing criteria are critical EPA responsibilities in the third decade of water quality control programs.

EPA's future criteria development must be guided (and modified) by the experience gained in implementing water quality standards. After 20 years, almost 25 percent of States have not adopted water quality standards that are satisfactory to EPA. This delay is attributable in part to a perception that EPA criteria are not always technically valid, nor representative of the most up-to-date scientific information. For example, in July the Harvard School of Public Health Center for Risk Analysis recommended that EPA's existing cancer classification systems "should be abolished" because they are "too simplistic to convey meaningful information to scientists, risk managers and the public."

Regulated agencies feel that peer review has often been limited to in-house evaluations and public comment periods that have been too short and that have occurred too late in the criteria development process. Additionally, the majority of water quality criteria developed by EPA are more than 10 years old and have not been modified to reflect new empirical data or the most current thinking of the scientific community.

It is hoped that EPA will use a peer review process similar to that used in developing sludge regulations to create future criteria for controlling water quality. Equally important, EPA must strive to routinely reevaluate existing criteria and modify them as necessary to ensure their effectiveness.

WHAT SHOULD EPA INITIATE THAT IT HASN'T DONE IN THE PAST?

Admittedly, a recommendation for more rigorous scientific peer review of new criteria and routine evaluation/modification of existing criteria will burden EPA's limited resources. This burden will worsen with the increased responsibility for criteria development proposed under the Clean Water Act Reauthorization. It behooves EPA to initiate a working partnership with affected parties and such research organizations as the Water Environment Federation's Research Foundation to help develop new criteria and reevaluate existing criteria.

Many of the member agencies of the Association of Metropolitan Sewerage Agencies (AMSA) have technical staffs and financial resources available to aid EPA in this effort. AMSA recognizes the importance of well-developed criteria to guide water quality control efforts, and has provided EPA with technical evaluations and comments on a variety of proposed and existing criteria. EPA is encouraged to make greater use of the technical resources, information and experience of permitted agencies. In addition to "in-kind" support, permitted agencies may also help fund the reevaluation of existing criteria as a cost-effective alternative to complying with permit requirements based on water quality criteria not consistent with current information or scientific thinking.

WHAT SHOULD EPA DEFINITELY NOT GET INVOLVED IN?

Increasingly, water quality control programs are shifting from indirect to more direct predictors of environmental/biological impact. However, the use of such direct measures requires implementation of control programs that reflect regional or site-specific conditions. Historically, States have implemented EPA guidance and criteria with little if any modification to account for the regional character of water bodies under their authority. It is critical that EPA not get involved in implementing control programs based on biocriteria.

EPA developed biocriteria to guide programs that control water quality by establishing standards for the "biological integrity" of aquatic communities. Integrity is measured by the species composition, diversity, and functional organization of communities compared to "reference waters" that are least impaired by human activities. The cornerstone for determining waterbodies impacted by anthropogenic activities is the selection of site-specific or ecologically similar reference waters, and development of field sampling and biological assessments that are regionally relevant.

Although EPA should direct these efforts with general guidance, it must provide States the time, flexibility, and clear direction to use EPA guidance to develop programs that accommodate the varying geographic, climatic, geologic, and hydrologic conditions of the region.

WHAT IS THE SINGLE MOST IMPORTANT CHANGE YOU WOULD LIKE TO SEE IN THE CWA REAUTHORIZATION?

Incorporating a comprehensive watershed management approach to water quality control in the reauthorization of the Clean Water Act provides the most effective water quality enhancement and protection. AMSA is developing a legislative proposal with this intent.

Present water quality control programs emphasize a command-and-control approach that focuses almost entirely on regulating permitted point source dischargers at the end-of-pipe. Water quality control based on comprehensive watershed management offers the following advantages:

- Risk-based prioritization of water quality control efforts reduces ineffective use of limited resources;
- Monitoring and regulation of all pertinent pollution sources, both point and nonpoint, thus providing true water quality-based toxics control;
- Control program limits based on site-specific standards that provide reasonable rather than over- or underprotection of beneficial uses; and
- Increased use and integration of a variety of chemical, biological, and ecological measures to guide water quality control efforts.

ADVOCATES FORUM

Robert J. Overly
Senior Environmental Engineer
James River Corporation
Green Bay, Wisconsin

WHAT SHOULD EPA DO MORE OF OR IMPROVE?

There are three primary areas in which EPA can do more or improve. These are management, research, and cooperation:

1. **Management** - <u>There is a need for more leadership and direction from EPA Headquarters to the Regions.</u> There are considerable discrepancies in the way the 10 Regions interpret and apply national policies. Headquarters should develop clear policies, within and between programs, and hold the regions accountable for the application of these policies on a uniform timeline. To accomplish this, Headquarters needs to identify and prioritize environmental problems through a scientific understanding of the relative risks to the environment and human health.

   This will prevent misdirected efforts such as the Great Lakes Initiative. The purpose of the initiative is to provide the Great Lakes States with uniform policies and procedures for developing and implementing water quality standards for toxics, even though seven of the eight States already have EPA- approved programs in place. The initiative focuses almost exclusively on point source discharge when convincing evidence shows that the problems which prompted this effort are occurring because of past practices (i.e., sediment contamination) or nonpoint sources (i.e., atmospheric deposition). If implemented as proposed, the money spent on compliance, which ultimately comes from "society," will have been wasted in the sense that no real environmental benefit or reduction of risk is attained.

   Providing this leadership will be a significant challenge. EPA will have to move away from the present method of setting priorities, which have largely been determined by political mandate and public perception. Basing policies on sound science and education of the public will help EPA Headquarters provide this leadership.

2. **Research** - EPA needs to identify and address real problems, not the perceived or "politically correct" problems. EPA has developed a research strategy following SAB's recommendations to use a risk assessment framework. The goal is to maximize risk reduction where the opportunities are the greatest. Integrating the various program offices must be accomplished to take full advantage of this new strategy. Increased research is needed in the areas of environmental monitoring and assessment to determine the potential for, or the magnitude and cause of, environmental impact. This information will allow regulators to develop rational control strategies and determine whether there are cost-effective methods to reduce impacts.

   In adopting this research strategy, EPA will be assessing the risk of chemical substances using facts, statistical models, and assumptions. When scientific consensus is lacking models or assumptions, the range of uncertainty should be clearly defined to policy makers and the public. The assignment of a priority should clearly distinguish between the scientific basis and the policy basis for the Agency's conclusion. This will identify the conservative biases embedded in risk assessment, which impart a substantial margin of safety. Margins that may actually increase health and safety risks by misdirecting priorities. EPA should strive to improve risk assessment by reducing conservatism and bias.

3. **Cooperation** - EPA needs to involve more "stakeholders" in development of management strategies from the start. Historically, involvement or input from outside the Agency has come at the tail end of the process, resulting in expressions of dissatisfaction from the environmental and the regulated community. Using dissatisfaction as an evaluation of a program's worth is a poor measure of its intended environmental benefit. Involving more stakeholders would help define problems and reasonable cost-effective solutions early in the process, resulting in improved setting of priorities. It would also have the potential to prevent politics from overriding good science. If significant gains are to be made in providing environmental protection, EPA must abandon the "command control" mentality and develop a more cooperative approach.

WHAT SHOULD EPA INITIATE THAT IT HASN'T DONE IN THE PAST?

This question cannot be answered with an outlook specific to the water quality program. Part of the existing problem stems from taking a compartmentalized approach toward environmental problems and not one that fully recognizes ecosystem dynamics. In trying to achieve its charge of protecting the Nation's environmental assets, the efforts of different program offices have rarely been consistent or coordinated. Even though these fractionated efforts have worked in the past, they will not be as successful in the future as the most obvious controls already have been applied to the most obvious problems. EPA should initiate a revision of environmental policies and break away from the traditional site-specific approach.

EPA needs to develop policies that are integrated and more focused on opportunities for environmental improvement based on relative risk. To accomplish future improvements, EPA must develop integrated solutions by requiring the various program offices to work together to provide an ecosystem approach to solving environmental problems. There are not unlimited resources to solve all environmental problems at one time. Identification of the source posing or imparting the greatest adverse effect will assist in focusing resources to provide the greatest environmental benefit. It is not an efficient or effective use of resources to be chasing picograms of a substance in a point source discharge when it is raining kilograms into the same ecosystem. Focusing strictly on toxic substances while ignoring the effects of habitat loss, introduction of exotic species, or other impacts is not sound scientifically based environmental protection policy.

WHAT SHOULD EPA DEFINITELY NOT GET INVOLVED IN?

EPA should not become directly involved in dictating what production technology should be employed to achieve a desired result. The Agency has avoided this in the past, yet the United States has some of the cleanest water in the world. It has been clearly demonstrated in Eastern Europe and Asia that government-controlled industries are inefficient and not protective of the environment. EPA should continually renew its pledge to work with industry to improve processes, and resist the arrogance implicit in thinking it knows better how to do it than those who have been doing it successfully for years.

WHAT IS THE SINGLE MOST IMPORTANT CHANGE YOU WOULD LIKE TO SEE IN THE CWA REAUTHORIZATION?

The most important change to the CWA would be the elimination of the language "prohibiting the discharge" of a list of substances based on their potential to bioaccumulate. If implemented, this section would probably increase more than reduce risk to the environment. It totally ignores the importance of social and economic considerations. It also ignores any potential of increasing environmental or human health risks in other areas. This concept has no scientific justification and should be dropped from the reauthorization.

This section has the potential to severely restrict or eliminate necessary recycling efforts intended to save natural resources and valuable landfill space. The list already includes substances whose manufacture has been banned in the United States for years. The procedures described for adding substances to this list have the potential to include substances that pose no significant adverse effect. In reality, it does not consider how a substance moves through the environment or its ultimate fate. There is a great likelyhood that attention will be focused away from far more important environmental risks or impacts unless this language is deleted.

ADVOCATES FORUM: RESPONSE TO GENERAL QUESTIONS

Terry Williams
Director
Fisheries Department
Tulalip Tribes of Washington
Maryville, Washington

WHAT SHOULD EPA DO MORE OF OR IMPROVE?

Promote Environmental Equity

EPA has taken a positive first step toward addressing the issues of environmental equity by forming a work group (Environmental Equity), and producing a report in which environmental equity issues are identified and defined. EPA should now act swiftly to implement the recommendations made by this work group.

Revise Fish Consumption Rates for Human Health Risk Criteria

EPA should support tribal efforts to reevaluate the fish consumption levels. Recent studies indicate that the current EPA fish consumption rate is an inaccurate reflection of tribal fish consumption. The rate of 6.5 grams per day is derived from an outdated study and does not account for the higher fish consumption levels associated with coastal Tribes. A recent Puget Sound study found that the *median* fish consumption rate was 95 grams per day.

Contribute to the Development of Water Quantity/Quality Database

EPA should provide greater support for the collection, access, and management of water resource data. Water withdrawals can impact the productive capacity of fish and wildlife resources, groundwater supplies, potable water, and watershed ecosystems. The goals of the Clean Water Act are jeopardized, and standards are increasingly compromised by the lack of data on this subject.

WHAT SHOULD EPA INITIATE THAT IT HASN'T DONE IN THE PAST?

Management of Nutrient Loading in River Systems

Despite EPA's regulatory efforts in the arena of surface water standards, it has yet to adequately address the issue of nutrient loading in river systems. Management of nutrient loading in river systems should be integrated into EPA's water quality programs.

WHAT SHOULD EPA DEFINITELY NOT GET INVOLVED IN?

Making Resource Allocation Decision Unilaterally

The process by which EPA allocates Federal resources to Indian Tribes is flawed to the extent that EPA makes these important decision unilaterally. A tribal voice in this process would assist in the development of more appropriate and effective water quality protection activities.

WHAT IS THE SINGLE MOST IMPORTANT CHANGE YOU WOULD LIKE TO SEE IN THE CWA REAUTHORIZATION?

Affirm Long-Term Goal of "Treatment as a Tribe"

For purposes of implementing the Clean Water Act, "Treatment as a State" is recognized as the short-term, but necessary, vehicle by which legal, administrative, and financial responsibilities are transferred from the Federal Government to Tribes. EPA should now begin to implement the long-term goal of replacing "Treatment as a State" with "Treatment as a Tribe," the latter phrase reflecting the sovereign nation status and government-to-government relationship between the Federal Government and Indian Tribes.

EPA Recognition of Tribal Jurisdiction

Without EPA recognition of tribal jurisdiction, the development of regulations and infrastructure on reservations is stunted. To effectively operate, tribal governments need stability, which is undermined by unresolved litigation. Unresolved jurisdictional issues create an undesirable legal and economic climate for business and industry. In turn, tribal governments suffer from an unstable and diminishing tax base. Yet it is this tax base that allows Tribes to become self-sufficient, to develop an infrastructure and programs that protect the health of their environment and people.

ADVOCATES FORUM: RESPONSE TO GENERAL QUESTIONS

Roberta (Robbi) Savage
Executive Director
Association of State and Interstate
Water Pollution Control Administrators
Washington, D.C.

WHAT SHOULD EPA DO MORE OF OR IMPROVE?

Create and implement more and better water quality criteria and guidelines.

- Update existing criteria and guidelines.
- Create and implement new criteria and guidelines.
- Establish an effective development process to include direct and continuing communication and consultation with the States.
- Develop a workable implementation strategy in consultation with the States.
- Focus on successful integration of numeric, biological, chemical, and narrative criteria to better balance the technological and water quality-based approaches.

A suggestion would be the creation of a State/EPA Water Quality Standards Development and Implementation Advisory Board to expedite the processes for (1) development; (2) implementation; and (3) tracking of water quality standards and effluent guidelines.

WHAT SHOULD EPA INITIATE THAT IT HAS NOT DONE IN THE PAST?

- An effective coordinative process with State and Local governments.
- A mechanism to ensure consultation and communication with affected groups.

- A procedure to assure the issuance of an acceptable number of guidelines responding to the needs of the program rather than those of the courts and environmental groups.

- A strategy to promote pollution prevention in the water programs and across environmental media.

- Increased and enhanced coordination and cooperation between Federal agencies (e.g., U.S. Geological Survey, Department of Agriculture, Department of the Interior, NOAA).

WHAT SHOULD EPA DEFINITELY NOT GET INVOLVED IN?

- The discussion and debates over the use of water (quality and quantity) should remain at the State level.

- The State promulgation of water quality standards.

- Ongoing public or legislative discussions on standards at the State level.

- The development of State ground water standards.

- The re-creation of a national grant program to fund point source projects.

WHAT IS THE SINGLE MOST IMPORTANT CHANGE YOU WOULD LIKE TO SEE IN THE CWA REAUTHORIZATION?

The Congress needs to put the water quality program on sound technical and financial footing within the next 5 years. To do so, the Congress must:

- Authorize adequate funds for development and implementation of criteria, guidelines, and standards, which should include monitoring.

- Focus on achieving a creative balance between technology and the water quality-based program with the assumption that best available technology (BAT) is achieved.

ADVOCATES FORUM

Peter L. deFur
Senior Scientist
Environmental Defense Fund
Washington, D.C.

WHAT SHOULD EPA DO MORE OF OR IMPROVE?

Currently, there are several major regulatory initiatives that EPA needs to complete quickly: completing the dioxin reassessment; setting sediment quality criteria; finishing the toxics standards/criteria for the laggard States; developing standards for the Great Lakes under the Great Lakes Initiative; updating the effluent guidelines; and setting criteria for the protection of wildlife. Completing these would go a long way toward solving the problems with toxic chemicals.

Much of the progress made in cleaning up the Nation's surface and ground waters resulted from applying the original provisions of the Clean Water Act. The criteria and standards promulgated under the CWA were an important tool in this effort. Indeed, recent reviews of national standards and studies of three rivers document improvements in water quality. Installation of secondary treatment systems for industrial and municipal dischargers led to these improvements. These reviews suggest that considerable improvement would result from enforcing the existing statutes.

Regulatory programs to clean up the Nation's waters depend on the quality and quantity of information available for use by EPA and State program staff. For that reason, EPA research facilities need to continue research programs using professional staff and high-quality equipment. EPA must prevent any erosion of the ability of the EPA laboratories to conduct research and provide high-quality technical support.

WHAT SHOULD EPA INITIATE THAT IT HAS NOT DONE IN THE PAST?

EPA needs to protect the most heavily affected component of the population--usually a subpopulation--from the total threats that exist in the real world. We recommend refocusing efforts away from protecting the "average individual" over a lifetime from cancer due to a single chemical in one medium. EPA needs to improve the technical ability to address multiple threats and multiple end-points in groups, subpopulations, and identified age groups. EPA also needs to broaden, expand, or begin efforts to address dispersed multimedia contamination to include all sources. Thus, there will have to be breakdown of the walls between the Offices of Water and of Air.

• Accept moving targets in the scientific and technical world. Both the environmental community and the citizenry have heard that EPA cannot act until the analysis is complete and "the answer" has been identified. As a result, nothing happens until "the answer" is found. Stop depending on the researchers to finish the experiments--well- designed experiments always result in more research. Science should always improve and we can always correct the numbers for the latest data. So, stop asking for the right answer for the lawyers to love and defend.

WHAT SHOULD EPA DEFINITELY NOT GET INVOLVED IN?

EPA should not apply "risk assessment" broadly across the board to every action using the present approaches. The area of risk assessment is new and changing quite rapidly to meet the demands of specific sites, cases, and issues. These cases involve primarily human cancer, rather than a range of health end-points, subpopulations, targets, and effects. Thus, the methods developed to protect "average" humans from lifetime cancer risks probably do not apply to populations of birds, marine mammals, amphibians, endangered freshwater mussels, or a component of an ecosystem.

Protecting humans from cancer risks associated with chemicals in drinking water does not protect humans from the same chemical when found in fish. The standards that protect people do not protect populations of mammals or birds from either risk.

WHAT IS THE SINGLE MOST IMPORTANT CHANGE YOU WOULD LIKE TO SEE IN THE CWA REAUTHORIZATION?

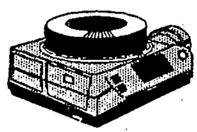
Make the nonpoint source pollution program a fully funded watershed restoration and protection program with mechanisms to address the difficult sources. The 319 program operates like a pilot program with a modest level of funding in comparison to the need and size of the State program budgets. If this were fully funded and staffed at the Federal and State levels, it would identify sensitive areas before impacts occur, restore degraded habitats such as wetlands, and direct resources to the most critical problems. This program offers a means of coordinating end-of-the-pipe, runoff, storm water, and CSO efforts within a functional water unit--the watershed. At the same time, the 319 program could bolster the wetland protection program by demonstrating the critical functions that wetlands perform in watersheds.

Ecological Risk Assessment

SLIDE PRESENTATION

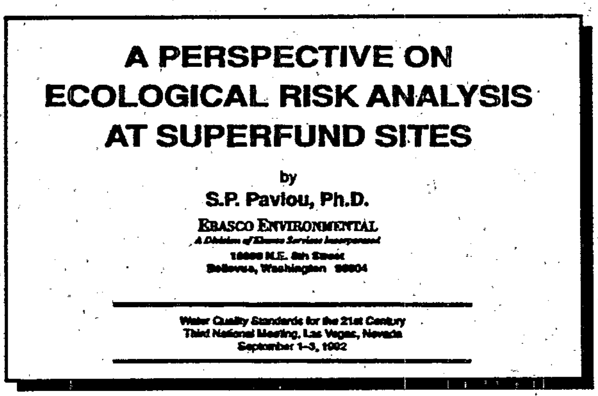
Spyros Pavlou
Manager
EBASCO Environmental
Bellevue, Washington

In lieu of a paper, the slide presentation is as follows:



Slide Presentation

Slide 1



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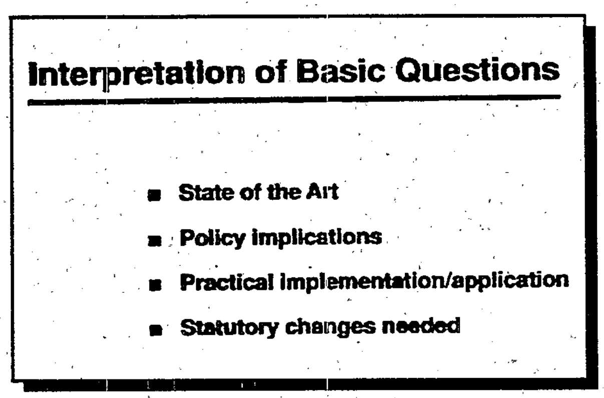


Slide 3

Additional Questions Applied to Superfund ERAs

- Policy Implications
  - Superfund/ERAs consistent with new direction in environmental protection?
- Practical implementation/application
  - site-specific approach appropriate?
  - effectiveness in remedial decision making?
  - ERA based criteria meaningful?
- State of the Art
  - approach for "true" ERA developed?
  - explicit ERA guidance available?
  - new research priorities needed?

Slide 4

New EPA Direction in Environmental Protection

- Pollution prevention vs. control
- Waste elimination at source
- Risk reduction
- Cumulative risk and integrated risk assessment
- Quantification of uncertainty
- Risk management and risk mitigation

Slide 5

EPA's new Ecological Research Strategy

- Environmental monitoring and assessment (hazard identification)
- Ecological exposure assessment
- Ecological effects (dose-response/tissue concentration relationships)
- Ecological risk characterization
- Ecosystem restoration and management
- Risk communication

Slide 6

Approaches and Methodologies for ERAs

- Administrative Approach *(expedient/cost effective)*
  - exceedance of legal standards by measured concentrations in site-specific contaminated media
- Weight of Evidence Approach *(rigorous/highly specific)*
  - administrative criteria
  - media toxicity tests/bioassays
  - biosurveys/epidemiological evaluations

Slide 7

Critical ERA Questions for Complex Sites

Maximum Allowable Tissue Concentration (MATC)

- Appropriate end points used to compute MATCs (e.g., reproductive effects, brain enzyme depression)?
- Protection of population vs. individuals?
- Dose-response/tissue concentration relationship?
- Toxicity data for specific trophic compartments?
- Uncertainty in toxicological information?

Slide 8

Critical ERA Questions for Complex Sites (continued)

Biomagnification Factors

- Input parameter data for each trophic compartment of the BMF model?
- Adequacy of experimental design for parameter quantification?
- Adequacy of predictive model?
- Spatial considerations in proper estimation of BMF in biosurveys (e.g., colocation of samples, home range)?
- Adequate calibration/validation method?

Biota Criteria

- Tissue-based vs. dose-based approach?
- Choice of value from probabilistic analyses?

Slide 9

Critical ERA Questions for Complex Sites
(continued)

Hazard Index/Risk Estimation

- Spatial adjustment to exposure?
- Appropriate exposure medium concentration data used to represent exposure (e.g., spatial adjustment)?
- Incorporation of below-detection data in estimating risk and defensibility of statistical treatment?

Slide 10

Complex Site Example: Rocky Mountain Arsenal (RMA)

- NPL/CERCLA site
- Site: 27 square miles
- Identified potential sites: 184
- Area of known contamination: 4+ square miles
- Type of contamination: persistent organics and trace metals

Slide 11

Complex Site Example: Rocky Mountain Arsenal (continued)

- Projected land use: open space to industrial
- Target receptors: humans/biota
- Ecosystem: aquatic and terrestrial
- Endangered species: eagle
- Exposure media: soils, sediments, surface water
- Exposure pathways: multiple (direct, indirect)
- Contamination assessment:
  - soil and sediments (15,000+ samples)
  - biota (1,400+ samples)

Slide 12

ERA Objectives at RMA

- Quantify risks to aquatic and terrestrial biota
- Develop criteria for contaminants in soils and sediments for protection of wildlife and supporting ecosystem
- Identify areas of potential criteria exceedances for remedial action planning

Slide 13

See Blowup of slide on next page

Slide 14

Computation of Risk

$$\text{BMF} = \frac{\text{Tissue Concentration}}{\text{Soil Concentration}} \quad (1)$$

$$\text{Soil Concentration} = \frac{\text{Tissue Concentration}}{\text{BMF}} \quad (2)$$

$$\text{Allowable Concentration} = \frac{\text{Maximum Allowable Tissue Conc.}}{\text{BMF}} \quad (3)$$

$$\text{PBC} = \frac{\text{MATC}}{\text{BMF}} \quad (4)$$

$$\text{Hazard Quotient}_i = \frac{(\text{Measured Contaminant Concentration})_i}{\text{PBC}_i} \quad (5)$$

$$\text{Hazard Index} = \sum_i \text{HQ}_i \quad (6)$$

$$\text{Risk} = \text{HI} \quad (7)$$

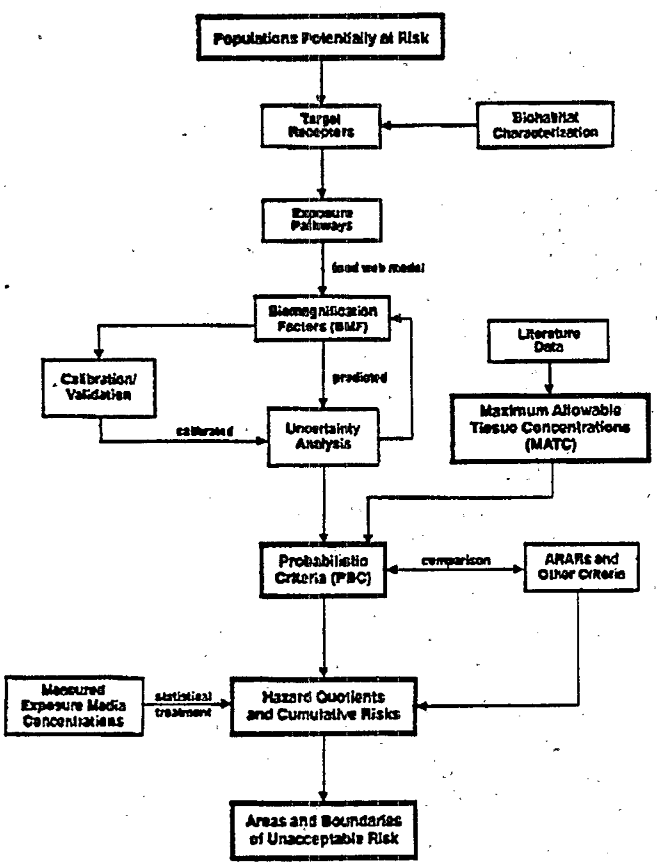
Slide 15

Research Priorities

- Development of dose-response/tissue concentration relationships for bioaccumulative chemicals and a variety of species
- Enhance rigorousness of methodology for deriving toxicity reference values (variety of chemicals and species)
- Develop standardized methodology for estimating parameters in aquatic and terrestrial food-web models
- Improve biomagnification/modeling theory and computational framework
- Develop methodology for statistical treatment of exposure indices/risks

Slide 13 Blowup

Proposed ERA Approach for RMA



TREATMENT OF UNCERTAINTY IN ECOLOGICAL RISK ASSESSMENT: BE CAREFUL WHAT YOU WISH FOR . . .

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INTRODUCTION

The quantitative incorporation of uncertainty into probabilistic assessments of ecological risks has attracted considerable attention recently in both academic and regulatory communities. A number of researchers have developed sophisticated methods for probabilistic risk estimation (e.g., Bartell et al., 1992, 1983; Lipton and Gillett, 1991; Suter et al., 1983). In this paper, we address the following simple question: Could (and would) these quantitative uncertainty models be used by environmental regulators?

BACKGROUND

The process known as "ecological risk assessment" (ERA) emerged as a "discipline" in the 1970s when concerns began growing about the potential impacts of contaminants on the environment. The first regulatory manifestation of this discipline appeared in environmental impact statements (EISs) prepared under the National Environmental Policy Act (NEPA). Publication by the National Academy of Sciences, in 1983, of "Risk Assessment in the Federal Government: Managing the Process" (NAS, 1983) provided a formalized framework for calculating *probabilistic* estimates of human health risks. This by-now familiar framework, consisting of hazard identification, dose-response assessment, exposure assessment, and risk characterization, was adopted by environmental scientists to apply to the calculation of ecological risks.

Ecological risk assessments play an important role in environmental policy and regulation. For example, standard-setting, site cleanups, and permit-writing all have ecological risk components. The vast majority of ecological risk assessments generate single-point deterministic estimates of the "risk" posed by a single contaminant to a single species. Often, these risk estimates take the form of a simple "quotient": for example, an environmental "benchmark" concentration (e.g., ambient water quality criterion) divided by the measured or estimated concentration of the contaminant in the environment. If the exposure concentration is less than the critical dose-response benchmark concentration (i.e., ratio is less than one), it is generally assumed that there is no significant ecological risk.

Such simplistic deterministic estimates fail to consider sources of uncertainty in the process. These sources of uncertainty include:

- Errors in measurement of site characteristics,
- Natural variability in site characteristics,
- Intra- and inter-species variability,
- Uncertainties regarding the dose-response models on which benchmark concentrations usually are predicated, and
- Uncertainties in inter-species extrapolations.

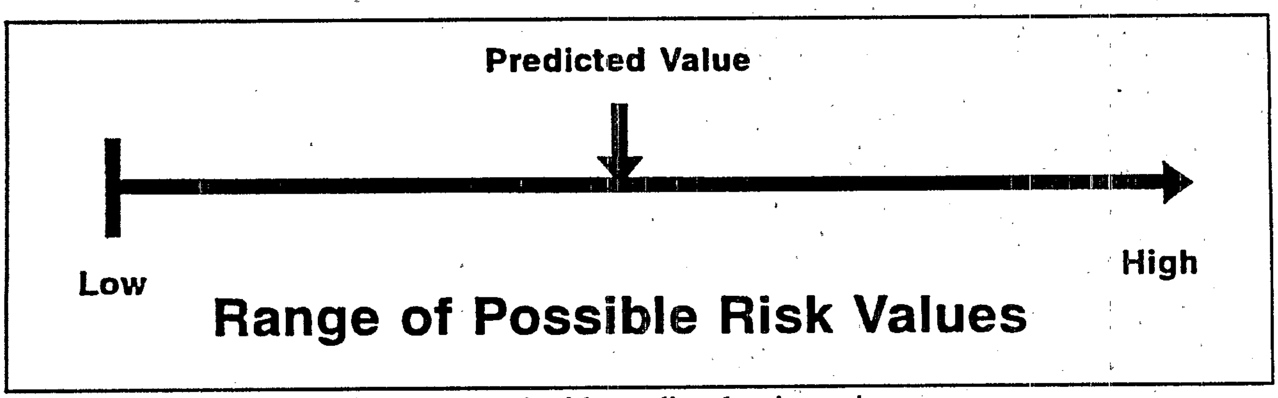

Figure 1. "Actual" Risk compared with predicted point estimate.

Point-estimates of risk therefore may not truly predict the <u>actual</u> risk posed by contaminants (Figure 1). This failure to account for uncertainty may limit the ability of policy makers to make informed decisions, can erode public confidence in risk-based decisions (Ruckelshaus, 1983), and may engender opposition within regulated communities.

TREATMENT OF UNCERTAINTY

Most commonly, uncertainties have been incorporated into the risk assessment process in a qualitative fashion by applying "safety factors." This often involves addressing a potential area of uncertainty (for example, the exposure estimate) by adjusting a point estimate by an arbitrary factor (often 10). The more uncertainties that are identified, the greater the number of safety factors used. It is important to remember that these factors may have little or no relevance to the actual variability or uncertainty associated with a parameter. Since the uncertainties have not been rigorously addressed, confidence in the actual risk assessment may be misplaced. On the one hand, effects that were unforeseen because the uncertainty was not addressed may occur once contaminants enter the environment. On the other hand, the use of such assessment methodologies may result in overstringent standards or regulation. While this might not bother the cautious environmentalist too much, strident opposition will likely be encountered from regulated industries that may have to foot the bill for unnecessarily stringent regulation. It could also lead to the discrediting of ERA as an exact scientific tool. Indeed, the Office of Management and Budget (OMB, 1990) noted the following:

> . . . risk assessment practices . . . effectively intermingle important policy judgments within the scientific assessment of risk. Policy makers must make decisions based on risk assessments in which scientific findings cannot be readily differentiated from embedded policy judgments.

The formal incorporation of uncertainty analysis into ERA using some form of simulation methodology, such as Monte Carlo analysis, offers at least a partial way out of this impasse (Lipton and Gillett, 1992, 1991). At its most basic, this procedure involves quantifying the uncertainties specific to the two main variables in the ERA: the exposure and dose-response assessments. This is done by fitting or selecting statistical distributions for dependent variables in risk models, randomly selecting variables sampled from these input distributions, and calculating the model output many times. This iterative process yields probabilistic distributions of the model output rather than a single point estimate (Figure 2). These output distributions represent the probabilities of the occurrence of the hypothetical range of exposure concentrations, or responses of the receptor organisms. These curves can then be combined into an integrated probabilistic risk curve (Figure 3). This latter curve describes the probability of a chosen endpoint (e.g., increased adult trout mortality) occurring, given the probable distribution of exposure concentrations and dose-response conditions.

Such analytical techniques have a number of advantages over the single-point estimate, deterministic solution. Both the range of possible outcomes, and their associated probabilities, can be estimated. If output distributions are compared to standards and/or criteria, estimates of "exceedence frequencies" can provide policy makers with an indication of the likelihood of "being wrong" (i.e., overshooting the criterion and injuring a resource). Additional benefits of such formalized uncertainty techniques include the following (Finkel, 1990):

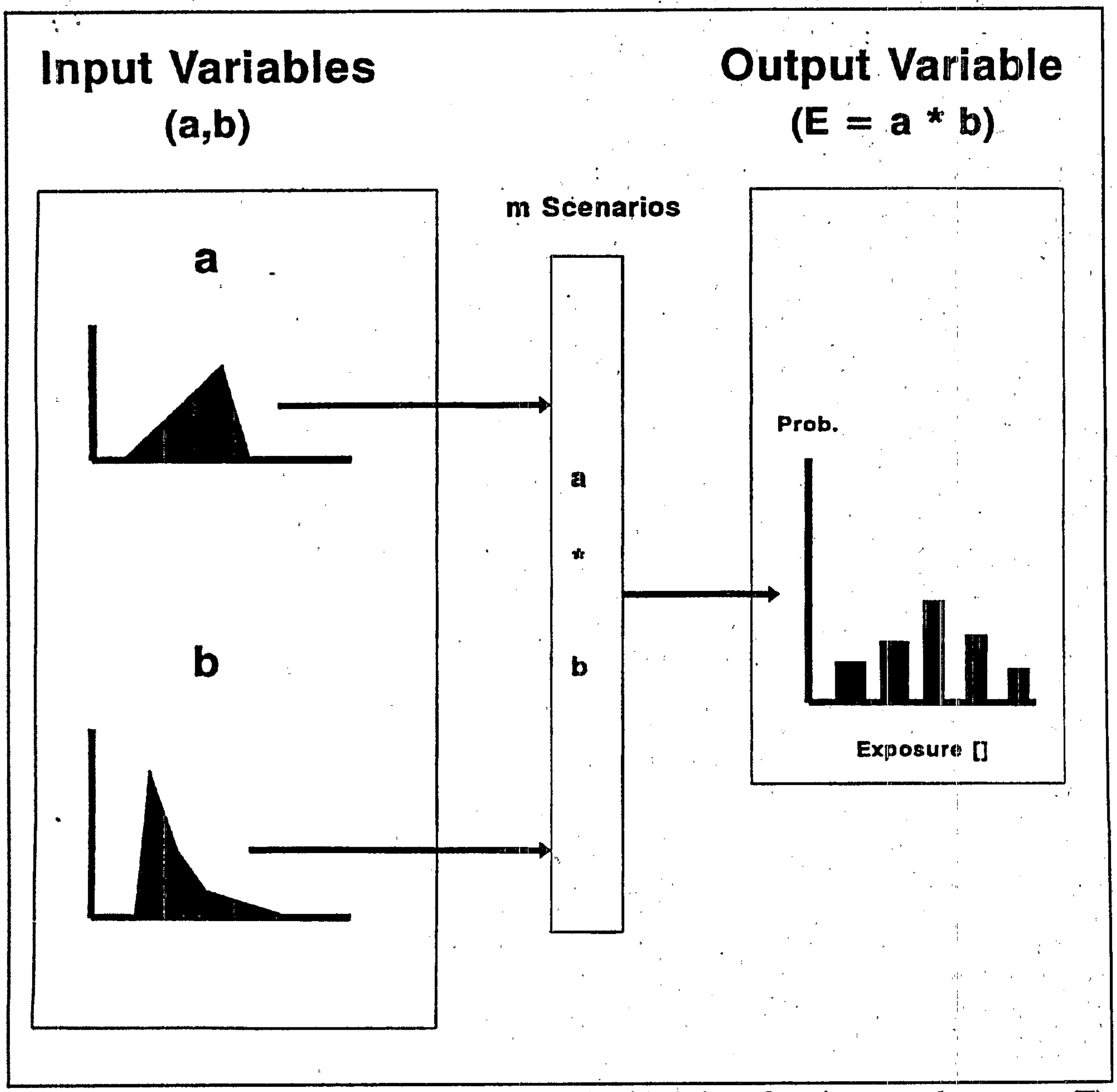

Figure 2. Schematic depiction of Monte Carlo simulation of environmental exposure (E). Curves a and b represent the assumed distributions of variables determining actual exposure.

- Improving understanding of the possible states of nature that may impinge on decisions, and
- Providing decision-makers with an understanding of the "costs" of being wrong.

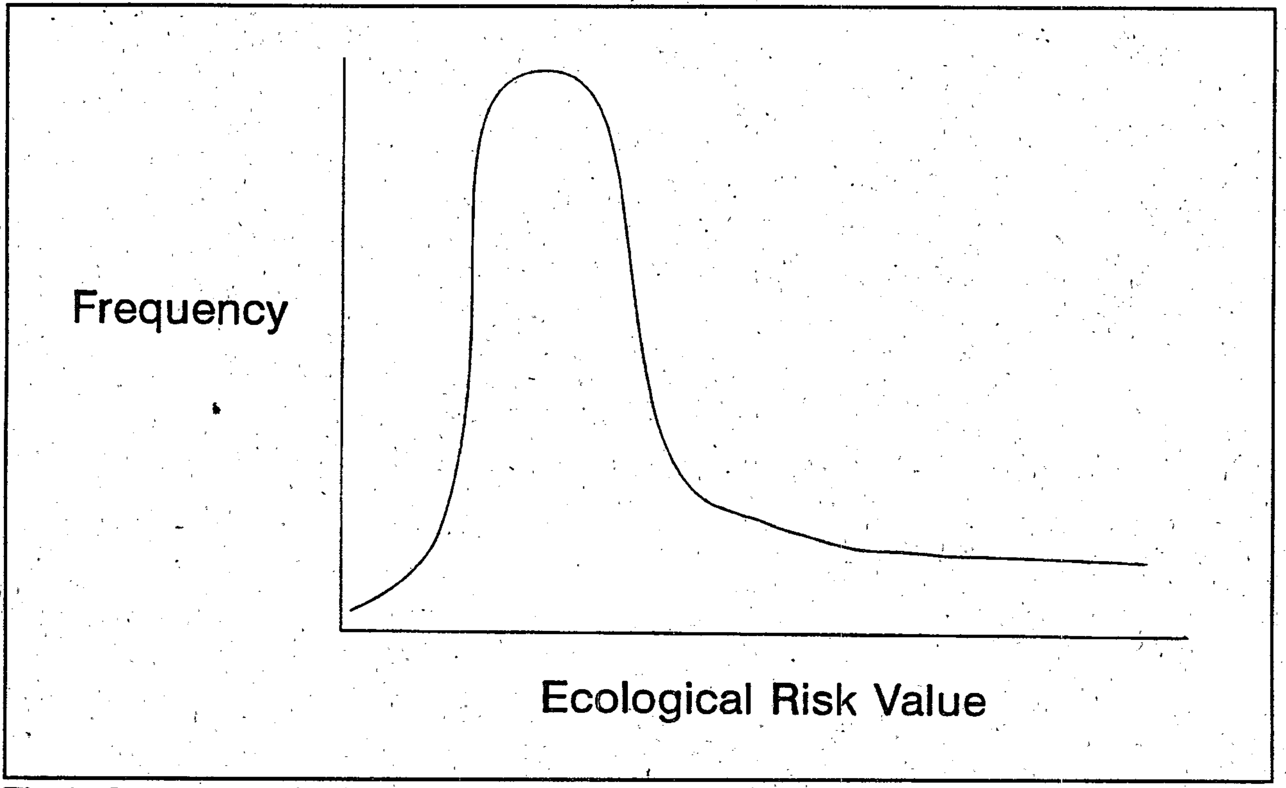

Figure 3. Probabilistic distribution of ecological risk values.

In addition, assessments that fail to consider uncertainties may not be reproducible (Bogardi, 1988), may appear to be (or may actually be) arbitrary, and may be politically and technically unconvincing (OMB, 1990).

DECISION-MAKING IMPLICATIONS

The development of a probabilistic ecological risk assessment methodology provides a more rigorous method for deriving standards and making decisions. Although this may benefit the regulatory community, caution must be exercised in its use. This may be a case that conforms to the maxim: Be careful what you wish for because you may get it!

What do analytical methods such as Monte Carlo analysis do for us in terms of risk-based decision-making? In many decision-making contexts (e.g., permit-writing), an acceptable regulatory standard or criterion (e.g., AWQC) often is used to predict possible adverse effects. This standard can be superimposed (as a vertical line) on a probabilistic exposure distribution to assess the likelihood of its exceedence (Figure 4). Of course, this begs the question "What

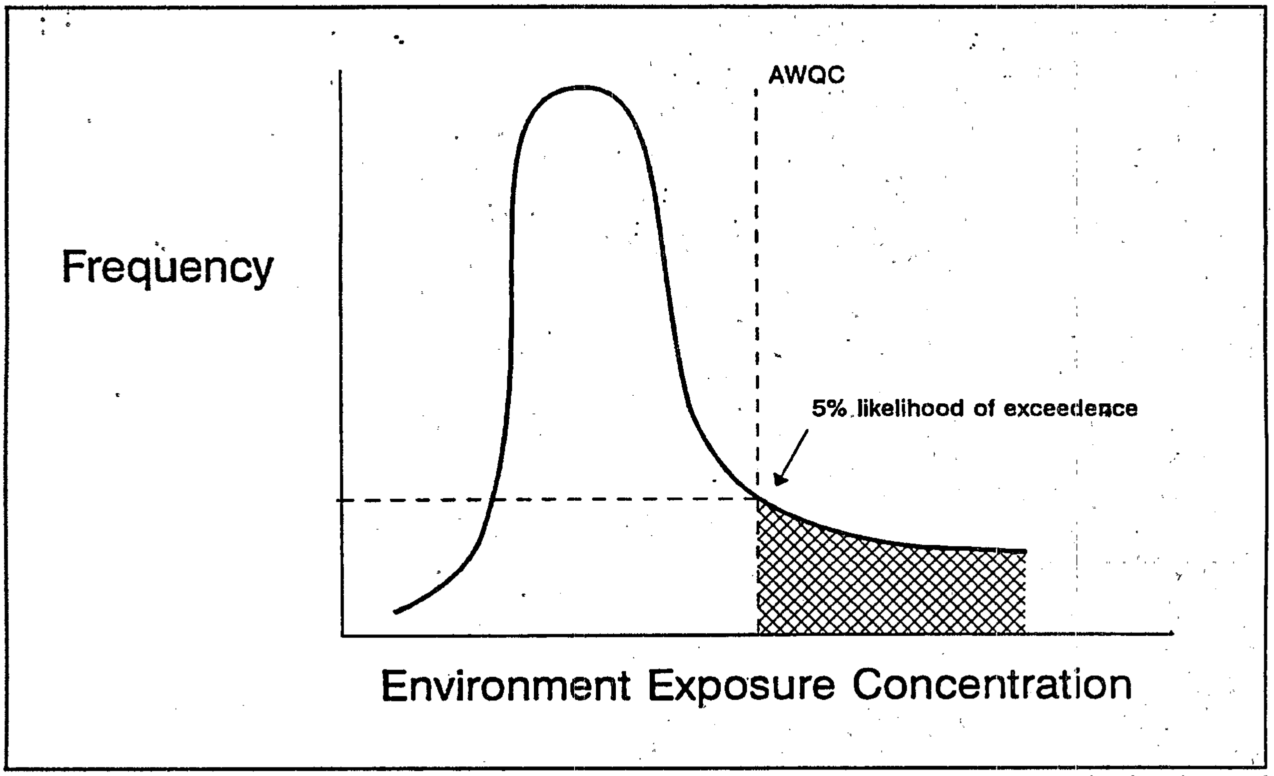

Figure 4. Ambient water quality criterion (AWQC) superimposed on distribution of exposure concentrations.

probability of exceeding the benchmark concentration is acceptable?[1,2] Unfortunately, simulation analysis won't help answer the "How much risk is acceptable?" question. For example, Figure 4 shows us that there is a 5 percent probability that ambient conditions will

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[1]This exceedence frequency represents the probability that the environmental concentrations of the contaminant of concern will exceed the AWQC based on variability in exposure conditions. This should not be confused with the number, or duration, of effluent excursions that may exceed an AWQC as a result of facility operation.

[2]Alternatively, we can derive a standard directly from the simulation modeling process by asking ourselves just how much ecological impact we are willing to accept. We might set our standard as the exposure concentration that will ensure that there is no more than a 5 percent probability that a selected ecological endpoint will be exceeded. Again, the same question must be addressed: How much "risk" is acceptable?

exceed the acute AWQC. Is this 5 percent likelihood of fish kills sufficiently protective of the environment? Is it too low?

In the absence of any constraints, the answer to the question "How much risk is acceptable?" is that no level of risk is acceptable. However, we do not live in a world without constraints. This is particularly evident to policy makers. Each environmental decision we make involves a series of trade-offs between different policies and resource uses. One constraint that is impossible to avoid in standard-setting is cost. For example, absent a cost constraint it is easy to say that we wish to have zero risk of exceeding an AWQC rather than the 5 percent value. However, what if that regulatory action results in industry incurring an additional $1

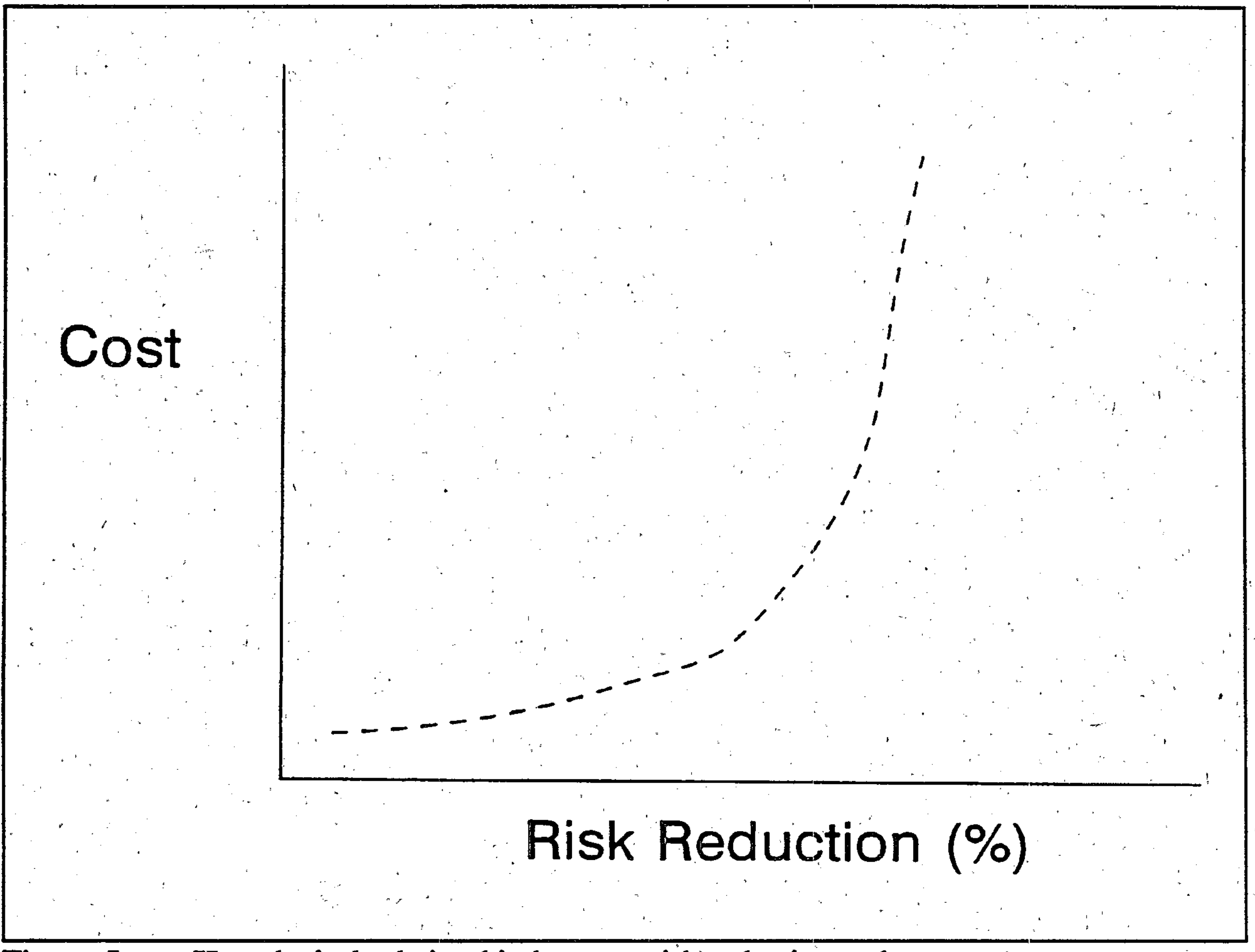

Figure 5. Hypothetical relationship between risk reduction and cost.

billion of treatment costs and a 25 percent increase in food prices (Figure 5)! What had seemed like a reasonable risk reduction now appears less palatable. In one study, Lipton (1992) showed that regulators' preferred "acceptable risk" levels (for human health) doubled when cost constraints were included in a decision problem. The bottom line is as follows: When uncertainties are included formally into risk assessments, regulators invariably will be asked to defend decisions regarding acceptable risk--and acceptable risk decisions invariably lead to the inclusion of economics as a regulatory consideration. This is not necessarily bad; it is part of making decisions that involve choices between societal alternatives. However, the ecological risk community must be aware of this aspect of their work.

CONCLUSIONS

By adopting more rigorous ERA tools which address uncertainty we are not necessarily ensuring that ecological impacts become less likely than they were under the deterministic, single-figure risk assessments. Rather, uncertainty techniques simply provide a means of formalizing many decision-making trade-offs. For example, the consistent use of conservative point-estimates is effectively a management decision rather than a scientific approach.

In addition, it has been noted (OMB, 1990) that the failure to characterize uncertainties can be used to hide value-based decisions. For example, a policy maker may consider the economic, social, or political costs of a given regulation to be too high. Individuals uncomfortable with stating decisions in terms of value-preferences may choose, instead, to mask this decision by "reassessing" the selection of an uncertain numerical parameter in the risk assessment, or by adding/removing safety factors from an assessment. To the extent that formalized uncertainty analysis clearly establishes sources and bounds of uncertainties, the temptation to utilize hidden decision rules may be circumvented and the value preferences of government regulators can be judged as part of the public record. Thus, the application of uncertainty analysis may provide a mechanism to assist in divorcing "scientific" risk assessment from regulatory decision-making.

This view was echoed further by OMB (1990) in a statement regarding risk assessment and risk management:

> These problems can be addressed by providing decision makers with the full range of information on the risks of a substance or an activity. Thus, decision makers should be given the likely risks as well as estimates of uncertainty and the outer ranges of the potential risk. Then, if regulatory decision makers want to choose a very cautious risk management strategy, they can do so and a margin of safety can be applied explicitly in the final decision. This approach is superior to one in which the expected risk and an unknown margin of safety are hidden behind the veil of a succession of upper-bound estimates adopted at key points in the risk-assessment process.

The development of new methods for ecological risk assessment must be coordinated with the decision-making models if the assessment process is to have any applicability for regulation (rather than simply being an academic exercise). For example, a risk assessment approach should be designed in a manner that will generate information that integrates easily into an existing decision-making model. Similarly, decision-making models should conform to the constraints, statutory and administrative, of policy analysis. Thus, a "top-down" approach could be devised according to the following tiered system:

- What are the regulatory (policy) alternatives available to decision makers?
- What decision-making model generates decisions that conform to these available alternatives?
- What risk assessment approach provides information required for the decision-making model (i.e., all assessment methodologies are not necessarily appropriate for all decision-making fora)?
- What data need to be collected to support such a risk assessment approach?

Quantitative models for uncertainty analysis <u>are</u> capable of providing useful information to regulators. This information can be factored into a decision-making calculus that involves consideration of the scope of potential outcomes and their probabilities of occurrence. Application of such approaches ultimately may aid in optimizing risk-based regulation, thus ultimately reducing total ecological risks. Moreover, to the extent that application of uncertainty analysis can prevent the obfuscation of value-based or political decisions as "science," environmental policies may become more responsive to social goals. Given the expanded uses of ecological risk assessment in environmental regulation, we believe that it lies within the scope of responsible Agency behavior to begin viewing ecological risk assessments within the framework of this mode of analysis.

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Human Health Risk Assessment: Reviewing EPA Guidelines

HUMAN HEALTH RISK ASSESSMENT: REVISING THE EPA GUIDELINES FOR DERIVING HUMAN HEALTH CRITERIA

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The Clean Water Act of 1977 required the Environmental Protection Agency (EPA) to develop ambient water quality criteria for the protection of human health from toxic pollutants. EPA responded by publishing Guidelines for deriving these criteria in the Federal Register on November 28, 1980. Human health protective criteria for surface water for more than 100 toxic pollutants, including pesticides, heavy metals, synthetic organics, and dioxin were published by EPA using these Guidelines.

The Clean Water Act also required EPA to review and revise these human health criteria when necessary so that they reflect the latest scientific knowledge. EPA is now in the process of doing this. The first and most important step is to ensure that the Guidelines used to derive the criteria do reflect the latest scientific knowledge. This session will discuss the basis of the current Guidelines and explore some of the major changes under consideration for revising the Guidelines.

The panel members who will talk about the Guidelines today cover a wide range of opinions in their presentations:

- The Guideline methodology is over-conservative.
- The Guideline methodology is insufficiently protective.
- The Guideline methodology should be updated to reflect scientific advances.
- The Guideline methodology should reflect the intended protected use.

We agree with all of these! The difficulty lies in figuring out what we need to change in the Guidelines to satisfy all these concerns.

For many pollutants, the EPA human health criteria form the basis for State water quality standards. In turn, these determine the pollutant limits in surface water discharge permits. The ambient water quality criteria are also utilized as limits in requiring cleanup at Superfund sites. The need to have scientifically supportable, protective criteria cannot be overemphasized!

The Guidelines for deriving human health criteria have not been updated since their original publication in 1980. Since that time, there have been significant advances in our ability to characterize and quantify the risk to human health of pollutants in surface water. These advances should enable EPA to develop a more scientifically supportable set of Guidelines for calculating the human health criteria.

The current version of the human health criteria Guidelines, which is under revision by EPA, was subjected to intensive public comment and peer review before its publication in 1980. A proposed methodology was published for public comment in the Federal Register, and the EPA Science Advisory Board (SAB) conducted an extensive review of the Guidelines.

EPA will initiate its formal revision of the 1980 Guidelines with a 3-day workshop later this month in Washington, D.C. The workshop will include about 75 invited participants from EPA, academia, environmental groups, industry, and other Federal agencies. We will examine all aspects of the Guidelines with separate working groups on cancer and noncancer risk assessment, microbiology, exposure, bioaccumulation, and minimum data requirements for developing criteria. After the workshop, we will go to the Science Advisory Board and the public for comment.

The input that we receive at this Conference on Water Quality Standards will also be factored into the revision of the Guidelines. It is important that you express your concerns and comments so that we know where to focus our attention.

The panel discussion that we are about to hear provides an excellent forum for presentation of diverse viewpoints on the current human health Guidelines. The only thing that the panel will probably agree on is that the Guidelines do need to be reviewed, updated, and revised to make them the best science that EPA can provide. With the help of all of you, we will be able to do that.

HUMAN HEALTH RISK ASSESSMENT: REVISING THE EPA GUIDELINES FOR DERIVING HUMAN HEALTH CRITERIA FOR AMBIENT WATER. THE METHODOLOGY IS OVER CONSERVATIVE

Paul Anderson
ENSR Consulting and Engineering
Acton, Massachusetts

I have been invited to present the view that the current methodology for deriving human health criteria is over-conservative. Throughout the majority of my presentation, I will present information indicating that the methodology is over-conservative in several of the areas the invitation asked that I consider. Before getting to the "conservative nature" of specific elements of the methodology, I think it is important to consider what is meant by "conservative" and then, the conservatism of the methodology, or lack of, in a broader public health context.

Human Health Risk Assessment Methodology
Position: It Is Too Conservative

Paul Anderson, Ph.D.
ENSR
ENSR Consulting and Engineering

When public health risk assessment specialists refer to an assumption, methodology or criterion as "conservative," generally that means that the potential risks to public health will be overestimated. This paper defines "conservative" in the same way. The degree of conservatism, however, is generally not quantified and, indeed, varies from assumption to assumption, methodology to methodology, and criterion to criterion. The public health consequences of this unquantified variation in conservatism can be enormous and unintended. Unintended because the variation can lead to diminished protection of public health--the exact opposite of what conservative methodologies are designed to accomplish.

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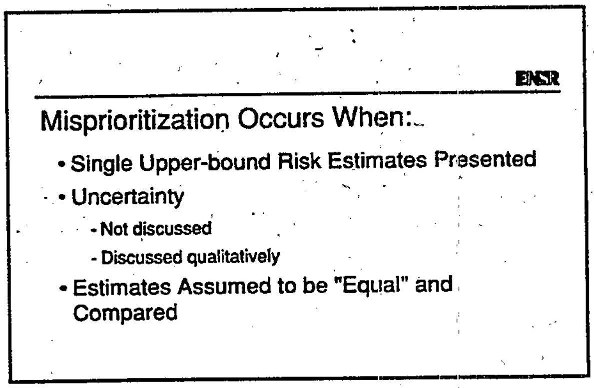
What is Conservative?

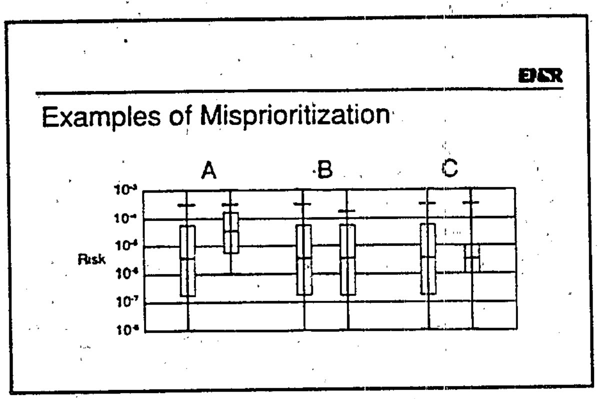
- An Estimate of Risk That Overestimates Actual Risk
- Usually Degree of Conservatism is Not Quantified
- Consequence of Unquantified Conservatism is Misprioritization

How can this happen? Imagine that each of several regulatory programs whose goal is to protect public health uses risk assessment methodologies that have varying degrees of conservatism. Imagine further that the actual risk posed by a particular compound that falls under the purview of these programs is identical. Yet, because the methodologies differ in their degree of conservatism, the estimated risks posed by this compound will vary between regulatory programs. Because the estimated risks are reported by the regulatory program and are also one of the key elements in forming regulatory, public, and congressional perception about this compound and regulatory program, they (the estimated risks) govern how we as a society will prioritize our efforts to reduce them.



If the actual risks are identical and the degree of conservatism in each regulatory program is similar, then it is unlikely that substantial risk-based misprioritization will occur. If, on the other hand, the conservatism varies substantially, then it is likely that the highest risks, those estimated most conservatively, will receive the greatest priority. As long as the actual risks under the purview of each regulatory program are roughly similar, the initial overall public health consequences of this scenario may not be of great concern. However, if the actual risks are different, or when they become different due to reduction of the high-priority risks, i.e., those with the most conservatism, then a potentially disturbing unintended consequence arises: The regulatory programs with the lowest actual risks may still be viewed as addressing public health risks of greatest magnitude. They will receive priority not because they pose the greatest actual risk but because they are the most conservative, i.e., they overestimate actual risks the most.

If the only public health risks that society had left to deal with could be termed "relatively minor," then the consequences of any misprioritization caused by differences in conservatism would also likely be "relatively minor." This is not the case, however. Society is faced with a variety of public health risks that are better described as "major." These range from the potential public health consequences of ozone layer thinning, to AIDS, to an infant mortality rate in the United States of about 1 in 100. In addition, society is also faced with estimating and mitigating other kinds of risks (other than strictly public health risks), including



those associated with differences in socioeconomic status as well as risks to the environment. As pointed out by the Science Advisory Board in their report on ranking risks, the latter type of risks may be especially significant.

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Avoiding Misprioritization

- Quantify Uncertainty
- Try to Include All Uncertainty
- Best Method is Monte Carlo Analysis

The potential unintended consequences of conservatism can be avoided, at a minimum for various public health risks, and possibly for other risks as well, by quantifying the uncertainty associated with estimates of risk. While such quantification may have been difficult and time consuming several years ago, today it can be done easily using Monte Carlo analysis and readily available and relatively inexpensive software programs. The notion of "conservatism" can be largely taken out of the risk assessment process, because the goal of, and end result of, a Monte Carlo risk assessment is the calculation of a range of potential risks corresponding to the range of actual risks. If a risk assessment produces a realistic range of risks, then it is neither conservative or non-conservative. Armed with such information, the conservativeness of a criterion is dependent upon how a risk manager uses the range of realistic risks. If all regulatory programs were able to estimate a range of realistic risks, then the above discussed unintended consequences of conservatism and prioritization of societal effort could be largely avoided. That is not to say that priorities would change. They might remain the same. However, then the prioritization would be intended and not unintended.

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Is the Current Methodology Too Conservative?

- Yes, Overall
- All Elements Not Conservative
- Must Quantify This Conservatism

The remainder of this paper addresses the notion that the current methodology is over conservative in several of the eight areas the invitation asked that I comment on. The paper's perspective is that a risk assessment methodology should derive realistic estimates of risk. To the extent that many of the elements of the existing methodology were designed to overestimate actual risks, I suggest ways to make the methodology more realistic, and thus less conservative. Note, however, that some elements of the existing methodology may lead to an underestimate of actual risks. These also need to be modified such that realistic estimates of risk are derived.

THE EXISTING METHODOLOGY ASSUMES THAT THE CONSUMED FISH CONTAIN 3 PERCENT LIPID AND THAT ONLY THE EDIBLE PORTION IS CONSUMED. WHAT NEEDS TO BE CHANGED IN THE THESE ASSUMPTIONS?

Conservatism of Specific Areas

- Fish Lipid
  - Use actual data
  - Lipid based criteria
- Fish Tissue or Water Based
  - Doesn't affect conservatism
  - Application may

Lipid content is a critical factor in determining the amount of many chemicals in fish. The lipid content of fish varies as does the portion of fish that people eat. Consequently, an ambient water quality criterion that is driven, in part by fish consumption, should be based upon a lipid content that is representative of the fish people eat. In most cases, that will be different from 3 percent. One way to account for this is to have water quality criteria that are dependent upon the percent lipid content of edible portions of fish in the water bodies to which the criteria will be applied. The edible portion lipid content should be derived using a method designed to estimate a realistic lipid content, and not an over- or underestimate. The proposed sediment quality criteria take this approach when dealing with organic carbon content of sediments.

SHOULD CRITERIA FOR HYDROPHOBIC CHEMICALS BE EXPRESSED AS FISH TISSUE CONCENTRATIONS INSTEAD OF WATER COLUMN CONCENTRATIONS?

From the point of view of whether the current method for deriving ambient water quality criteria are overly conservative or not, the answer to this question should not affect the conservativeness of the criteria. This assumes the application of the criteria does not affect their conservativeness. To the extent that fish tissue criteria may be easier to apply for some hydrophobic chemicals than water quality criteria, such criteria may be more desirable. Regardless of whether the ultimate criterion is for fish tissue or water column, it is imperative that the procedure used to determine whether a water body meets the criterion not add conservatism to the criteria. For example, the long-term average fish tissue concentration, and not the maximum, is appropriate for comparison to a criterion that assumes a long-term exposure to chemicals through consumption of fish.

SHOULD THE EPA DEVELOP "LESS THAN LIFETIME" CRITERIA FOR HUMAN HEALTH? HOW SHOULD THE HUMAN HEALTH IMPACTS OF SHORT-TERM EVENTS BE ASSESSED?

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Conservatism of Specific Areas (Cont'd)

- Less Than Lifetime
  - Not with current conservatism
  - May with unbiased criteria
- Other Exposure Contribution
  - Not with current methodology
  - Perhaps with unbiased criteria
  - Total allowable exposure should be unbiased

The potential human health impacts of short-term events should be assessed using the same approach as was proposed for long-term events, i.e., using a methodology that predicts realistic estimates of potential risks. The results of such an assessment would indicate whether there was a need for "less than lifetime" criteria. Given the conservative nature of the current methodology, it seems unlikely that "less than lifetime" criteria would be more stringent than existing lifetime criteria. However, if the methodology for estimating potential lifetime risks is modified such that it predicts realistic risks, it would be prudent to also estimate less than lifetime risks and develop criteria for both endpoints. Both methodologies need to calculate realistic estimates of potential risk so that an accurate comparison of the two endpoints can be made.

SHOULD OTHER EXPOSURE SOURCES BE CONSIDERED IN SETTING CRITERIA? IF SO, WHAT CONTRIBUTION SHOULD BE ASSUMED?

As with the other areas, the answer to this question depends entirely upon whether the methodology predicts realistic estimates of potential risk, or retains the conservativeness of the current methodology. If the methodology remains conservative, then the need to account for other sources of exposure is eliminated. The conservative elements in the current procedure reduce the criteria sufficiently to account for other sources of exposure. If the methodology is made realistic, then for some compounds, it may be necessary to modify criteria to account for other sources. Once again, please note that the possible need for an apportionment of exposure assumes that the total allowable exposure has been established using realistic estimates of potential risk. Because current EPA estimates of allowable exposure are designed to be conservative, they would need to be modified before use in an apportionment of exposure. Finally, the apportionment of exposure is likely to vary among chemicals, depending upon how much exposure typically comes from ambient water versus other environmental media.

SHOULD BIOACCUMULATION BE CONSIDERED IN CALCULATING CRITERIA? THE EXISTING METHODOLOGY ONLY ACCOUNTS FOR BIOCONCENTRATION. HOW WILL THESE FACTORS BE DERIVED?

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Conservatism of Specific Areas (Cont'd)

- Account for Bioaccumulation
  - Yes
  - Realistic model (or measurements)
  - Not GLWQI method
- Risk Management Implications of Biased Assumptions
  - Remove bias
  - Accurately characterizing range of risk
  - Multiple populations

"Of course," is the short answer. Bioconcentration is a laboratory phenomenon. By definition, it estimates uptake of a chemical from water only. Such conditions are not possible in ambient water where other sources will contribute to, or even dominate, total uptake. The traditional application of BCFs, used by existing criteria, to total water column concentrations of a chemical, while technically incorrect, accounts for the uptake of chemicals from the other exposure pathways because it overestimates the concentration of the chemical actually dissolved in the water. (The correct application of a BCF is to only the dissolved portion of a chemical in the water column.)

Accurate derivation of BAFs is far more difficult because no user-friendly and widely acccpted method is currently available that allows for accurate prediction of a range of BAFs. (The Great Lakes Initiative cannot be used for a number of reasons, including its dependence upon BCFs, use of assumptions specific to the Great Lakes and thus not transferable to other waters of the United States, and its failure to accurately predict accumulation in other waters as well as for many species in the Great Lakes.) Clearly because an accurate estimate of accumulation is critical to development of realistic criteria, the development of a method that leads to realistic estimates of bioaccumulation is critical and should be a priority. In the absence of such a method, an alternative is to use available data from various water bodies to estimate bioaccumulation in the ambient environment. Even this needs to be done with care because the variable nature of environmental sampling can introduce biases into field-derived estimates of bioaccumulation.

WHAT SHOULD THE BALANCE OF STRINGENT VS. NONSTRINGENT PARAMETERS BE TO ACHIEVE A BALANCED RISK ASSESSMENT? SHOULD SOME OF THE FACTORS IN OUR "RISK ASSESSMENT" METHODOLOGY MORE ACCURATELY BE CHARACTERIZED AS RISK MANAGEMENT DECISIONS?

The achievement of a balanced risk assessment is an essential and laudable goal. The current methodology does not achieve that goal. Indeed, the only way to achieve a balanced risk assessment is to use realistic assumptions, not a balance between stringent and non-stringent assumptions. Because the current methodology contains mostly stringent and some non-stringent assumptions, it contains "risk management" decisions. This violates the fundamental tenet of the National Academy of Science's "Red Book," which is that risk assessment and risk management decisions need to be made explicit and hopefully be kept separate. Use of Monte Carlo analysis achieves this end, because done correctly, it will provide a risk manager with a range of realistic risks (or conversely, a range of potential criteria associated with a particular level of protectiveness) from which the risk manager will have to choose a criterion based upon the allowable level of risk, among other factors.

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Conclusions

- Current Methodology is Biased (Conservative)
- Remove Bias
- Accurately Characterize Range of Risks
- Make Risk Management Decisions Explicit

Some of the key factors that a realistic methodology needs to account for include: a range of fish consumption rates for the general population at a minimum and perhaps also for sport and subsistence fishermen and their families; a range of bioaccumulation factors; a range of duration of residence times; and a range of cancer potency estimates and reference doses. Given these and other inputs, a range of potential risks associated with a range of water concentrations can be calculated and provided to a risk manager. Given this range, the risk manager can decide how protective criterion should be. The information provided the risk manager would also let him decide to protect various populations at different allowable risk levels. For example, the average (or some upper or lower bound) member of the U.S. general population at a 1 in 1 million excess lifetime cancer risk level; the average sport fisherman (or some upper or lower bound) at a 1 in 100,000 risk level; and the average subsistence fisherman (or some upper or lower bound) at a 1 in 10,000 risk level.

The elegance of a methodology that provides a complete and realistic characterization of potential risk is that the risk manager can ask for, and be provided, information on the potential risks for a variety of endpoints that may be of concern. Such a method also avoids the unintended risk management consequences commensurate with methods that provide estimates of risk without a quantification of how conservative or non-conservative they are.

OPPORTUNITIES FOR UPDATING THE METHODS FOR THE DERIVATION OF HEALTH-BASED WATER QUALITY CRITERIA

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EPA's mission centers on the protection of the environment. The protection of human health from effects due to contaminants that have found their way into the environment has become an important component of that mission. A major turning point that caused the Agency to recognize the importance of human health issues as a key component of environmental protection was the mandated requirement to develop water quality criteria during the late 1970s.

BACKGROUND

The basic concepts incorporated into the methodology for the derivation of health-based water quality criteria have strongly influenced the Environmental Protection Agency's ability to establish limiting concentrations in ambient water and drinking water. The methodologies for the derivation of such limiting values are clearly part of the discipline of risk assessment, and involve many related specialty areas.

It is a fairly simple task to trace the development of the methodology for the derivation of water quality criteria for the protection of aquatic life from their early beginnings through the encyclopedic treatment by McKee and Wolf (1963), through the Green Book (U.S. Department of the Interior, 1968), the Blue Book (NAS, 1972), to the precisely circumscribed procedures in U.S. EPA (1987).

In contrast, development of methods for the derivation of health-based criteria has a much more complex history, primarily because many groups had already been active in the interpretation of toxicological and epidemiological data for the protection of human health during many years prior to creation of the U.S. EPA. Before the U.S. EPA was established, most of the limiting values were established on the basis of scientific judgment and consensus. Thus, the Water Quality Standards for drinking water were determined in this manner by the U.S. Public Health Service (U.S. Department of Health, Education and Welfare, 1962).

Clearly, the Agency borrowed risk assessment concepts for the derivation of water quality criteria from many institutions. The methodologies that were formalized as part of the derivation of Water Quality Criteria in turn exerted strong influences on the ways in which other institutions conducted their risk assessments. The general characteristics of the process were summarized by NAS-NRC in 1983, after the basic methodologies for our present health-based water quality criteria had already been established. The report *Risk Assessment in the Federal Government: Managing the Process* clearly distinguished between risk assessment and risk management (NRC, 1983). The area of risk assessment was subdivided into a number of subspecialties, namely hazard identification, dose-response assessment, and exposure assessment, to arrive at a risk characterization.

An early trend in EPA's risk assessment activities was a declining emphasis on professional judgment, and an increasing reliance on codified procedures. The introduction of standardized procedures has resulted in consistent criteria for wide ranges of data sets. However, this has also diminished the extent of advanced scientific inputs by substituting worst case default assumptions when there were any reservations concerning the quality of the database.

In turn, recent risk assessments conducted by the Agency for Toxic Substances and Disease Registry (ATSDR), the Consumer Product Safety Commission (CPSC), the Food and Drug Administration (FDA), and the National Institute for Occupational Health and Safety (NIOSH) exhibit a noticeable influence from the methodologies developed and modified by the U.S. EPA. Within the U.S. EPA, the methodologies have influenced the derivation of limiting concentrations in ground water, soils, sediments, and air. In the aggregate, the end result of these methodologies has been a significant reduction of wastes discharged to the environment.

The apparent successes attributable to the health-based risk assessment methodology are clearly evident. Then why should there be any credible motivation for change? There are important scientific issues that determine the true relationships of contaminant concentrations and potential health effects. It is important to remember that the basic development of the present methodologies for the derivation of health-based water quality criteria dates back to 1978 to 1979, when the criteria were being developed in response to a suit by the Natural Resources Defense Council (NRDC). The Agency's response was influenced by court-imposed deadlines and the urgency to develop criteria for a specified list of contaminants. Clearly, the methodology for the derivation of the criteria was developed in deliberate haste, and their development took the path of least resistance, so that the criteria are based upon <u>protective risk assessments</u> rather than <u>predictive risk assessments</u>, which result in significant differences that will be discussed in greater detail later in this paper. At this time more than a decade has been elapsed, which has seen significant advances in the science of risk analysis. Yet, there have been relatively few changes in the methodology for the development of health-based water quality criteria. This apparent inertia to change is in part due to the success of the water quality criteria process in controlling environmental pollution, but on the other hand this inertia also seems to be sustained by the interactions among various interest groups that use the health-based criteria issues to support their own agendas, without regard for the scientific underpinnings for the criteria.

Protective Versus Predictive Risk Assessments and Uncertainties

Although the Agency's achievements in limiting the releases of contaminants into the environment have been admirable, there are a number of basic conflicts in the present fabric by which the Agency seeks to control the adverse impacts of human activities upon the environment and upon humans themselves. The basic problems may have their foundations in generic semantic concepts, such as "protection, safety, and ample margins of safety." On a purely scientific basis, absolute safety cannot be guaranteed, except when the stressor that may compromise safety is completely absent. Similarly, the concept of protection is often used interchangeably with safety. A strict adherence to these basic concepts would demand a steady reduction and eventual elimination of all contaminants. These concepts are simply stated, easily comprehended, and if executed, they would guarantee the protection and safety from any conceivable effect that might be produced by the contaminants that had been selected for this action. At this stage, one of the cornerstones for the protective strategy is the selection of specific substances for action. This selection process has developed a class of substances referred to as "toxics," which have been chosen to receive special treatment, often without regard for the concentrations in which they occur. Aside from the fact that the word "toxic" or "toxics" as a noun is not to be found in the dictionary, conflicts arise when most toxicologists are firm believers in the concept that any substance can be toxic, and that the dose makes the difference. Although it is clearly possible to eliminate many substances from the waste stream, and although it is clearly possible and desirable to reduce the amounts of waste produced, it is clearly impossible to construct a human civilization that produces no waste at all. The known physical and natural laws are not going to be held in abeyance in favor of Federal or State laws!

Given the public mandates, the immature state of the science of risk assessment, and the existing time pressures, EPA's present health-based risk assessments are characterized by a selection or listing process, followed by the development of water quality criteria that are almost exclusively the product of protective risk assessments. For this type of risk assessment, data on the human health experience and/or experimental data from laboratory animals are evaluated to determine their significance and the qualitative uncertainties associated with the data. The present methodology separates substances into carcinogens and noncarcinogens. It is assumed that all carcinogens exhibit no threshold with respect to the dose that is expected to produce an effect, and that the dose-response relationship is linear at low doses. The modified multistage risk assessment model (Crump, 1982) commonly applied in these situations also incorporates linearized confidence limits on doses given a specified risk. In practice, the model is applied to the particular combination of cancer sites in the most sensitive species that provides the highest calculated upper limit to risk.

For noncarcinogens, the methodology codifies uncertainties and translates them into uncertainty factors (formerly safety factors) and modifying factors that tend to accumulate uncertainties in ways that lower the acceptable exposure for the criterion (Dourson and Starra, 1983). In addition, protective risk assessments evaluate the available toxicological information selectively; information that reports adverse effects is given much greater credence than information that reports the absence of adverse effects. Although the process appears to yield criterion exposure limits that are likely to be protective in nearly all cases with a large margin of safety, these criterion exposure limits have essentially no predictive power, because the magnitude of the actual uncertainties is unknown due to the methodology by which the criterion has been derived. Moreover, the quality of the information upon which individual criteria are based differs tremendously, so that the actual uncertainties differ from substance to substance.

In contrast, at the present time predictive risk assessments are used primarily by the insurance industry. Ideally, these predictive risk assessments are based upon prior experience or actuarial information, e.g., 1 out of 44 Americans can expect to die as a result of a motor vehicle accident (as a driver or passenger, or as a pedestrian). The uncertainties for this prediction are evident from year to year and site to site variations plus any effects due to long-term trends.

If one were to take this approach with substances where most of the information is indirectly provided, such as through studies with laboratory animals, then obviously both the most likely actuarial prediction, as well as the uncertainties, would be much more difficult to assess than the relatively simple case cited above. When the available toxicological information is derived through laboratory studies using model systems, then the risk assessments need to resort to extrapolations. These extrapolations need to encompass the qualitative and quantitative differences in the susceptibility of the test animal and the human. The extrapolations need to address the differences in the range of sensitivities in the human population when compared to the range found in the test species. Humans are not always the most sensitive species, neither are they always the most resistant species. Potentially, predictive risk assessments can provide an opportunity to express the uncertainties around the predicted condition and the dose rate at which they are expected to occur.

The obvious advantages of protective risk assessment approaches are that they are relatively easy to construct, and that they are responsive to the most obvious concerns. Their disadvantages are primarily due to a failure to address underlying issues, which in turn curtail the ability to deal with complex causes of risks. The advantages of predictive risk assessments are that they provide information on the dose regimen most likely to produce adverse effects, and in addition provide a best estimate on the range of uncertainties about this estimate.

ASSESSING THE EXPOSURE

The Agency's water quality program appears to be constrained by a compulsion, created by perceived legislative mandates, to deal with problems arising from contaminants in the aquatic environment by controlling the concentrations of those contaminants in water. While this approach has the advantage that it can address effluent discharges by considering various dilution scenarios, and the buildup of persistent organic chemicals in biota through bio-accumulation coefficients, it fails to address many environmental processes that determine the ultimate exposures and therefore the ultimate risks. It is impossible to estimate human exposures related to discharge permits unless one considers environmental transport and fate in addition to the extent of dilution that may occur. It is therefore inappropriate to apply stream-based discharge permitting schemes that are suitable for the Hudson, Columbia, or Mississippi Rivers to the Great Salt Lake or the Great Lakes System. It should be obvious that the hydrology in these large lake systems, which are characterized by very long residence times, exerts a very strong influence on the concentrations of contaminants that are attributable to discharges into these systems. Thus, most of the perceived needs for a Great Lakes Initiative do not have their foundations in any unusual sensitivity of the organisms living in the Great Lakes to persistent contaminants, but instead have their basis in a historical failure to recognize the applicable concerns for the fate and transport of persistent chemicals in the Great Lakes. Another example of simplistic applications can be found in the attempts to link bio-accumulated chemicals to discharge permits through the application of a bio-accumulation coefficient. Clearly, the concentration of persistent chemicals in fish is of paramount importance to fish-eating species, including humans. However, there are many intervening steps and processes that lead from the discharge of a substance to its accumulation in sediments and directly or indirectly into biota. Consequently, the ability to predict the corresponding concentrations of contaminants among water, biota, and sediments is fraught with major difficulties. Obviously, if one wishes to protect the consumers of aquatic life, then the most important parameter to control is the concentration of a substance in the aquatic life that is likely to be consumed. In other words, the limiting concentration should be set for the aquatic life. Ultimately, substances that are bio-accumulated need to be controlled by limiting their inputs to watersheds or lake systems. However, it needs to be recognized that the control of bio-accumulating substances through the application of limiting concentrations in ambient waters or in discharges is increasingly remote from the locus of the problem, resulting in increasing uncertainties. These uncertainties are part of reality. They need to be identified and assessed as part of the overall process.

OPPORTUNITIES FOR IMPROVING HEALTH-BASED RISK ASSESSMENTS FOR CRITERIA DEVELOPMENT

It is obviously futile to expect an immediate conversion from protective to predictive risk assessment models. Nevertheless, a gradual conversion is desirable, largely because predictive risk assessment paradigms allow a better assessment of the uncertainties surrounding the process. To date, the Agency's program of Reduction of Uncertainties in Risk Assessment (RURA) has been applied mostly to its current protective risk assessment methodology, and the success of RURA for this application has not been outstanding; and given the underlying approaches for most of our current risk assessment methodologies, the prognosis for significant future successes for RURA is very poor. Therefore, the risk manager will continue to have little tangible information on the robustness and the extent of uncertainties about the risk assessments that are to be used in any specific action.

To approach these problems, I will consider carcinogens separately from noncarcinogens. This follows the present risk assessment methodology of the Agency which assumes that all carcinogens exhibit no threshold, and that the toxicity of noncarcinogens is characterized by the presence of thresholds for responses above certain dose levels. The risk assessment methodology for carcinogens is characterized by the application of a linearized multistage risk assessment model, while the risk assessment for noncarcinogens relies primarily upon the codified application of uncertainty factors (formerly called safety factors).

NONCARCINOGENS

Once the minimum data requirements have been met, the methodology for the derivation of water quality criteria for noncarcinogens revolves around extrapolations on individual differences, interspecies differences, short-term to long-term differences, and differences attributable to the quality of the data. The extrapolations take the form of 10-fold uncertainty factors or a variable modifying factor. The usual underlying assumption is that humans are at least as sensitive as the sensitive individuals in the most sensitive species tested. These separate factors are presently used as components of a protective risk assessment in the derivation of health-based water quality criteria, but it is also possible to begin to address the issues underlying the use of these factors in predictive risk assessments.

Individual and Inter-specific Differences

In most cases, the current methodology selects the No-Observed-Effect Level (NOEL), occasionally the No-Observed-Adverse-Effect Level (NOAEL), in mg/kg/day that was observed, and divides this dose rate by an uncertainty factor of 10 for individual differences and a further uncertainty factor of 10 for differences between species. A major problem associated with the approach is that the exact dose levels associated with the NOEL or the NOAEL are a result of the dose levels selected by the investigator at the beginning of the chronic or subchronic experiment. Furthermore, the NOEL or NOAEL is not influenced by either the quality of the experiment or the number of animals used per dose level. Some of these issues are addressed by the "benchmark dose" concept, which seeks to substitute a calculated effective dose near the threshold, at a low percentile response, e.g., an ED_{10} for the NOEL or NOAEL. However, while this approach addresses some of the mechanistic frailties of the derivation of the NOEL or the NOAEL, it does not address the issues that are directly related to individual and inter-specific differences in sensitivity. More direct measures of the extent of individual differences can be found in the slope of the dose-response curve. If the response axis measures the proportion of the exposed individuals that respond at any one dose level, then the slope of this dose-response curve is a direct measure of the extent of individual variability. Several problems associated with this approach still need to be resolved. The most important ones are (1) to what extent is the slope of the dose-response curve a property of the variabilities in response found among the individuals, and to what extent is it a property of the interactions of the chemical with the individuals; (2) to what extent does the variability among individuals found in one species relate to the variability in another species; (3) are there unusually sensitive subgroups in the human population; and (4) to what extent do they differ from the dose-response projections for the bulk of the population. It is possible to begin an analysis of many of these issues, especially by analyzing toxicological data on drugs, where there exists an extensive database on effects in laboratory animals with direct comparisons to humans.

While the issues related to inter-specific differences in the derivation of health-based water quality criteria have been commonly dealt with by using another factor of 10, considerable progress has been made in exploring the bases for inter-specific differences in responses. Differences in pharmacokinetics, metabolism, and toxico-dynamics among species have been found to relate strongly to the observed species differences in response. Thus, physiologically based pharmacokinetic (PB-PK) models have been found to be very useful in explaining many observed inter-specific differences (Klaassen and Rozman, 1991). A further combination of PB-PK models with a knowledge of molecular mechanisms of toxic action has great potential in improving inter-specific extrapolations of toxicity.

Less-than-Lifespan Exposures

At present, the methodology for the derivation of health-based water quality criteria considers studies that involve exposures from weaning to the end of the normal life span to be chronic exposures, and in almost all instances shorter exposures are considered to be subchronic. Subsequently, subchronic toxicity data are extrapolated to chronic conditions by applying an uncertainty factor of 10. However, when McNamarra (1976) explored the relationships of responses to subchronic as compared with chronic exposures, he found many instances where subchronic exposures were more sensitive than chronic exposures in eliciting responses, so that in some instances subchronic exposures elicited responses at dose levels 10 times lower than the chronic exposures required to produce similar responses. This appeared to be in part due to the obscuring effects of aging. Furthermore, laboratory data that involve intermittent exposures are commonly adjusted by time-weighting. The time-weighted average (TWA) is based upon Haber's Rule (Filov et al., 1979),

$$E = k \times C \times t$$

where:

E = a fixed effect.
k = a constant.
C = concentration or dose rate.
t = duration of exposure.

However, this simplistic relationship appears to approximate reality only over small differences in dose rate or duration of exposure. Clearly, while a factor of 10 may produce adequate protection, it lacks the ability to predict.

The Application of Uncertainty Factors in Monte Carlo Simulations

The applicability of the individual uncertainty factors in a protective risk assessment has been adequately justified by Dourson and Starra (1983). However, there has been no logical justification of the present policy for multiplying all identified uncertainty factors. In practice, each uncertainty will have a distribution of its own, and the uncertainties will interact with one another independently, or with various degrees of interdependence. Such relationships are more appropriately dealt with using Monte Carlo simulations or similar processes.

CONCLUSIONS

The present approaches to health-based water quality criteria have arrived at a dead end. Although the list of substances covered may be expanded using the current protective risk assessment methodology, the ability to judge the quality of the assessment, the ability to examine the extent of variability, and our ability to deal with the vagaries of effects due to sensitive subgroups and duration of exposure will elude us. To incorporate the next level of sophistication combined with defensibility for the health-based water quality criteria, it is necessary to surrender the protective risk assessment methodology in favor of a predictive risk assessment methodology that is able to incorporate the uncertainty issues from its inception.

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PUBLIC WATER SUPPLY AS AN INTENDED PROTECTED USE OF WATER RESOURCES: IMPLICATIONS FOR REVISING THE EPA GUIDELINES FOR DERIVING HUMAN HEALTH CRITERIA

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The protection of public water supplies is one of the main purposes of maintaining or restoring the quality of the Nation's waters. Recently, however, the U.S. Environmental Protection Agency (EPA) has issued a proposed National Toxics Rule (NTR), which would establish human health water quality criteria and standards that differ significantly from Safe Drinking Water Act standards. The differences bring into focus whether the proposed criteria fully consider the intended protected use of water resources for public water supplies.

EPA is presently reviewing and updating their guidelines for deriving human health water quality criteria and the underlying risk assessment methodology. From the perspective of water supply agencies, it is important that public water supply uses of water be fully considered in that review. This paper discusses inconsistencies found in the NTR, and the main issues those inconsistencies brought into focus for water suppliers concerning the development of revised guidelines.

BACKGROUND

Water resources have always been judged by their abundance and suitability for intended use. Historically, the availability of water and the uses that could be made of it have determined the areas where people lived and how prosperous those areas could eventually be. Ample fresh water allows for consumption by the residents of the area, and irrigation, transportation, and energy uses. It also provides a source of fish and shellfish, supports wildlife, and allows recreational uses. However, when water resources fail to meet their intended uses--through diversion, drought, overuse, pollution, or other means--economic conditions as well as public health and well-being are put in jeopardy. The intended uses of water are, therefore, key elements to be considered in establishing standards for water quality.

This fact was recognized early in the development of legislation governing water quality. Intended protected uses of water resources have been a part of the Clean Water Act (CWA) since its passage. In various sections, the Act[1] lists intended protected uses, including the following:

- protection of public water supplies,
- protection and propagation of a balanced indigenous population of shellfish, fish, and wildlife,
- protection of recreational activities in and on the water, and
- protection of use for navigation.[2]

The Act also defines water quality standards in terms of protected uses in section 303 (c) as State rules or laws that distinguish the uses of waters and the level of water quality to protect those uses. The U.S. EPA is charged with developing water quality criteria for the States to use in setting standards. In section 304 (a), the Act states that EPA shall develop and publish,

> . . . criteria for water accurately reflecting the latest scientific knowledge (A) on the kind and extent of all identifiable effects on health and welfare including, but not limited to, plankton, fish, shellfish, wildlife, plant life, shorelines, beaches, esthetics, and recreation which may be expected from the presence of pollutants in any body of water. . . .

Clearly, EPA must consider impacts on public water supplies in developing water quality criteria, and, therefore, in the review of human health risk assessment methodology. To consider those impacts, one must understand some of the requirements of the key piece of legislation affecting water suppliers, the Safe Drinking Water Act (SDWA).[3]

To protect drinking water consumers from chemical and microbial contaminants, the SDWA mandates drinking water standards consisting of maximum contaminant level goals (MCLGs) and maximum contaminant levels (MCLs). MCLGs are established at a level where no known or anticipated adverse human health effects occur, and incorporate a margin of safety. MCLGs are not enforceable standards. MCLs are enforceable and set as close to MCLGs as feasible considering factors such as available technologies, treatment techniques, and costs. All MCLGs are developed based on human health effects, and, together with MCLs, are subjected to the regulatory process including opportunity for public comment. Once promulgated, public water suppliers are then responsible for meeting MCLs. Those that do not are subject to civil penalties, public notification, and corrective actions. These sanctions can be imposed by EPA or State agencies, or as a result of citizen suits.

Corrective actions may require capital construction and/or increased operating costs. Most contaminants regulated under the SDWA do not occur naturally in source waters used for drinking water supplies. They are the result of pollution discharge or land use practices of industries and others regulated in whole or in part under other statutes, including the CWA.

NATIONAL TOXICS RULE

The National Toxics Rule,[4] proposed in November 1991 under the CWA, highlighted several areas of concern for water suppliers because of the contaminants involved and the standards proposed. The rule proposed water quality criteria (WQC) for the priority toxic pollutants in those States that had not adopted criteria as required by the CWA. The criteria included specific quantitative levels for protection of aquatic life in fresh and salt water, and for protection of human health considering consumption of water and aquatic organisms, and organisms only. Forty-one of the priority toxic pollutants under the CWA are also regulated under the SDWA. Sixty-one of the contaminants regulated under the SDWA correspond with those subject to required monitoring in National Pollution Discharge Elimination System (NPDES) permits. Water suppliers, therefore, expected levels proposed for the human health water quality standards to be consistent with MCLs promulgated under the SDWA for contaminants regulated under both Acts. This expectation was not realized in every case.

Comparing the NTR and SDWA standards for noncarcinogenic pollutants reveals several cases where the human health water quality standard (WQS) for consumption of water and organisms is less stringent than the corresponding drinking water standard, as shown in Table 1.

Taking one example from the table: 1,1,1-trichloroethane has a drinking water MCL of 200 ppb,[5] while the proposed NTR water and organisms standard is 3,100 ppb--more than 15 times higher. This difference means that point sources of pollution can contribute high levels of 1,1,1-trichloroethane to a public drinking water source--levels that the SDWA regulations do not consider to be protective of public health in drinking water. Public water supply customers will bear the costs of removal of the contaminant to levels that are protective of public health. These costs are more properly borne by the original sources of pollution.

Other NTR standards were also proposed at unexpectedly high levels. The NTR lists 50 ppb for lead as the human health WQS for water and organisms. In developing the National Primary Drinking Water Regulation for Lead and Copper,[6] EPA considered establishing a source water MCL for lead at 5 ppb as the level adequately protective of public health. Although the MCL was dropped in favor of a treatment technique approach, the final lead and copper rule requires States to establish enforceable maximum levels for lead leaving treatment facilities when those levels make a significant contribution to lead levels at consumers' taps. No exact level

Table 1. Comparison of Selected Human Health Water Quality Standards for the Consumption of Water and Organisms from the Proposed National Toxics Rule and the Corresponding Drinking Water Maximum Contaminant Levels (MCLs)

Chemical	Water Quality Standard (μg/L)	Drinking Water MCL (μg/L)
Antimony	14	6
Cadmium	16	5
Nickel	610	100
Selenium	100	50
Silver	105	50
Cyanide	700	200
Ethylbenzene	3100	700
Toluene	6800	1000
1,1,1-Trichloroethane	3100	200
Hexachlorocyclopentadiene	240	50
1,2,4-Trichlorobenzene	not listed	70

is specified, but it appears that EPA, through preamble discussion in the final rule and guidance criteria, is guiding the States toward the 5-ppb level.

It should also be noted that the overwhelming majority of surface water sources presently have lead levels below 5 ppb. Setting the WQS for consumption and organisms at 50 ppb may send the wrong signal to the public, which is appropriately concerned about the health effects of lead, particularly when the continuous concentration criterion for aquatic organisms is proposed at 3.2 ppb. Additionally, the higher standard does not appear to be consistent with the Agency's overall lead control strategy or the ongoing consideration of further lead regulation under the Toxic Substances Control Act.

Chromium provides another example of an unexpectedly high proposed level. The NTR proposes separate human health WQS for water and organisms for chromium III and chromium VI at 33,000 ppb and 170 ppb, respectively. In contrast, the drinking water MCL for total chromium (III and VI) is 100 ppb based on an extensive review of human health criteria. During development of the National Primary Drinking Water Regulation, EPA noted that chromium III is readily oxidized to the more toxic chromium VI by normal drinking water disinfection.[7] A high water and organisms standard for chromium III is not appropriate, therefore, in drinking water sources because of the potential for production of chromium VI in water treatment processes.

IMPLICATIONS FOR HUMAN HEALTH RISK ASSESSMENT METHODOLOGY REVIEW

The problems found in reviewing the National Toxics Rule point to the challenges faced by EPA in coordinating action on the various environmental statutes. The statutes often have significant overlap but specify divergent criteria and approaches. Internal coordination of EPA programs, policies, and priorities within the framework of those statutes is difficult at best. The lack of consistency in these activities, even in areas as closely related as drinking water standards and human health water quality criteria, serves to highlight the extent of these challenges. The quest for consistency has served as one of the driving forces behind the present review of guidelines for deriving human health criteria under the CWA. Consistency between the two sets of standards should, therefore, be a major factor in developing guidelines. Requiring such consistency will ensure that public water supply uses are considered as standards are established.

The lack of consistency concerns water suppliers because they are responsible for protecting public health, and are subject to enforcement and costly corrective actions for MCL violations. When MCLs are not met because the corresponding WQS are less stringent, drinking water consumers are subject to additional costs. As noted earlier, they effectively subsidize industries and other point sources by paying for the removal of contaminants that do not occur naturally in source waters. Human health WQS for water and organisms should generally be set below corresponding drinking water standards to prevent this type of inequity. The level chosen for such standards should contain an appropriate safety factor so that slight variations in contaminant levels will not cause water systems to violate MCLs.

The major implication of the problems found within the NTR is that a review of the human health criteria for water quality criteria is appropriate. Throughout this discussion, comparison has been made between MCLs and such standards. This does not imply that the methodology used to develop human health risk assessments for drinking water is any better or worse than that used in WQC development. Both methodologies can and should be improved, and continue to evolve based on advances in scientific knowledge and capabilities. The improvement and evolution of each should go hand in hand with the other because of their close relationship and the need for consistency.

The NTR excluded organoleptic (taste and odor) criteria from consideration in establishing water quality standards. The reason given is that organoleptic effects are not toxic effects, so their consideration is unnecessary. The NTR (1991) noted, however, that organoleptic effects cause:

> . . . taste and odor problems in drinking water which may increase treatment costs or the selection by the public of alternative but less protective sources of drinking water; and may cause tainting and off flavors in fish flesh and other edible aquatic life reducing their marketability, thus reducing the recreational and resource value of the water. . . .

Organoleptic effects can, therefore, pose a severe threat to the intended uses of water. Disregarding such effects is not compatible with the intent of the CWA. There is nothing within the CWA which limits the consideration of criteria for the priority toxic pollutants to toxic effects. For those few contaminants where organoleptic criteria may prove more stringent than human health or aquatic organism criteria, they should take precedence to ensure that intended uses are met. The phenols deserve special attention because chlorophenols formed during drinking water chlorination can cause off-flavor problems that can be very costly to correct.

SUMMARY

The preceding discussion can be summarized in four statements that highlight the concerns of water suppliers in the revision of the EPA guidelines for deriving human health criteria:

- Human health water quality criteria should be consistent with drinking water standards.
- Human health water quality standards for consumption of water and organisms should generally be more stringent than corresponding drinking water standards.
- The risk assessment methodologies for both human health water quality criteria and drinking water standards should incorporate current scientific capabilities and knowledge. They should be consistent with each other and evolve together.
- Consideration of organoleptic criteria should be included in the development of human health water quality criteria where appropriate.

Major portions of these issues fall more in the area of policy or risk management than risk assessment. From a practical point of view, whether or not they are included specifically in the human health risk assessment methodology is not critical. It is critical, however, that they be part of the overall guidelines or framework for deriving human health criteria. Coordination of clean water and drinking water programs, policies, criteria, and standards is essential so the intended benefits of both programs can be realized.

The Association of Metropolitan Water Agencies is made up of the directors and managers of 90 of the Nation's largest cities and metropolitan areas serving more than 78 million drinking water consumers. The association's formal positions on regulatory actions undertaken by EPA pursuant to the Clean Water Act are evolving as the impacts of these actions on metropolitan water suppliers are evaluated. This paper reflects a combination of personal views and preliminary thoughts of members of the association on the issues involved in human health criteria for water quality standards.

FOOTNOTES

1. Federal Water Pollution Control Act Amendments (Clean Water Act), P.L. 92-500, October 18, 1972.

2. Water Quality Act (Clean Water Act), P.L. 100-4, February 4, 1987.

3. Safe Drinking Water Act, P.L. 99-339, June 19, 1986.

4. Amendments to the Water Quality Criteria for Toxic Pollutants Necessary To Bring All States Into Compliance with Section 303(c)(2)(B) (National Toxics Rule), Federal Register, November 19, 1991 (56 FR 58420).

5. National Primary Drinking Water Regulation: Volatile Synthetic Organic Chemicals; Final Rule, Federal Register, July 8, 1987 (52 FR 23690).

6. National Primary Drinking Water Regulation: Lead and Copper; Final Rule, Federal Register, June 7, 1991 (56 FR 26460).

7. National Primary Drinking Water Regulation: Synthetic Organic and Inorganic Chemicals; Final Rule, Federal Register, January 30, 1991 (56 FR 3526).

HUMAN HEALTH RISK ASSESSMENT AND WATER QUALITY CRITERIA FOR TOXIC POLLUTANTS

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INTRODUCTION

Human health criteria define the maximum concentration of individual toxicants in surface waters that should not result in adverse effects to individuals exposed to those toxicants through consumption of contaminated fish and other aquatic organisms, and through consumption of contaminated drinking water. Criteria are developed for toxicants with two types of response curves--nonthreshold and threshold. The nonthreshold response is traditionally associated with chemicals that are classified as carcinogens while the systemic effects of noncarcinogenic chemicals are considered to occur in a threshold manner.

The Human Cancer Criterion (HCC) is derived for substances that are known, probable, or possible carcinogens using the U.S. EPA's standard risk assessment techniques (Federal Register, 1986). Human Cancer Criteria are numbers used to define maximum acceptable concentrations in surface waters of nonthreshold acting toxicants. The HCC is intended to protect humans from an unreasonable incremental risk of developing cancer resulting from contact with, or ingestion of, surface waters and from ingestion of aquatic organisms taken from surface waters.

The Human Threshold Criterion (HTC), sometimes called the Human Noncarcinogen Criterion, is intended to protect humans from adverse effects resulting from contact with noncarcinogenic substances through ingestion of surface waters and through ingestion of aquatic organisms from surface waters. The HTC is derived for toxic substances for which a clear threshold dose or concentration is displayed.

The basis for development of both Human Cancer and Human Threshold Criteria is the potency of specific chemicals. Potency for carcinogens is reflected in the slope factor (q_1^*) and in the Reference Dose (RfD) for threshold toxicants (noncarcinogens). Derivation and use of the q_1^* (NAS, 1983; Anderson et al., 1983) and the RfD (Barnes and Dourson, 1988) have been described extensively in the literature.

Human health criteria are not used directly to control the discharge of toxic substances to surface waters. Rather, they are utilized in the development of effluent limits for toxic pollutants that are discharged from point sources. Criteria are also used to determine whether a surface water system has attained applicable Water Quality Standards, and to regulate other (e.g., nonpoint) sources of toxic pollutants to surface waters. In this paper, I discuss the risk-based approach to development of human health criteria as well as the application of criteria in programs to regulate toxicants in surface waters.

RISK ASSESSMENT AND HUMAN HEALTH CRITERIA

Much discussion and criticism of traditional risk assessment methodologies, particularly for carcinogens, has occurred (see for example Ames and Gold, 1987; Ames and Gold, 1990; and Finkel, 1990). At the center of the controversy for predicting human risk and effects associated with exposure to toxic chemicals is the lack of human epidemiologic evidence for most chemicals. A human dose-response relationship is usually derived, when epidemiologic data are lacking, from laboratory studies conducted at relatively high doses on rodent species. The dose-response relationship determined from these studies is then used to develop estimates of potency for carcinogens (q_1^*) and for noncarcinogens (RfD) at low human doses or exposures.

The result of the uncertainty associated with derivation of the q_1^* and the RfD based on a NOAEL to predict human risk may be error about the risk estimate of one or more orders of magnitude. However, whether this error underestimates or overestimates true risk is unclear. What is clear is that considerable discussion of the error about the dose-response curves, particularly for carcinogens, has occurred without commensurate discussion of the other factors that are used to calculate human health criteria. The remainder of this section of the paper discusses the factors, other than those associated with chemical potency, that are used in the derivation of human cancer and human noncancer criteria.

Risk Levels, Exposure Assumptions, and Other Factors Used To Derive Human Health Criteria

The U.S. EPA develops cancer criteria to protect adults who weigh approximately 70 kg, consume two liters of water per day, and consume 6.5 grams of fish per day. The Agency does not, however, choose an acceptable risk level to calculate the cancer criterion but rather allows States to adopt criteria associated with the risk level of their choice (Federal Register, 1980).

The choice of a cancer risk level in the development of the HCC is a purely nonscientific issue. The basis for the choice may be public opinion, economic impact, or political expediency but a scientific basis cannot be invoked to support such a choice. Acceptable cancer risk levels generally range between 1 x 10^{-4} to 1 x 10^{-6} (Bailar, 1990). States in the Great Lakes Basin have chosen acceptable risk levels that range from 1 x 10^{4} to 1 x 10^{6} to calculate state-specific human cancer criteria (Foran, 1990). The U.S. EPA takes regulatory action (e.g., for Superfund cleanups) when cancer risks are greater than 1 x 10^{-4} and usually does not take regulatory action when cancer risks are less than 1 x 10^{-6} (Travis et al., 1987).

The choice of the cancer risk level has an important impact on derived human cancer criteria. Since cancer risk levels chosen to develop Water Quality Criteria may vary by one or more orders of magnitude, criteria resulting from the use of different risk levels will also vary by at least one order of magnitude. Yet, the choice of a cancer risk level is only one of several considerations in the regulatory process that will affect the development of the HCC as well as the human threshold criterion.

U.S. EPA's Technical Support Document (U.S. EPA, 1991) states that more than one fish consumption rate may be appropriate for use, depending on the population to be protected, in calculating human health criteria. However, the U.S. EPA uses a fish consumption rate of 6.5 grams/day to estimate average consumption of fish and shellfish from estuarine and fresh waters by the entire U.S. population. It is this consumption rate that is utilized to derive national human health criteria.

The choice of a 6.5 g/day fish consumption rate was based on a survey of average fish consumption in the U.S. population in the 1970s (Rupp et al., 1980). This rate represents a one-half pound meal of fish once every five weeks. During the 1980s, the popularity of fish as an important, healthy source of protein increased substantially. For example, the Institute of Medicine reports in its text *Seafood Safety* (IOM, 1991) that the average individual consumption of fish and shellfish in the United States totaled nearly 20 g/day (one 1/3-pound meal per week) in 1989. However, a new fish consumption rate for the U.S. population has not been adopted to reflect the increased popularity of fish and shellfish and to address the potential increase in exposure to toxicants contained in fish and shellfish.

The EPA does recognize that some individuals may consume significantly greater quantities of fish than the general U.S. population. For example, residents of the Great Lakes Basin may consume several meals of fish weekly due to the availability of a vibrant sport fishery. Few data are available to accurately estimate the quantities of fish consumed by Great Lakes residents. Some States in the Great Lakes Basin have adopted consumption rates as high as 30 g/day to derive human health criteria to reflect the potential for increased consumption of Great Lakes sport fish (Foran, 1990), although many States still use 6.5 grams/day to develop human health criteria.

The use of a 70-kg human weight and water intake of 2 L/day in the derivation of human health criteria is designed to represent average adult weight and water consumption. Thus, criteria are developed to be protective of adults. Children also ingest fish and drinking water from surface water systems although the U.S. EPA does not recommend criteria development that recognizes exposure to children. When the average weight and the average water intake are modified to represent younger individuals, resultant criteria are considerably more restrictive.

Development of human health criteria also includes consideration of the accumulation of toxic chemicals in tissues of aquatic biota. These concentrations may be several orders of magnitude higher than concentrations of the toxicant in surrounding surface waters. For example, a number of fish species in the Great Lakes Basin have accumulated toxic chemicals in their tissues to levels that have prompted States surrounding the Great Lakes to issue consumption advisories that warn individuals to reduce or eliminate the consumption of some highly contaminated species.

The relationship between log BCF and log K_{ow} (Veith and Kosian, 1983) has been used by most State and Federal agencies to regulate the concentrations of bioconcentratable pollutants in surface waters. However, prediction of BCF from log K_{ow} may be relatively poor when log K_{ow} is greater that 6.0. The relationship between log K_{ow} and BCF also does not account for the accumulation of chemicals in tissues via biomagnification or uptake through the food chain. Biomagnification may play a considerable role in determining the concentration of a chemical in tissues of aquatic biota. For example, Thomann and Connolly (1984) suggested that more than 99 percent of the observed concentration of PCB (Log K_{ow} = 6.4 to 6.8) in Lake Michigan lake trout resulted from exposure through the food chain. Use of the octanol-water partition coefficient to predict lake trout tissue concentration underestimated observed concentrations by a factor of 4. In this case, consideration of only bioconcentration in calculating human health criteria would underestimate total accumulation of a chemical in tissues of aquatic biota.

Recommendations have been made for the use of a food chain multiplier (FM) to account for bioaccumulation of chemicals in tissues of aquatic biota. However, most States have not used a food chain multiplier or other adjustment factor to account for food chain uptake of toxic chemicals. Rather, most States rely solely on the BCF to predict the accumulation potential of chemicals in aquatic biota and to generate human cancer and human threshold criteria.

The choice of fish consumption rate, human weight, and bioaccumulation factor has a profound effect on development of the human health criteria. Fish consumption rates ranging from 6.5 grams/day to 180 grams/day (several meals per week) will change criteria by a factor of up to 28 when all other factors are held constant. Further, a derived criterion for chlordane (a carcinogen) calculated for a 15-kg individual ingesting one-half liter of water per day is 4 times more restrictive than the criterion calculated using the adult weight and water consumption rate. And the use of a BCF without a food chain multiplier results in Water Quality Criteria that may be up to 100 times less stringent depending on chemical and food chain characteristics (U.S. EPA, 1991).

The choice of combinations of these factors has an effect on the final Water Quality Criterion that is much more profound than effects elicited by these factors individually. In the chlordane example, the choice of the least conservative risk levels and exposure factors (weight, water intake, and fish consumption) results in a criterion that is nearly four orders of magnitude greater than a criterion resulting from use of the most restrictive risk levels and exposure factors (Table 1).

Table 1. Human health criteria for chlordane (in μg/L).

GRAMS FISH/DAY	HUMAN WEIGHT (KG)	RISK LEVEL		
		10^{-4}	10^{-5}	10^{-6}
6.5	70	0.20	0.02	0.002
	15	0.05	0.005	0.0005
20.0	70	0.07	0.007	0.0007
	15	0.015	0.0015	0.00015
90.0	70	0.016	0.0016	0.00016
	15	0.003	0.0003	0.00003
180.0	70	0.008	0.0008	0.00008
	15	0.002	0.0002	0.00002

q*1 = 1.3/mg/kg/day
BCF = 3804

Another important consideration in criterion derivation is exposure to chemical toxicants through routes other than drinking water and fish consumption. In many cases, data are not available to quantify human, nonsurface water-related exposures to toxic substances on a State or regional basis. However, two States in the Great Lakes Basin use default values for nonsurface water-related exposures. Minnesota uses a default value of 0.2 (called a Relative Source Contribution - RSC) to adjust the HTC to account for nonsurface water exposures. Wisconsin uses an Exposure Adjustment Factor (EAF) of 0.8 to modify the HTC to account for nonsurface water exposures; thus, Wisconsin assumes that 20 percent, and Minnesota assumes that 80 percent, of human exposure to individual toxicants is derived from nonsurface water sources. Both States use the adjustment values only when data are not available to address actual, nonsurface water exposures.

Finally, concurrent exposure to more than one contaminant must be incorporated into criterion development. Human health criteria generally address human exposure only to individual chemicals. In many, if not most, cases, surface waters and aquatic biota contain a multitude of toxic pollutants. For example, the U.S. Fish and Wildlife Service has identified more than 400 different chemicals in Great Lakes sport fish (Passino and Smith, 1987). Concurrent exposure to more than one toxicant requires some consideration of the cumulative risk associated with exposure to multiple contaminants. The U.S. EPA (1991) has suggested that, for carcinogens, risks should be considered to be additive, although this consideration is generally not incorporated into criterion derivation.

Use of the additivity concept in criterion development reduces allowable concentrations of individual carcinogens in surface water well below levels allowed when criteria are based on risks or effects associated with exposure to individual toxicants only. For example, a cancer criterion for each of two equally potent, co-occurring carcinogens would be half the HCC for each of the chemicals should they occur alone.

APPLICATION OF HUMAN HEALTH CRITERIA

Criterion development is only one step in the regulation of toxic pollutants in surface waters. A host of non-health-based factors, which contribute to the variability in the pollutant regulatory process, are introduced through the application of human health criteria in the regulation of sources of toxic pollutants. Therefore, the application of human health criteria must also be included in any discussion of the adequacy of criteria to protect human health from the impacts of toxic pollutants in surface waters.

Human health criteria do not, by themselves, define the mass or concentration of pollutants that may be discharged from industries, agricultural activities, urban areas, and many other sources of toxic pollutants. Rather, the amount of a pollutant that can be discharged to a water body is calculated so that the concentration of the pollutant will meet human health and other criteria after mixing with the receiving water. The quantity of a pollutant that can be discharged from a point source to a receiving water body is determined by the quantity of pollutant that can be assimilated by the water body as well as by the quantity of pollutant that already exists in the water body.

A receiving water's assimilative capacity is defined operationally by the total maximum daily load (TMDL) or the mass of a pollutant which can be discharged into a surface water without exceeding ambient Water Quality Criteria or otherwise violating Water Quality

Standards; that is, by the ability of the surface water to dilute a toxicant to levels that meet WQC. The portion of the TMDL available for allocation among point sources is called the wasteload allocation (WLA).

Water quality-based effluent limits (WQBEL) for toxic pollutants, incorporated in NPDES permits, are determined by the wasteload allocation. The goal of the WLA is to prevent a pollutant discharged from a point source from reaching an instream concentration that will exceed any numeric Water Quality Criterion or otherwise violate a State's Water Quality Standards. The wasteload allocation is developed based on the maximum concentrations of toxicants allowed in surface waters determined by numeric Water Quality Criteria, the amount of dilution provided by a receiving water, and other factors including analytical detection capabilities, the source of intake water, the co-occurrence of other toxic pollutants in the effluent, background concentrations of toxic pollutants, and variability of toxicant concentrations in effluents.

Analysis of wasteload allocation procedures utilized by the States in the Great Lakes Basin indicates that the quantities (loads) of pollutants discharged from point sources vary dramatically between states (Figure 1). This variation is due only in part to differences between human health criteria. Differences in the wasteload allocation processes are also critical in determining how much of a pollutant can be discharged to a surface water system. For example, most of the States in the Great Lakes Basin use relatively similar numeric WQC for lead (with the exception of Illinois - Figure 1). The result of use of a less stringent criterion to regulate point sources of lead in Illinois is, of course, substantially elevated lead discharges (loads) to surface waters. However, substantial variation also exists between States with similar lead criteria due to the choice of dilution capacity utilized in the calculation of the WLA for lead. Use of different dilution flows in the WLA by States with similar criteria results in substantial differences in the allowable loads of lead that can be discharged from a point source to surface waters.

The control of pollutants discharged from point sources can be affected further, without changes in numeric criteria, when the water quality-based effluent limit for a toxicant is below the method detection limit for that toxicant. Some State policies to address this problem result in the discharge of extremely large loads of pollutants. For example, if the concentration of PCB in an industrial discharge is at or near the detection level used for compliance purposes by Wisconsin (0.6 μg/L), the load of PCB discharged by this facility will be approximately 50 times greater (54 kg/year) than the PCB load discharged in the effluent with a PCB concentration that meets the Water Quality-Based Effluent Limit (1 kg/year). The PCB load in the same effluent will be over 7,000 times greater than the PCB load discharged in an effluent where the concentration meets the human health criterion at the point of discharge (0.007 kg/year, Table 2). Even discharges at the detection level used in most Great Lakes States, or at half this detection level, result in annual loads over 800 times and 400 times larger, respectively, than the load resulting from an effluent with a PCB concentration set at the EPA Water Quality

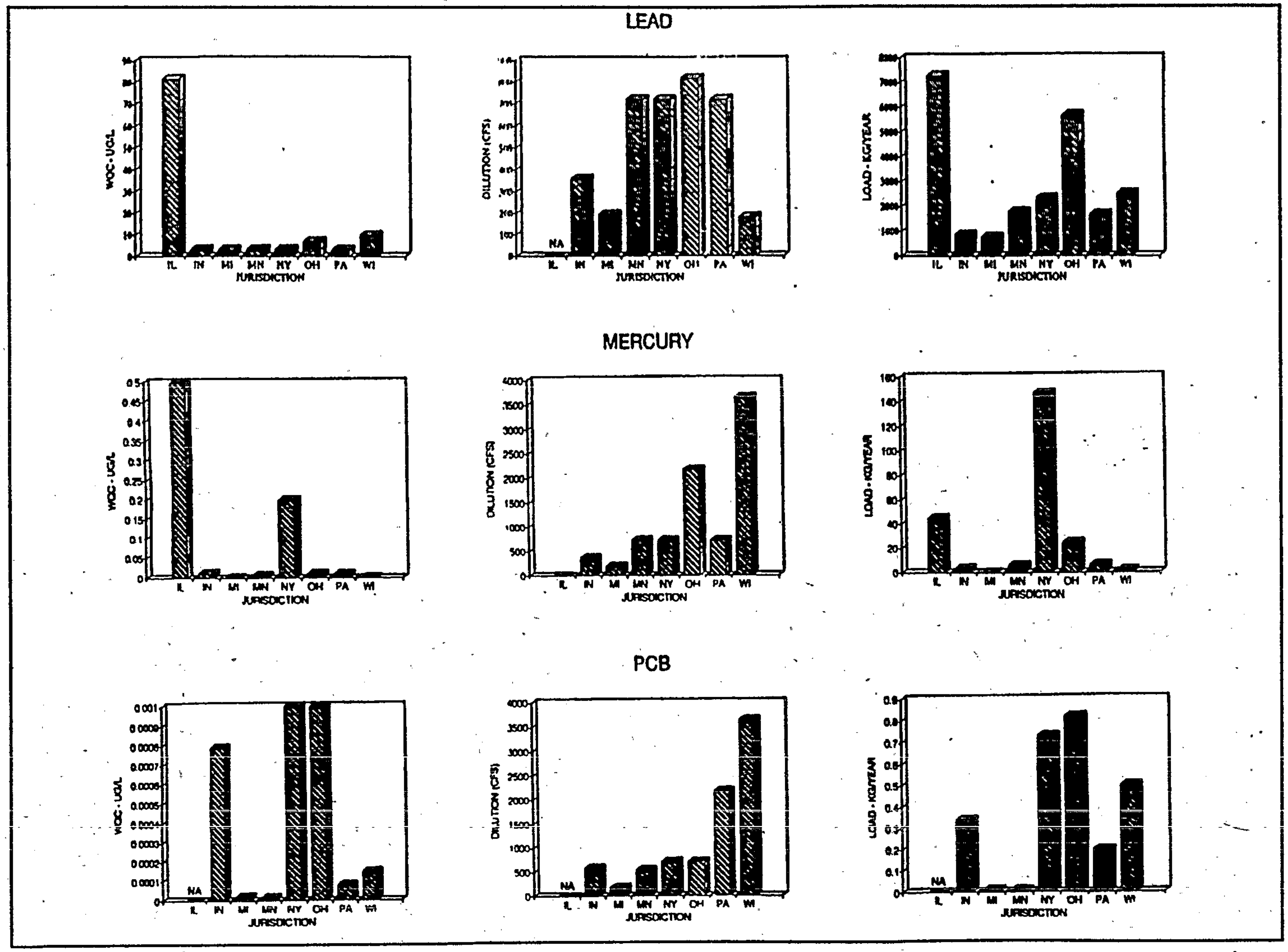


Figure 1. State-specific Water Quality Criteria (WQC - first graph) and dilution flows (second graph) used to calculate annual loads (third graph) of three pollutants (lead, mercury, and PCB) discharged by a hypothetical industry with an effluent flow of 100 CFS. Wasteload allocation and dilution flows are specific to criteria in the first graph (see Foran, 1992, for a description of the use of numeric criteria and dilution in the calculation of the WLA). NA indicates that a State does not have a WQC for that substance.

Table 2. Loads of PCB resulting from an effluent limited by various analytical detection levels used in the Great Lakes States.

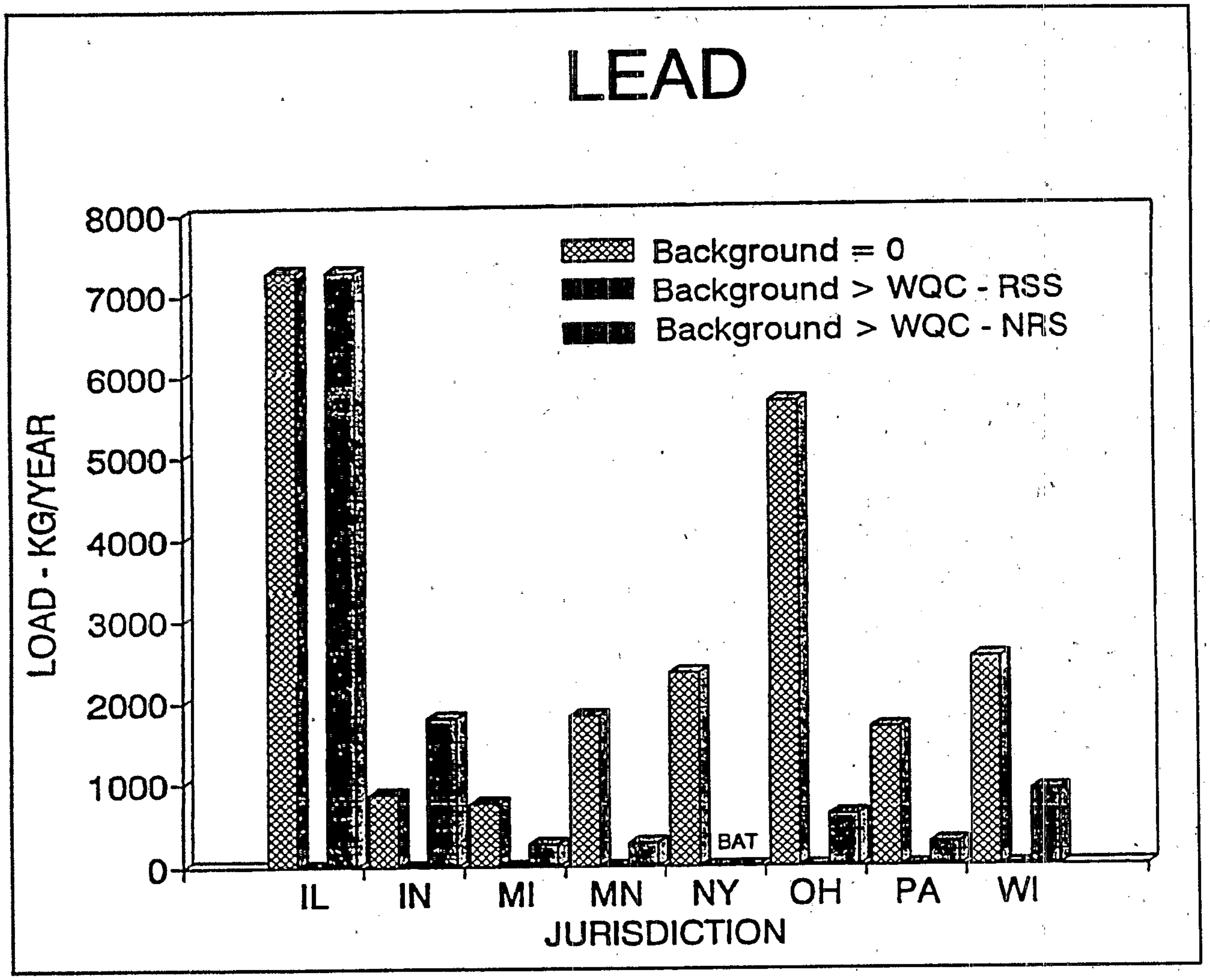
EFFLUENT CONCENTRATION (μg/L)	LOAD (KG/YEAR)	LOAD (POUNDS/YEAR)
0.6 (LOQ used by WI)	53.6	118.2
0.2 (LOD used by MN)	17.9	39.5
0.1 (LOD used by IL, IN, MI, OH, PA)	8.9	19.6
0.065 (LOD used by NY)	5.8	12.8
0.000079 (EPA WQC)	0.007	0.02

Criterion. These differences can occur even where States adopt and utilize identical human health criteria for PCBs.

Background concentrations of a pollutant usually result in a reduction in the load of pollutant that can be allocated to point source dischargers. However, when background concentrations are above numeric Water Quality Criteria, States alter their discharge regulations and, in some cases, allow elevated loads of pollutants to be discharged to an already polluted receiving water. For example, the outcome of State policies on elevated background concentrations, expressed as the load of pollutant discharged from a hypothetical industry, is shown for lead in Figure 2. For this analysis, the background concentration for lead was assumed to be two times the least stringent criterion in the Great Lakes States.

The load discharged to the receiving stream from a point source, where the background concentration is zero, is calculated using the standard WLA derivation procedures and is represented by the hatched bars in Figure 2. The net load to the receiving stream discharged where the background concentration is two times greater than the criterion, and where the

Figure 2. Annual load of lead discharged by a hypothetical industry with an effluent flow of 100 CFS and stream background concentrations set at 2x the least stringent State chronic criterion. Loads are calculated by employing each State's policy to address background concentrations in the derivation of the WQBEL for three situations: (1) Background concentration = 0; (2) Background concentration > WQC and the intake water is drawn from the receiving stream - RSS, and; (3) Background concentration > WQC and the intake water is drawn from a non-receiving stream source - NRS. See Foran, 1992, for a full description of calculation procedures.



receiving stream serves as the water source for the discharger, is indicated by the black bars. In this case, States in the Great Lakes Basin do not allow any net increase in the load discharged to the receiving stream. That is, point sources may discharge only as much pollutant as they take in from the water source; thus the black bars (or their absence) indicate no net increase in the load to the receiving stream. However, the load discharged by a point source to the receiving stream when the intake water is from a nonreceiving stream source (NRS), and where the background concentration of the pollutant in the receiving stream is two times greater than the criterion, is indicated by the gray bars in Figure 2. In this case, the bars indicate the increase in the load to the receiving stream above and beyond the pollutants already in the receiving stream. This example demonstrates that the discharge of substantial pollutant loads to an already polluted surface water system can result from the choice of policy decisions associated with WLA development, without any interstate differences in human health criteria.

DISCUSSION

The adequacy of existing risk assessment techniques, particularly for carcinogens, has dominated discussions of how such substances should be regulated. Generation of a potency factor (q_1^*) for carcinogens based on the linearized multistage model has caused considerable concern, particularly for substances that may act through something other than a nonthreshold mechanism (Roberts, 1991). The method to assess and regulate the risks of exposure to threshold acting toxicants, through the development of a RfD, has also been criticized (Goldstein, 1990).

The choice of risk level as well as the multitude of exposure factors used in the calculation of human health criteria can result in differences of nearly four orders of magnitude in derived criteria. Choices related to the bioconcentration factor (BCF) and use of a food-chain multiplier (FM), and concurrent exposure to more than one toxicant will influence the criteria further, perhaps by as much as three orders of magnitude. Criteria will be further reduced where regulatory agencies consider concurrent exposure to more than one contaminant and nonsurface water exposure routes.

A comprehensive evaluation of the impacts on human health of the regulatory process for toxic pollutants requires an understanding not only of how criteria are developed, but of the relationship between human health criteria, the wasteload allocation and its many components, and other mechanisms that influence the control of pollutants that derive from point and nonpoint sources. For example, examination of human health criteria in the Great Lakes Basin demonstrates the substantial variation that exists between State criteria for pollutants such as TCDD (dioxin), TCDF, PCB, mercury, and lead (Table 3). However, such a comparison does not provide any indication of the loads of pollutants that may be discharged from point sources to surface.

CHEMICAL	STATE							
	Illinois	Indiana	Michigan	Minnesota	New York	Pennsylvania	Ohio	Wisconsin
TCDD	NA	1.0*E^{-7} (HT)	NA	NA	2.0*E^{-7} (HC)	1.0*E^{-8} (HC)	1.4*E^{-7} (HC)	3.0*E^{-8} (HC)
TCDF	NA	NA	NA	NA	50.0**	NA	NA	NA
PCB (TOT)	NA	7.9*E^{-4} (HC)	2.0*E^{-5} (HC)	1.4*E^{-5} (HC)	1.0*E^{-2} (HC)	8.0*E^{-5} (HC)	7.9*E^{-4} (HC)	1.5*E^{-4} (HC)
Mercury	NA	0.14 (HT)	6.0*E^{-3} (HT)	6.9*E^{-3} (HT)	2.0 (HT)@	0.144 (HT)	1.2*E^{-2} (HT)	7.9*$E^{-2)}$ (HT)
Lead	50.0@	50.0@	9,400 (HT)	NA	50.0@	50.0 (HT)	50.0 (HT)@	50.0 (HT)

Table 3. Human health criteria used by the Great Lakes States (μg/L).

A comparison of both numeric WQC and the processes used to apply numeric WQC in the regulation of point sources through the WLA must be conducted to understand completely how regulatory actions control the discharge of toxic pollutants to surface waters. Such a comparison confirms that existing approaches to the regulation of point sources of toxic pollutants result, in many cases, in the discharge of extremely large loads of persistent pollutants, often to systems that are already polluted with these same toxicants.

A call for better (more scientifically justifiable?) risk assessment procedures, and incorporation of those procedures in the derivation of human health criteria, is laudable. However, such efforts will not necessarily result in adequate protection of human health, even where criteria are more stringent. The entire regulatory process from criterion development to source control must be considered as a package.

Traditional emphasis on end-of-pipe regulation for point sources, via reliance on human health and other numeric criteria, has not eliminated discharges of toxic pollutants to surface waters, particularly for those that are persistent and bioaccumulative. Nor has the existing point source regulation process eliminated the impacts of persistent toxic pollutants in surface water ecosystems. The ability of the end-of-pipe control process to achieve zero discharge is limited by analytical detection capabilities and treatment technology. Further, the existing regulatory process, which is based on human health and other criteria and on a recognition that receiving waters provide dilution for toxic wastes, does not force continuing reductions in the mass and concentrations of toxic substances in effluents. That is, the process does not force continuing progress toward zero discharge--the goal of the Clean Water Act and of the Great Lakes Water Quality Agreement.

Achievement of zero discharge of toxic substances requires a new approach to pollutant control. Such an approach is being developed, at least conceptually, and relies on control of pollutants at their source rather than at the point of discharge. Source reduction, source control, toxicant use reductions, or pollution prevention approaches have been incorporated into a few State and Federal statutes including the Federal Pollution Prevention Act of 1990 (42 U.S.C. Sections 13101 et seq.), the Massachusetts Toxics Use Reduction Act of 1989 (Chapter 265), and the New Jersey Pollution Prevention Act of 1991 (P.L. 1983, c. 315). A pollution prevention approach to water quality protection and to the regulation of toxic pollutants in surface waters has also been called for by the U.S. GAO (1991).

The basis for pollution prevention and source reduction is a net reduction of toxic pollutants discharged to surface waters (and ultimately all media) through reduction of the use of the chemical. Use reductions may be accomplished through industrial process changes, which include more efficient chemical use, chemical substitutions, and recycling. Or reduction may be accomplished through chemical bans or phase-outs, product changes or bans, and behavior changes which affect product consumption or use.

Reduction strategies as well as the source reduction concept should result in the reduction of waste production and reduction of releases to surface waters and other environmental media. As such, the concept will be effective in reducing discharges of toxic pollutants below levels which can be accomplished by waste treatment processes alone, and below those that may be limited by declaration of safe toxicant levels defined by human health and other criteria. Ultimately, where a chemical is eliminated from use in a process or product via substitution, process change, or other mechanisms, the discharge of that chemical will also be eliminated; thus, the zero discharge goal of the CWA will have been met without argument about the scientific justifiability of human health criteria or about analytical detection capabilities, how much (if any) dilution should be used to calculate the WLA, or implementation of increasingly expensive treatment technologies.

As the Clean Water Act is reauthorized during 1992 and 1993, the opportunity is presented to incorporate pollution prevention and toxicant use reduction concepts into the statute. This opportunity should be seized, bypassing comparatively trivial discussions associated with how to modify risk-based human health criteria as well as bypassing expenditure of immense resources devoted to those discussions. Gains in environmental improvement will occur much more rapidly, and perhaps less expensively, if we cease our attempts to define more and more precisely acceptable toxicant concentrations in surface waters and get to the business of achieving zero discharge of toxic pollutants.

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WQS for Ephemeral and Effluent-Dependent Streams

WATER QUALITY STANDARDS FOR EPHEMERAL AND EFFLUENT-DEPENDENT STREAMS

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PROBLEM STATEMENT: HOW TO STRIKE THE BALANCE IN THE ARID WEST BETWEEN PROTECTION OF DESIGNATED USES, PRESERVATION OF AQUATIC AND RIPARIAN HABITATS, AND THE BENEFITS OF WATER RECLAMATION

Appropriateness and Feasibility of Meeting Toxic Standards

All States are required to adopt new toxic standards to comply with a 1987 CWA amendment.

Western states feel they face special challenges to meeting toxic standards because of low dilution and waterbody types.

Dischargers argue that EPA's approach to water quality standards is costly, inappropriate when applied to effluent-dependent streams, and offers little environmental benefit to the waterbodies.

Unintended Effects of Standards on Instream Flows and Wastewater Reclamation

Adoption of water quality standards may have unintended environmental impacts such as drying up wetlands or riparian areas that are dependent upon municipal effluent discharges. If EPA requires strict standards to be met, municipalities may find it more economical to sell the treated effluent rather than upgrade sewage treatment plants.

High treatment costs may also discourage reclamation projects that require some discharge to the stream. In arid West, water reclamation is an effective way of augmenting the otherwise scarce water resources.

Protection of Ecological Values and Instream Flows

Many of West's water bodies are ephemeral and support aquatic uses in the stream for only a few weeks of the year.

In many cases in the arid West, the riparian habitats are more diverse and ecologically "valuable" than in-stream aquatic life.

Environmental groups criticize EPA's approach for failing to protect in-stream flows and other ecological values. Requested a need to broaden scope of water quality regulation to allow protection of valuable ecosystems and in-stream flows.

DOES THE CLEAN WATER ACT DEAL EFFECTIVELY WITH EFFLUENT DOMINATED, EPHEMERAL AND INTERMITTENT STREAMS?

Current Regulations Offer Flexibility

EPA's general policy is that water quality should be adequate to support designated uses whenever there is water in the stream.

Existing flexibility within current regulations including site-specific standards and use-attainability provisions addresses ephemeral/effluent-dependent streams:

EPA's metals guidance allows a "translator mechanism" for metals.

States have option of tailoring standards to local water quality conditions using site-specific standards. Arizona recently adopted alternate standards for ephemeral streams based on resident species.

High treatment costs can be addressed through the use attainability provision. If meeting standards will cause "widespread and substantial social and economic impact," standards may be adjusted.

EPA Region 9's Guidance Specifically Addresses Arid West Water Quality Issues

"Net Ecological Benefit" recognizes and considers standards implications on instream flow.

Guidance identifies how social and environmental benefits of wastewater reclamation may be considered with standards.

Identifies flexibility in regulations in order to streamline the standards process.

Establishes framework that allows states and local governments to make decisions about water quality standards, preserving valuable habitats, and water reclamation.

FUTURE STEPS

States Should Further Integrate Water Quality and Ecological Concerns

Western water law does not protect riparian corridors

Water quality and ecological concerns should be integrated into water appropriations systems.

Flow standards, in-stream appropriations, public trust, and water marketing are tools that States can use to preserve in-stream flows.

Solutions to flow related environmental problems should be tailored to each state's legal, institutional and political composition.

EPA Should Assist States to Develop Methodology for Arid West

Biological studies of species present in arid areas.

EPA can offer technical support to review/develop the scientific methodology for arid ecosystem criteria.

To better integrate water quality, economic, and ecological concerns, EPA can help implement a "watershed approach".

Additional Issues to Consider

Need to assess the future responsibility of maintaining flow to support the riparian habitats; particularly habitats that support threatened and endangered species.

Need to consider the benefits of creating a new riparian habitat versus benefit of maintaining an existing one.

CASE STUDIES OF EFFLUENT-DEPENDENT WATERS

Phoenix: Existing Discharge

- Existing Discharge of 200 mgd to Salt Gila River;
- Supports 6 mile reach of riparian habitat including endangered species;
- Proposing total water reuse/reclamation;
- Environmentalists concerned about habitat loss;
- Pollutants of concern are ammonia, metals, phenol

Eastern Municipal Water District: Proposed Discharge

- Existing reclamation facility; proposing new discharge of 15 mgd to accommodate urban growth;
- Santa Margarita River; free flowing river in Southern California;
- Provides valuable riparian habitat and supports endangered species;
- Santa Margarita River is primary groundwater recharge source for the basin;
- Pollutants: TDS, nutrients, freshwater flow to estuary

SPECIAL WATER QUALITY CRITERIA AND STANDARDS ARE NEEDED FOR ARID AREAS

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INTRODUCTION

As director of a major municipal wastewater utility, much of my time and effort is spent in meeting the requirements of the Clean Water Act.[1] The Act dictates that upon discharge into the waters of the United States, effluent must meet the limits of our facilities' discharge permits, and that industrial discharges to the treatment facilities must be regulated, all while generating sufficient financial resources to efficiently operate and maintain the sanitary sewer system. Additionally, operation and maintenance costs must be recovered through the assessment of user fees that are equitable and, according to my Board, affordable by the community. It is a formidable task anywhere, but in the arid west we face some particularly unique challenges in implementing the directives of the Act.

CRITERIA DOCUMENTS FOR DIVERSE ECOSYSTEMS

The United States has a variety of aquatic and nonaquatic ecosystems. The coastal regions have marine systems, the Great Lakes area has its own unique aquatic ecosystem, and wetland ecosystems support a wide array of terrestrial and aquatic species. Each of these ecosystems has specific criteria documents either established or in the process of being developed. In 1986, water quality criteria for aquatic habitats and marine ecosystems were published by EPA.[2] These are commonly known as the Gold Book criteria. In 1990, EPA published a guidance manual for wetlands.[3] A joint State and Federal effort is now under way to develop water quality criteria for the Great Lakes region.

Although there have been proposals to address ephemeral streams, which are typical of arid regions, there are no substantiated water quality criteria documents for such ecosystems. EPA Region 9, working with several western water and wastewater agencies, has developed an "interim final" guidance document for modifying water quality standards and protecting effluent-dependent ecosystems.[4] The guidance is a notable effort at addressing the unique water quality conditions found in the arid west and could be beneficial in modifying a designated use, adjusting Total Maximum Daily Load Allocations for a particular permit limit, or developing alternative criteria for a particular stream segment. The Region 9 Guidance primarily focuses on the use attainability process. This process allows the study of only one stream or small ecosystem. Its findings cannot be applied regionally in the arid west.

In June, the Western Governors' Association passed a resolution supporting the development of water quality criteria for ephemeral waterways and effluent-supported waters.[5] The Association's policy also calls for the establishment of water quality criteria for the wide variety of ecosystems that exist throughout the country.

There is recognition on a national level that water quality criteria specific to unique regional ecosystems are needed. At its national meeting in Cleveland, Ohio, in May, the Association of Metropolitan Sewerage Agencies (AMSA) adopted a position statement emphasizing the need for water quality criteria for ephemeral and effluent-dependent streams.[6] AMSA requested that Congress and EPA consider the net benefits of effluent discharge in the standards development process, modify the use attainability and site-specific standards processes, establish peer review procedures, and fund an effort to develop water quality criteria documents for ephemeral and effluent-dependent streams and other atypical water bodies.

The Western Coalition of Arid States (WESTCAS), a group of water and wastewater agencies in California, Arizona, Nevada, and New Mexico, adopted a similar position at its July meeting in San Diego.[7] WESTCAS maintains that water quality standards and criteria should be based on sound scientific data and common sense practices rather than on arbitrary calculations that now exist. WESTCAS also believes there must be an adequate confidence level in water quality criteria that are expected to protect species in the arid west. WESTCAS wants water quality criteria developed for the arid west to provide realistic standards for water and wastewater agencies in our region.

The State of California Water Quality Control Board has also found that the sound science for appropriate water quality criteria is lacking. The board has requested a 5-year study period in which to develop appropriate water quality standards for the areas under its jurisdiction.

In all my recent discussions with congressional staff, EPA, and other agencies, there is a consensus that specific water quality criteria documents are needed for the arid west. These water quality criteria documents must be based on scientific research of indicator species native to and representative of the arid west.

The Clean Water Act

The basic fundamentals of the Clean Water Act are both appropriate and commendable. In 1972, when Congress approved the Clean Water Act, the main objective was to restore and maintain the chemical, physical, and biological integrity of the nation's waters.

The goal of achieving technology-based standards (secondary treatment) has for the most part been successful. Most major cities in the country now provide secondary treatment of municipal wastewater. However, secondary treatment is not required in certain marine waters that can demonstrate that the ecosystem is protected.

The Clean Water Act Amendments of 1987 introduced a new emphasis on water quality standards. States were required to adopt numeric water quality standards to limit priority pollutants in effluent by February 1992.

Development of Water Quality Standards

Effluent discharges to waters of the United States are regulated by the National Pollutant Discharge Elimination System (NPDES) program. The basis for the discharge limits in NPDES permits is State water quality standards. In establishing these standards, the States use a combination of two factors: designated uses and criteria data. Criteria data are supposed to be used to calculate standards to protect the designated use. After a State has established acceptable designated uses, the next step is to apply appropriate criteria and calculate standards to protect each of the designated uses. The States are given ample flexibility in assigning designated uses to stream segments, but availability of appropriate criteria is limited.

If an existing designated use is questioned, EPA advises the application of the use attainability process to identify suitable designated uses. Many have expressed concern, however, that EPA's process is difficult to implement; in response, EPA Region 9 is attempting to develop a more workable process. But the problems of the arid west do not lie in the reclassification of designated stream uses, but rather in the lack of criteria to protect actual uses.

Many States were under pressure to meet EPA's February 1992 deadline to develop water quality standards that included numeric limits. The lack of criteria documents for regional ecosystems forced those States without adopted standards to rely on Federal criteria documents that are insensitive to unique ecosystems. States that missed EPA's deadline will be required to use federally promulgated standards, which are based on national criteria rather than regional criteria protective of representative ecosystems.

During the triennial review process in Arizona, initial drafts of the water quality standards included limits that were based on the protection of aquatic species that did not exist in the ecosystem. The draft standards were proposed in the absence of scientific research on species similar or native to those found in the streams of the arid west. A joint effort was undertaken by municipalities and industry to develop criteria for priority pollutants to protect the different beneficial uses that did exist in Arizona.[8,9] EPA recognized the inapplicability of the Gold Book criteria and approved the Arizona Department of Environmental Quality's use of these criteria in the State water quality standards. EPA's approval of that State's standards is contingent on the following:

- The reevaluation of the species list for ephemeral waters to verify that the list is comprehensive, to result--if necessary--in the modification of criteria for ephemeral waters.

- An evaluation of the mercury risk for wildlife on effluent-dependent and ephemeral waters to determine the effects of bioaccumulation.

- The reevaluation of technical assumptions on bioconcentration and human exposure pathways for selected criteria for protection of human health.

- A review of incremental risk level for human health criteria for carcinogens.

Currently, individual States must extrapolate standards and NPDES limits from a limited water quality criteria database that fails to recognize regional differences in ecosystems across the country. Another option is for a State to develop its own site-specific scientific data for water quality criteria. This means arid States developing water quality standards either must utilize national criteria for their ecosystems, which will ultimately lead to inappropriate limits for discharge permits, or must invest their limited financial and scientific resources to develop site-specific data.

Toxicity testing also remains a contentious issue as EPA continues to include whole-effluent toxicity in many discharge permits. The question of which aquatic species is appropriate to utilize in the measurement of effluent toxicity has been of concern in the arid west, especially when the effluent is discharged into ephemeral streams. In addition, the testing methodology, which is under debate across the country, needs better testing protocols, control parameters, and peer review.

How is the Arid West Different?

When most people think of "fishable or swimmable" the picture that comes to mind is a cool mountain babbling stream with a relaxed fisherman on the banks, or a lakeside retreat with laughing children splashing water. However, a typical riverside setting in the arid west consists of parched dry sandy washes, the constant humming of cicadas, and tire tracks from the most recent all-terrain vehicle. During a summer monsoon evening, a typical western arroyo flowing with rainfall runoff might also attract croaking toads, a great horned owl, or a wily coyote stalking a tiny kangaroo rat.

A lush riparian ecosystem can develop along normally dry washes as a result of continued effluent discharges. The habitat then becomes dependent on the effluent as the only reliable source of water, which attracts many wildlife species and creates a diverse terrestrial biotic community. It then becomes important to protect the biotic community that has been established as a result of effluent discharges. The development of water quality criteria documents would identify the species of plants and animals that need to be protected, and would produce appropriate water quality limits for effluent-dependent habitats and streams.

Ecosystems that rely on ephemeral streams support a different kind of habitat than perennial streams. Water quality criteria developed for full flowing, wet streams are inappropriate for ephemeral streams.

Storm water in the arid west is often the only water that ever flows in an ephemeral stream. Storm water data from non-urbanized areas should form the basis for background water quality. The range of ecological habitats found in the basin, and the interaction of storm water flows and ground water quality, should be identified to establish the level of water quality protection required from urban storm water discharges. From these data, water quality criteria could be developed to protect the arid ecosystem from urban storm water flows. Currently, the database on ambient storm water quality for arid, ephemeral streams is inadequate. Data on the impact of urban storm water on these habitats are also limited.

The development of water quality criteria to protect the arid ecosystem from urban storm water flows should consist of an integrated environmental monitoring network. Such a network would characterize the water quality of storm water flows from both urban and non-urban areas. The habitat that is dependent on these periodic storm water flows would be identified, and the impacts of these storm water bursts on representative species could then be assessed. The existing database on ambient storm water quality for arid, ephemeral streams is inadequate. The range of ecological habitats found within a basin and the interaction of storm water flows and groundwater quality should be identified to establish the level of water quality protection required from storm water discharges.

In the arid west, manmade systems of canals or water transportation systems are used to convey surface water for municipal, industrial, or agricultural uses. These artificial water bodies are not intended to be fishable or swimmable. Water quality standards are needed to protect the intended uses of water transported through manmade systems used for municipal, industrial, and agricultural purposes. The water quality standards to protect these intended uses should take into account water rights; protection of existing ephemeral, intermittent, and effluent-dependent water bodies; and protection of designated uses as determined by the States.

The water rights issue has provoked all-out war in the West. The West is very conscious of water supply issues and for that reason has pioneered water use planning methods. In Arizona, for example, Phoenix and Tucson are drafting plans to provide the present and future populations assured supplies of water for the next 100 years. An important component in these assured water supply plans is the utilization of effluent. Both cities are incorporating effluent use on turf and/or agricultural irrigation, and both have long-range plans that include the recharge of effluent for potable use.

Along with these ambitious plans for effluent, there is one important missing link: the integration of water supply planning with water quality protection. Currently, there is no consistency among many regulatory programs. Although State water rights allocations and uses have been the driving factor in planning water uses, specific water quality standards that protect those uses have not been developed. With EPA regulating surface water discharges, and State agencies regulating groundwater protection and reuse standards for turf and agricultural irrigation, the lack of scientific criteria and standards development becomes an even more acute problem.

Criteria Objectives for the Arid West

The primary objective of water quality criteria is to protect ecosystems. When developing water quality criteria for the arid west, the following tasks must be performed:

- Describe the existing biotic environment in ephemeral and effluent-dependent streams.
- Identify wildlife uses of riparian habitats.
- Determine the effects of effluent on stream-side terrestrial plants.
- Determine what pollutants, if any, are moving through the food chain.
- Determine what wildlife populations, if any, show evidence of pollutant contamination.
- Determine the effects of effluent, if any, on the wildlife population (e.g., abnormal behavior, birth defects, absence of "indicator" species that should be present).
- Perform pollutant fate analysis for the biotic community found in ephemeral and effluent-dependent streams.
- Develop criteria for representative species.

Research Followup

Water quality criteria would include technical studies, peer review protocols, and technology transfers resulting in the publication of criteria documents that can be used by States for the standards-setting process. Technical studies must include scientific analysis to determine what must be protected, what levels of pollutants harm the habitat, and what limits are required.

An important aspect of the water quality criteria process is the development of peer review protocols. Approved procedures are needed for receiving input and comments from the scientific community on the analytical methodology used for criteria development. This peer review process is vital. Other areas requiring peer review include analysis of the policy implications and impacts of the new criteria. This would involve EPA, State regulators, and the regulated community.

Once water quality criteria have been developed and accepted, the information gathered must be shared with regulators, regulated agencies, and others so that criteria can be applied to ecosystems that support similar habitats. A final step in the development and implementation of water quality criteria is the publication of criteria documents.

CONCLUSIONS

Environmental protection is our common goal. Whether we are regulated agencies, regulators, or concerned citizens, we all have a duty and responsibility to protect the environment of the arid west. The arid west's unique ecosystem, now dependent on effluent, must be protected. Protection cannot take place until water quality criteria developed specifically for such ecosystems are implemented. These water quality criteria must be based on sound scientific data. When appropriate criteria are developed, the States will be able to develop appropriate water quality standards and effective treatment options.

Research must be conducted using full-scale models that replicate the arid environment. Work should be performed in a location that typifies the arid west with respect to limited rainfall and high evapo-transpiration rates. These conditions are important to facilitate control and understanding of all factors in assessing pollutant impacts. The availability of infrastructure, land, and a consistent effluent source are also important considerations, as is the availability of research and analytical resources for scientists from other institutions across the West.

The unique ecosystems of the arid west are what we are trying to protect. In many instances, these ecosystems have been created by effluent discharges and are dependent on the presence of the effluent. The ecosystems here are so unique that water quality criteria documents, not special use classifications, are needed. The objective is not to obtain less stringent water quality standards, but to develop regional criteria documents that are protective of these ecosystems.

In this context, net environmental benefit means water quality criteria and standards that protect the ecosystem already in place, so that the investment in wastewater treatment can produce a tangible benefit to the ecosystem. This approach will not create Kestersons, but will preserve the riparian valleys of the West.

Water rights and reclamation policies are complex and controversial issues in the West. For EPA regional and national policy to be constructive, more dialogue and understanding are needed.

Consideration should be given to the potential impacts on nonaquatic species and the value of effluent ecosystems for wildlife and migratory birds. If water criteria documents appropriate to the arid west are developed, other current or emerging Clean Water Act requirements will be compatible with the potential changes resulting from the use of these criteria.

The need for water quality criteria for regional ecosystems is a critical concern for water and wastewater agencies nationwide. However, the impacts are currently most acute in the arid west. Without water quality criteria based on sound science, high capital costs imposed on treatment facilities will result in a "higher" quality of water that does nothing to benefit the arid ecosystem--or worse, in the de-watering of desirable riparian habitats.

Criteria documents for the arid west would also assist EPA in implementing workable approaches that are environmentally protective and scientifically defensible. More research and resources should be devoted to the development of the data necessary to address this issue. Such research should be done now rather than on an ad hoc basis.

The development of water quality criteria documents for the arid west offers no guarantees for anyone; indeed, their establishment could very well result in more stringent water quality standards. But whatever the outcome, criteria development specific to the environment of the arid west will assure us and future generations that our unique ecosystems are protected for those species and habitats that rely on ephemeral and effluent-dependent streams for survival.

FOOTNOTES

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2. U.S. EPA. 1986. U.S. Environmental Protection Agency, Office of Water Regulations and Standards. Quality Criteria for Water 1986. EPA 440/5-86-001. Washington, DC.

3. ______. 1990. Water Quality Standards for Wetlands--National Guidance. Office of Water Regulations and Standards, Office of Wetlands Protection, Washington, DC.

4. ______. 1992. Guidance for Modifying Water Quality Standards and Protecting Effluent-Dependent Ecosystems. Interim Final. Region 9. San Francisco, CA.

5. Western Governors' Association. 1992. Resolution 92-Q: Reauthorization of the Clean Water Act. Jackson, WY; June 23.

6. Association of Metropolitan Sewerage Agencies. 1992. Board of Directors. Position Statement No. 7: Water Quality Standards for Ephemeral and Effluent Dependent Streams. Annual Meeting, May 17-22, Cleveland, OH.

7. Western Coalition of Arid States. 1992. Board of Directors. Resolution No. 1992-3; Water Quality Standards for Ephemeral Streams. Quarterly Meeting, July 24, San Diego, CA.

8. Carter, D. and L. Tischler, EBASCO Environmental. 1990. Proposed Human Health Ambient Water Quality Standards for Arizona. Phoenix, AZ.

9. Parkhurst, B. 1990. Numeric and Narrative Water Quality Standards for Arizona Aquatic and Wildlife Limited Waters. Phoenix, AZ.

MORE TIME IS NEEDED TO APPROPRIATELY BALANCE WATER QUALITY PROTECTION AND RECLAMATION

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Section 303 of the Clean Water Act requires development of standards for toxic pollutants by the States. Caution must be used in the development of these standards for water courses in the arid West, where stream flows are low or non-existent for the majority of the year. Inappropriate standards can result in unjustified costs to dischargers, impede vital water reclamation projects, and actually impede implementation of programs that could improve water quality. Our ongoing experience in the San Diego Region may, unfortunately, serve as an example of the problems that occur when an effort is made to put standards in place prematurely.

Water courses within the borders of the San Diego Regional Water Quality Control Board (Regional Board) are similar to those throughout most of the Southwest, being historically ephemeral in most areas. Dry season flows consist of a variety of "nuisance" waters that have already been used at least once, including return irrigation flows, landscape and agricultural irrigation runoff, swimming pool drainage, street and sidewalk wash-down water, and water from car washing. Although recent data indicate these flows are of surprisingly good quality, volumes are usually low and, as a result, support limited aquatic life.

Many of the water courses in the San Diego Region received discharges of wastewater in the past, some as late as the mid-1970s. These discharges were at best disinfected secondary effluent without chlorination. All were eventually terminated because of water quality problems. The problems were exacerbated because of the generally low levels of treatment and the fact that most of the streams in the San Diego Region terminate in landlocked coastal lagoons, which are sensitive to nutrient and freshwater inputs and serve to concentrate pollutants during the dry seasons. The Regional Board is particularly sensitive to the water quality issues involved with discharges of wastewater to inland water courses because of this past experience.

In 1988, the Regional Board developed their "Live Stream" program. The concept is simple. Natural water courses can be used to transport reclaimed water from point of production to point of use. Also, water courses can be used for the discharge of excess reclaimed water during the wet season, thereby avoiding the need for costly and hard-to-site wet weather storage facilities or pipelines to ocean outfalls. As a further payoff, the reclaimed water flows will enhance aquatic habitat and improve and restore beneficial uses in the streams.

To implement the "Live Stream" program, the Board envisioned a proactive róle, including making a number of specific changes to its adopted water quality control plan (Basin Plan) to encourage dischargers to proceed. To avoid recurrence of the past problems, the Board established conditions for regulatory approval of any projects including, but not limited to, the following:

1. No changes in the water quality objectives of the Basin Plan for discharges upstream of waters used for municipal water supplies.

2. Modifications to the water quality objectives of the Basin Plan for total dissolved solids concentrations and concentrations of other mineral constituents to reflect the concentrations of those constituents in the available water supply.

3. Wastewater treatment at all times to conform to all State Department of Health Services' Title 22 requirements for unrestricted body contact.

4. Modifications to the water quality objectives of the Basin Plan for nutrients (nitrogen and phosphorous) to reflect existing concentrations coupled with best practicable treatment of wastewater.

5. Management programs to cope with potential problems that may arise as a result of Basin Plan changes.

As a result of the Board's encouragement, planning began for a number of projects. One of these, for the upper Santa Margarita River, has advanced almost to the point of implementation. More on this project later.

Midway through implementation of the Board's "Live Stream" program, the State Water Resources Control Board (State Board) began development of the "California Inland Surface Waters Plan" (Inland Surface Waters Plan), the State's water quality control plan for the inland surface waters of California. The primary purpose of the State Board's effort was to develop water quality standards for toxic pollutants to meet the requirements of section 303 of the Federal Clean Water Act.

As I am sure you are aware, California is a "Delegated" State under the Clean Water Act. As a delegated State, California is responsible for establishing water quality standards for the waters within its boundaries, subject to oversight by the U.S. Environmental Protection

Agency (EPA). In adopting the Porter-Cologne Act, the enabling legislation for California's water quality programs, the Legislature, in Section 13300, found that a statewide program for water quality control could be most effectively administered regionally, within a framework of statewide coordination and policy. Thus the regional boards were rightfully given wide latitude to make decisions impacting water quality within their respective regions.

You may not be aware of some fundamental conflicts between California's water quality planning process and that contained in the Clean Water Act. Clean Water Act section 303 indicates that standards are to protect public health or welfare, enhance the quality of water, and serve the purposes of the Clean Water Act. The language in section 303 goes on to specify that standards are to take into consideration their use and value for protection of public water supplies; propagation of fish and wildlife; recreational, agricultural, industrial, and other purposes; and navigation.

Section 13000 of the Porter-Cologne Act states the Legislative mandate that regulations result in attaining the highest water quality reasonable, considering all demands on waters and total values involved, beneficial and detrimental, economic and social, tangible and intangible.

Section 13241 of the Porter-Cologne Act states the factors to be considered in establishing water quality objectives. These factors are to include past, present and probable future beneficial uses of the waters involved; environmental characteristics of the hydrologic unit involved; water quality that could be reasonably achieved with coordinated control of all factors affecting water quality in the area; economic considerations; and the need for developing housing within the region. These factors are to be considered by the State Board when adopting statewide policy and by the regional boards when adopting water quality control plans or taking other regulatory actions that impact waters within their respective regions.

During the development of the Inland Surface Waters Plan, the EPA applied considerable pressure to have the so-called Gold Book standards for toxic pollutants adopted. These standards are intended to apply to natural surface waters that have been minimally affected by man's activities. There was considerable opposition to the blind adoption of these standards from many segments of the regulated community and the "regulators" (the regional boards in this instance). After considerable debate, the State Board adopted their Inland Surface Waters Plan, consistent with the Porter-Cologne Act, and including provisions both protective of water quality and consistent with beneficial water reclamation projects.

Specifically, the State Board established Category (a), a special category of surface waters. Category (a) applies to water courses that are not naturally perennial and that support, or will support by April 1997, aquatic habitat beneficial uses during the dry season as a result of the discharge of reclaimed water. In those cases, the stringent water quality objectives for toxic pollutants in the Inland Surface Waters Plan do not automatically apply as they do to other surface waters in the State. Instead, these water quality objectives will be considered as "performance goals" for a 6-year period from the date of adoption of the Plan.

During this 6-year period, water quality investigations are to be performed and, where appropriate, site-specific objectives are to be developed. Performance goals require the best efforts of the dischargers to meet the objectives. As a result, dischargers to these bodies of water would not be required to meet inappropriate waste discharge requirements during the period in which truly appropriate, site-specific objectives are generated.

The designation of the water quality objectives for toxic pollutants as performance goals, for discharges of reclaimed water to Category (a) water bodies, was one factor leading to EPA's disapproval of the Inland Surface Waters Plan. Another was the inclusion of the so called due diligence provisions for determining compliance with the water quality objectives for toxicity. Under these provisions, dischargers exceeding effluent limits for acute or chronic toxicity are required to perform toxicity reduction evaluations (TREs). Once the source of toxicity has been identified, dischargers are required to take all reasonable steps necessary to reduce toxicity to the required level. If these provisions are met, the discharger is considered to have implemented the objectives for toxicity as required by the Inland Surface Waters Plan. The "due diligence" provisions were strongly supported by the agencies promoting reclamation projects because of the potentially chilling effect of fears of noncompliance for reasons beyond their control.

During their meeting on February 24, 1992, the Regional Board designated a number of water bodies, including the Santa Margarita River and its upper basin tributaries, Murrieta Creek and Temecula Creek, as Category (a). In doing so, the Board concurred with the recommendations of the proposed dischargers and designated the water quality objectives for all of the toxic pollutants in the Inland Surface Waters Plan as inappropriate and candidates for site-specific studies for these streams.

On May 18, 1992, at their regularly scheduled meeting, the Regional Board adopted NPDES permits for the Eastern Municipal Water District and the Rancho California Water District discharges of reclaimed water to the Santa Margarita River. Both of these permits implemented the Inland Surface Waters Plan, including the designation of water quality objectives as performance goals and inclusion of the "due diligence" provisions. They also included river monitoring and management provisions in accord with the Regional Board's previously established conditions for implementation of live stream programs. On May 15, 1992, the Regional Board received a letter from the EPA objecting to the permits for a variety of reasons, including the inclusion of the aforementioned provisions of the Inland Surface Waters Plan. The Regional Board will hold a hearing, to consider actions to take in light of the EPA objections, on August 24, 1992. If, at the conclusion of the hearing, the Regional Board does not modify the permits to satisfy the EPA objections, it is likely that EPA will assume jurisdiction and issue the permits. The final chapter in this saga has yet to be written.

Implementation of the Inland Streams Policy, together with the Regional Board's Basin Plan, will ensure protection of water quality in our region. Appropriate beneficial uses will be clearly and specifically identified and protected. At the same time, allowances will be made for generation of site-specific water quality objectives, which are not unnecessarily stringent, when appropriate. However, the Regional Board is concerned that rushing to implement overly stringent water quality objectives, which may be inappropriate in many instances, will have a chilling effect on vital water reclamation projects in the San Diego Region and throughout the Southwest.

ZERO DISCHARGE, ANTI-DEGRADATION, AND SOURCE REDUCTION: REPLACING THE FAILED ASSIMILATIVE CAPACITY MODEL WITH EFFECTIVE SURFACE WATER QUALITY STANDARDS FOR THE 21st CENTURY AND BEYOND

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The slides you saw a few minutes ago give a pretty good picture of what some of Arizona's ephemeral riparian areas look like, but what the slides don't show are the "DON'T EAT THE FISH" signs put up on the Gila River by the Fish and Wildlife Service and the State Game & Fish Department 50 miles downstream of the Phoenix wastewater treatment plants. And the slides don't show the mostly low-income people fishing next to those signs, or people catching turtles and frogs to eat, or people floating on those waters in inner tubes.

The Effluent Dependent Waters (EDW) problem is interesting in several ways; it is representative of our continuing failure after years to achieve the primary goals of the Clean Water Act. Obviously, if we had been serious about zero discharge, we wouldn't have to be concerned with EDWs now.

The degree of our failure is indicated by the EPA's changing terminology. Where we used to talk about effluent-dominated water, we're now supposed to talk, as indicated in Region 9's guidance document, about effluent-dependent waters. There was some hope of correction in the old term, but "effluent-dependent waters" indicates that the Agency apparently has given up.

A great deal of what we've heard in the past few days indicates that the new Region 9 guidance is consistent with the Agency's new nationwide policy, which rather than pointing the way toward cleanup and prevention, toward maintenance and enhancement, would institutionalize what many dischargers have come to think of as a right to pollute.

For example, in Arizona the Agency is routinely accepting discharge limits in NPDES permits that are considerably lower than criteria levels. We've heard that 42 States now have their toxic standards approved by EPA, but I wonder how many of those States' standards are under appeal--as Arizona's are-because (among other reasons) the Agency has allowed the State to set toxics levels far below levels the Agency itself has identified as unprotective.

We obviously make a mockery of the process if we define progress simply as getting the paperwork signed when we do it by lowering our standards.

Instead of pushing the process upstream, forcing cleanup at the source, what we've been hearing for the past few days indicates what seems to be an upper-level decision to accept contamination as inevitable and to continue the hopeless business of trying to control pollution at the end of the pipe and then spending millions of dollars assessing the damage.

This approach, by which our agencies spend most of their time doing Risk Assessment and Risk Management, is simply wrongheaded. It begins by asking the wrong questions. We are asking: How much can I discharge? How much contamination can I get away with? Instead, we should be asking: How much exposure can we prevent?

In general, the public doesn't care if the risk is one in a million or two in a million, especially when we know that risk assessment is essentially a computer game that lets you come up with any figures you want. What the public does want is for EPA to stop trying to figure out how little of a substance it takes to kill us and figure out how to prevent exposure, to eliminate unnecessary and avoidable risk.

We can go on forever assessing and prioritizing risks, and while that may be a good way to keep a lot of consultants and lawyers employed, it does nothing to help those people like the Native American nations in the Northwest we heard about yesterday. And it does nothing to protect the people or fish and wildlife downstream from Phoenix, Tucson, and our other major dischargers.

And it's a notoriously ineffective way to address noncancer problems. Cancer, in fact, may be the least of our worries. Of far more concern in the long run are transgenerational mutations and potential synergistic effects, and all the millions we are spending on risk assessment don't get close to those issues.

Instead of policies that encourage us to pollute up to the level of our ignorance, which is what quantitative risk assessment does, we should be actively applying what in other parts of the world is called the Precautionary Principle. In the United States we generally translate this as Pollution Prevention, a less satisfactory term since it is typically--especially, it seems, in the Water Office--limited in practice to waste minimization and after-the-fact risk management. But if we understand that what we really mean is source reduction, cutting down on toxics at the front end of the system, banning those substances we really can control, and substituting benign processes, then it's probably OK to call it Pollution Prevention. That term, at least, has the benefit of already being in our regulatory lexicon--even if it is misused and underemployed.

As we've heard from several speakers during the conference, the preventive approach is already being taken in the Great Lakes, and as we heard Dr. Foran and others say yesterday, it is the operative principle behind the International Joint Commission (IJC) strategy for addressing the otherwise intractable pollution problems there. I strongly recommend that the EPA take a more active role in the IJC proceedings than they have. The IJC model is far superior to the one the Agency has been operating under.

If we're serious about clean water, and we should be, then we have to dump the disproved theory of Assimilative Capacity and stop relying on end-of-the-pipe remedies. Instead, we need to move into the 21st century with water quality standards based on prevention and the polluter pays principle.

The EDW problem in the Southwest is a good example of the failure of the Assimilative Capacity model and illustrates our need to push standards upstream to the source.

As you know, Assimilative Capacity is the belief that we can keep dumping our garbage into the environment and the environment will clean it up. But however well that theory might have worked when applied to biological toxins, when it comes to toxics, and especially to persistent and bioaccumulative toxics, the model obviously doesn't work and the policies based on it are obviously bankrupt. As we know from bad examples like the Great Lakes, the New River, the Columbia, Boston Harbor, global warming, and the ozone layer (to name a few), allowing a little bit here and a little bit there adds up to a lot, and in effect, we're nickel-and-diming ourselves to death.

We all live downstream--both in time and in space. As the Earth Summit has made us aware in focusing attention on the global environment, sustainability requires that we respect the rights of future generations to an environment in at least as good a shape as the one we've inherited--and hopefully better. We simply can't afford to continue the incremental loading of toxics into our environment--into our streams.

Affordability, of course, is of major concern, but in our focus on site-specific costs, we tend to miss the bigger picture. In fact, one of the biggest problems we have in attaining the goals of the Act is that we have allowed ourselves more and more to let cost rather than environmental health drive the process--not only in setting permit limits, but (contrary to statute and common sense) in our standards-setting process.

By and large, the environmental community recognizes that we can't ignore costs, and we're not generally opposed to the Use Attainability process, but if we're going to look at costs they have to be honest costs, and there has to be a full accounting including all costs and all benefits. That's not what we usually see.

In the case of the Phoenix WWTPs, for instance, when we first started talking about toxics standards during the triennial review, we were told that upgrading the plants would cost somewhere around $180-$200 million. A few months later, after the public had some chance to examine the figures, the cities' estimates dropped to about $140 million. A few months later, after a little closer scrutiny, it turned out that most of those costs weren't really for toxics controls, but were for upgrades that had been budgeted long ago to meet conventional pollutant standards that had been in place for years. When we got right down to it, the real problem wasn't toxics at all and the upgrades turned out to cost 40 to 60 percent less than the original estimates.

One of the nice things about living in Arizona is that you get pretty good at recognizing scams. As it turns out, the State and EPA were being subjected by the municipalities to a kind of environmental blackmail, which said that if you make us meet these standards then we'll just keep all our water out of the streambed and dry up your precious riparian area. Unfortunately, the State and Federal agencies caved in to this outrageous demand.

But in fact, the issue had little to do with toxics or water quality of any kind. The real issue was water quantity and who was the highest bidder for the cities' effluent. As was made clear later when NEB negotiations over proposed wetland creation as an alternative treatment broke down because the cities would not commit to keeping water in the stream, the municipalities were planning to cut off the flow in any case, no matter what the standards, as soon as the price of water got high enough for them to sell it for agriculture or golf courses or whatever.

The ethics and legality of the cities' plan to dry up some of the most important riparian areas in the State is an important issue, but it's not generally a toxics issue.

I'm not saying that the municipalities are rich. It's obvious that the new federalism of Reaganomics put incredible burdens on local communities with little funding. But if we're going to get into processes like Region 9's NEB, let's be sure the costs are real.

Honest accounting is especially important in these times when more and more people are being subjected to jobs vs. environment arguments--another form of the same blackmail. It's not that there isn't any money. There's plenty of money. There's trillions in the Pentagon's peacetime budget and we're spending billions on political saber-rattling in the Middle East. We can spend millions on S&L bailouts and the likes of Michael Milliken and Ivan Boesky and my friend Keating from Arizona, we can pay million dollar salaries to ballplayers and entertainers, but we can't afford clean water? Nonsense.

The problem isn't lack of money, but lack of political will, which is part of the phony accounting games of trickle-down economics (an especially appropriate term for water politics) that has transferred so much public money into deep private pockets over the past 12 years that the top 1 or 2 percent of our population now controls more wealth than the bottom 80 percent together.

Part of the scam is the mislabeling of some costs, and part is the failure to identify other costs at all. What, for instance, is the cost of drying up a river? What is the cost of continually loading a streambed with toxics?

Another interesting point that came up in our discussions of standards in Arizona was that although the incremental loading of toxics apparently had not yet caused violation of aquifer standards downstream from major WWTPs, the downstream wells do show elevated levels of toxics. There can be little doubt that if we keep it up, in time those wells will be contaminated beyond standards. And what is the cost of ground water cleanup? The cost of providing clean drinking water? And what are the savings to be had from really implementing Pollution Prevention?

Again, in figuring the costs of polluting or drying up a stream, we typically think of aquatic organisms and wildlife only as resources for humans to use. Our accounting is unbearably anthropocentric. But animals and ecosystems have rights whether or not they are of use to us. We have to have a biocentric--not just an anthropocentric--accounting. And I don't mean just the warm cuddly creatures and the bright green ecosystems. We have to respect the integrity of cold slimy critters too, those that live below the surface of the streams, even when the water isn't running. And we have to recognize the appropriateness of natural ecosystems, which may not display the features that urban populations, especially eastern urban populations, tend to value highly. In many western systems, year-round lush vegetation and high biotic diversity are simply artificial, what one of my Forest Service supervisors used to call "natural and park-like."

These questions point up another of the major problems with the way we do our accounting. Traditional accounting calls such problems <u>externalities</u> and tends to discount them, just as it discounts the future. But we live in a closed biosystem: There are no externalities and we simply cannot continue to discount the future, to put the burden of costs on our grandchildren and their grandchildren.

Instead, if we're going to have standards that really maintain and enhance our waters into the 21st century and beyond, we have to get serious about the original goals of the Clean Water Act, drop the contradiction of assimilative capacity and incremental loading, and insist on zero discharge, antidegradation, and antibacksliding.

We have to protect ground water and wildlife and ecosystems, and we have to stop making the taxpayer and the environment pay for cleaning up water that should be cleaned up at the source by the polluters. We have to insist that maximum Pollution Prevention and Pretreatment programs are in place before we cave in to environmental blackmail and phony economic arguments in the name of Net Environmental Benefit. And as we've heard in the past few days, it doesn't matter how good our standards are if they're not implemented. We have to insist on implementation and that means we have to have effective enforcement--at the Federal, State, and local community levels.

And we have to have funding at all levels to carry out the program.

And while we have to make it clear that zero discharge of pollutants and contaminants is one basic standard, that does not mean zero discharge of water. Maintaining minimum flow, keeping water in the stream, is a water quality requirement. Whether we call it physical, chemical, or biological, it's obvious that the quality of a stream is ruined if you take the water out. The requirement to maintain flow is, I think, very clear in the Act, and if it's not, I assure you the environmental community will be working to make it clear during reauthorization.

Appendix A:

Attendees List

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Office of Water
U.S. Environmental Protection Agency

August 31-September 3, 1992 Riviera Hotel Las Vegas, Nevada

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Appendix B:

Evaluation Comments

NATIONAL MEETING EVALUATION SUMMARY

Sixty-two evaluation forms were received. The meeting received an average score of 7.5 on a scale of 1 to 10. The majority of attendees felt the objectives were clearly stated (47), and all but one felt the objectives were completely or partially met. The top three sessions listed as very useful were Independent Applicability, Biological Measures, and Effluent Dependent Streams, respectively.

1. EPA RISK-BASED APPROACH/SOUND SCIENCE

Comments:

Very Useful	Useful	Adequate	Inadequate
12	30	14	1

EPA needs to pay more attention to this policy throughout its organization. Both are necessary to establish and maintain program credibility.

What is "sound science?" Is EPA really committed to such science? I don't remember these issues being addressed.

Need to quit having substitutes give speeches.

Probably best possible approach to absence of main speaker.

Not adequate, did not contain any practical information or potential methods.

Although perhaps unavoidable, message in LaJuana's absence not very positive (and strong to some!)

Graphics and some "broad perspective" descriptions by Bill Diamond very relevant and helpful.

I'm disappointed that this was omitted.

Too general, but good as introduction.

2. LIFE AFTER TOXICS

Comments:

Very Useful	Useful	Adequate	Inadequate
13	33	12	1

Not too much in the way of "what direction now?"

Regional flexibility is essential to obtain "buy in" to nonpoint source program and to move to more stringent standards affecting point source dischargers.

Toxics are not solved, major reexamination of the science and applicability are required. With 1/3 of the States and territories not adopting, it is clear that a national initiatives range of values for varying conditions is necessary to achieve a firm basis to regulate toxics.

3. BIOLOGICAL MEASURES

Comments:

Very Useful	Useful	Adequate	Inadequate
26	23	7	

Valuable and useful tool; however, variability problem requires caution and discretionary judgment when applied to compliance and enforcement activities.

Major emphasis on sewage systems and point source. Need more on NPS from agriculture sources. This is a very important area, but after attending several EPA WQ workshops, I have yet to see this area appropriately addressed.

The competing uses, especially in the West, must be resolved addressed at the National policy level. The WQ Criteria contain an eastern bias.

Harper speech was "slow."

Did not meet the stated purpose or include any detail on success.

Overall session well presented, well run. Forest Service presentation seemed too elementary (but acknowledged), and too "party-line" regarding enforceable standards issues.

More time and speakers should have been allowed.

Like it or not engineers, this the "wave" of the standards future!

Needed more specific description of biological measures to be considered.

4. CSOS/WET WEATHER

Comments:

Good presentations.

Very Useful	Useful	Adequate	Inadequate
4	7	3	1

Not clear of EPA's position or where Congress may be headed.

Need more discussion on CSO control programs that have been or are being built. Less on CSO projects still in the early planning phase. San Francisco's presentation was excellent.

Focused only on technology-based approaches to CSO. Did not address relevancy of WQC to CSOs or wet events.

5. WHOLE EFFLUENT TOXICITY

Comments:

Throw the engineers out!

Very Useful	Useful	Adequate	Inadequate
13	20	2	

Good background for someone who needed it.

Good range of speakers, good presentations, some "counter-point" or perspective from Regional EPA would be helpful.

I would have liked to have heard more about EPA's views.

NC is a demonstrated state in this field.

Old information.

6. INDEPENDENT APPLICABILITY

Comments:

Very Useful	Useful	Adequate	Inadequate
31	22	2	1

Better support for independent applicability would have balanced the presentation.

Good presentations, some concern with lack of active audience participation, not really very complete discussion of issues.

Just opinions with no organization which develops direction.

Good background for someone who needed it.

Good to get EPA perspective and perception of concerned environmental groups.

Weight of evidence is the only approach that makes good public policy.

It did not really deal with the difference between independent applicability as a principle for developing criteria or as a principle for applying criteria. The speakers and moderator talked too long, did not have enough time for questions.

7. HUMAN HEALTH RISK MANAGEMENT

Comments:

Very Useful	Useful	Adequate	Inadequate
5	25	4	2

Especially appreciated participation of Tribes. Hope EPA was listening.

Informative to become aware of problems that exist in specific groups (e.g., Native Americans)

Not useful, strictly posturing by speakers.

Session needed more focus. Would have been helpful for moderator to present more detail on EPA position and how it was derived.

Some speakers very good, particularly Wisconsin representative.

Very disappointed with the shallowness of the presentations.

Good range, but lack of very clearly defined focus or any attempt to reach resolution.

8. SEDIMENT MANAGEMENT POLICY

Comments:

Very Useful	Useful	Adequate	Inadequate
4	9	4	

Moderator did not leave enough time for questions.

Chris Zarba saved the discussion and did an excellent job of representing EPA's sediment activities. Yeah Chris!

Serious questions as to validity and need for sediment criteria. EPA strategy needs to go to public comment.

9. ADVOCATES FORUM

Comments:

Very Useful	Useful	Adequate	Inadequate
7	24	23	1

Too narrowly focused.

Kind of unfocused.

Good selection of speakers, but failure to effectively interact with whole group; not sure how to change.

I had little expectations for this session, and they were met.

May have helped to cover more issues.

No questions were read from the cards handed in.

Totally useless - no one wants to have six people say what everybody knows and is old.

Too much rhetoric and little substance.

Well done! Congratulations to Dave Sabock and the whole panel. Do more of these.

10. ECOLOGICAL RISK

Comments:

Very Useful	Useful	Adequate	Inadequate
1	17	13	2

There was adequate time for questions, but speakers still could be briefer. There was not enough attention to the issue of how Eco-Risk Assessment fits into CWA - standards regulatory structure.

The only speaker worth listening to was on uncertainty. The others put me to sleep with their garbage.

The best session.

Way too theoretical.

An emerging "technology" with questionable credibility.

All presentations were too complex to be useful. There did not seem to be much progress from 2 years ago.

Ecological Risk not beneficial; entirely too theoretical. Human Health session somewhat better (I moved!).

Generally poor presentations.

Again, good diversity.

11. HUMAN HEALTH RISK ASSESSMENT

Comments:

Very Useful	Useful	Adequate	Inadequate
3	7	5	

Since health criteria may have an error of plus/minus 10^4, why do they exist?

Jeff Foran's comments on pollution prevention useful.

Very good AV work, somehow the presentations lacked spark.

Professor Foran did an excellent job.

Old arguments and issues being restated does not help either regulators or dischargers.

Aspects of zero discharge discussed. This concept is fundamental to accomplishing the goals of the Clean Water Act.

12. EFFLUENT DEPENDENT STREAMS

Comments:

Very Useful	Useful	Adequate	Inadequate
20	15	15	2

Mr. Gregory stated in 20 minutes what has concerned me in Missouri for 20 yrs. I support his views fully.

A bit too much rambling!

The speakers were terrible and well below the quality of other panels.

Good example of the polarization that prevents environmental protection, through combined efforts of all groups. Michael Gregory does not speak for all the public as he claims, and doubtfully for the majority.

Other States besides western ones also have ephemeral stream dischargers--we have addressed that. What is so special about western arid States? Phosphorus detergent bans--have they been considered by the States.

Needs policy to bring wide range of issues into focus, i.e., what species should we protect and what conditions should we promote? Should causes be undone?

Speakers did tend to ramble.

This was absent the technical info that makes development, support, or opposition possible for these issues.

The level (i.e., technical sophistication) of several speakers was almost insulting to some in the audience. Although appropriate to hear all perspectives, the speakers should be informed of potential audience level of sophistication.

Liveliest session; good ending session.

The issues raised by the speakers were the same issues that usually come up with WQS. Did not demonstrate that EDS issue is all that unique, or even that they understood the issue very well.

This should have been a breakout, had limited applicability.

This was the best session/panel of the entire program!

Low only because does not have application to my geographic area.

Potentially the most important issue. Unfortunately the presentations by Brinsko and Forster were not well focused on the issues.

13. ASK EPA

Comments:

Very Useful	Useful	Adequate	Inadequate
18	20	4	2

Mostly EPA asking EPA and political speeches.

Worthwhile to hear
EPA goals direction and implementation plans.

Although I appreciate EPA's interest in our opinions via "Opinion Poll on Priority Activities" the language used in reporting on the results indicates that EPA is <u>not</u> going to necessarily change the priorities--"Surprised," "Interesting" that items which <u>are</u> being acted on ranked low.

Additional Comments:

Increased EPA presence on panels would have been helpful to explain and defend several EPA programs and perspectives and, hopefully, to discuss at least obvious "red herrings."

Overall, the conference organizers are to be congratulated for the variety (and range of perspectives) of speakers. Unfortunately, the size of the group did not allow the degree of interaction with the larger group (not sure if, e.g., smaller breakout session would have worked).

I work at EPA, so I didn't learn much new, but am sure it was helpful to others. Should have been more "social hours" to enable people to "meet and mix" more. With such a large conference, sending people for meals on their own meant most being out with folks they already know.

Overall, too much of an "intra-EPA" conference--supporting each group's programs and concepts; really needed to have more non-EPA representation in audience and spend time on comments/questions--need smaller roundtable-type sessions.

Tell speakers to use readable visual aids - this is a big room.

Very much, very good information, I often wonder how much EPA listens to opposing viewpoints, however, given that policy bears little resemblance to other viewpoints.

Tighten up the time for formal presentations. Leave more time for questions. We still need more audience participation.

EPA's effort to do this is to be commended. Need more agriculture nonpoint source activity. USDA-SCS initiated the National WQ Technology Development Staff (NWQTDS) based in Fort Worth, TX, in FY 89 to address President's 5-year WQ Plan. This staff has been very focused and very productive in area of NPS agriculture activities. Unfortunately, SCS has axed this staff by end of FY 92 to support their Fort Collins, CO, boondoggle. It appears they will be making very little contribution to technology in this area after FY 92. Does this concern EPA? Does anyone in the Office of Water or Pesticides & Toxics care to ask Chief Richards why they gave up this effort? Or what they intend to do (Fort Collins won't suffice).

Generally Good Conference - Problem with entire conference is the representation, or lack of it, from Great Basin State to discuss WQC/WQS issues as they relate to arid areas. National Standards don't apply in Nevada and other Great Basin States.

Need list of participants early in meeting. Need opportunity for social interaction of EPA staff.

The format of the meeting this year is excellent; three different view points; regulator, regulated, and environmental groups, all are represented in most of the panels.

Three-fourths of the workshop is rediscussing things from the previous two workshops. Why do we keep going over Old information - These workshops should be geared to future work and future ideas; not historic things that should have been implemented.

Las Vegas is a horrible choice for a setting (please include a "Poor" or "Unsatisfactory" rating on your evaluation sheet).

More topics in Workshop format with general session reports would be more beneficial.

The basic format of the Breakout Sessions was a great way to show the spectrum of opinions on the various issues. Speakers were generally excellent and gave strong support for their viewpoints.

You should limit questions from the audience to one per person. Also, EPA should prepare response or position papers on issues raised at this conference.

I cannot believe the shallowness and inadequacy of this meeting. Attending this conference has been a complete waste of time. It is no wonder we are having such difficulty nationwide with WQ Protection. EPA can't or won't seriously address development of information and options needs.

Overall the conference was very successful. Presentations were informative, presenting different sides of every issue. The conference was well organized to allow enough time for presentations and questions (comments). Excellent.

Overall very useful meeting, especially biocriteria-related discussions. EPA should concentrate efforts in reviewing the criteria documents, the toxicity raw data, and the Priority Pollutants list. EPA should also have the responsibility of dealing with the policy issues. Human health criteria should be EPA's responsibility. States should have more responsibility in developing the more progressive issues that characterize Regional concerns such as the biocriteria development, sediment criteria, and the aquatic and wildlife numbers for the different designated uses.

Most panels were pretty well balanced. Would be nice to have EPA speakers on each panel; not just as moderators.

Suggest that a participant list be provided in registration packet. Provide box for collecting plastic badge holders for reuse.

You should restrict speakers to "make presentations" and communicate with the audience; not read papers. Many poor presentations of generally good material.

Very informative. I enjoyed it.

Effort to create debate was very useful. Additional meetings should try to create further debate.

Overall, the conference could have been improved by: (1) Moderators needed to be much more concise--Most (except Harry Seraydarian and James Hanlon) spoke too long and did not clearly lay out the problem to be addressed by the panel; (2) Better, clearer presentations by many speakers--a handout (similar to that mailed out by Geological Society of America for Conferences) might have helped people to prepare clearer, more concise overheads and slides; (3) Moderators could have done a better job heading off excessive "comments" by the audience--i.e., Human Health Risk Management; (4) I appreciated the wide range of points of view that were presented. Although I appreciate EPA's interest in our opinions via "Opinion Poll on Priority Activities," the language used in reporting on the results indicates that EPA is <u>not</u> going to necessarily change the priorities--"Surprised," "Interesting" that items which <u>are</u> being acted on ranked low.

More emphasis on Human Health issues.

Excellent conference. Suggest an annual event. Try to encourage "speakers" not to read their talks. Speeches that are read are boring. Also encourage use of slides to break monotony of some talks. Include canal issues on next agenda. Good job of keeping speakers on time although there were some slip-ups. Sessions shouldn't go beyond 4:30. Schedule an hour and 15 minutes for lunch. Las Vegas is a good location because it's cheap and we can afford it on our chintzy State per diem.

Good conference. Poor notice of logistics, e.g., rendezvous point for tour, last minute assignment of breakout session rooms, etc. Good substantive sessions, in particular, Independent Applicability session.

Meeting only provided opinions. No indication of where EPA is going on these issues.

(1) Make name tags with first & <u>last</u> names in large print. Some of us know names, but would like to be able to put faces to those names. The last names are so small one must get very close to someone to read the name tag. In certain situations that could be very rude. (2) I appreciated the fact that the panels consisted of people with opposing views. This was especially good for EDS and Biological measures.

I think I could have formulated better questions (to ask presenters and EPA) if I had more advance information prior to the conference. Perhaps sending out abstracts before the meeting would serve this purpose. Also, I heard a lot about WQ problems that we face today, but I'm not sure I'm clear on what lies ahead in the area of criteria (more stringent or same?).

Thanks for making this a "free," i.e., no registration fee, conference! Format good. Manageable number of topics. Appreciate the level of EPA management involvement. Please choose a better location next time (e.g., Seattle, Minneapolis, Boston, etc.)!

It would be useful to have regional-based meetings more frequently than the 18-month national meeting--where specific topics can be defined. National and regional EPA staff could attend. Meetings should be set up without specific speakers, but with moderators. Breakouts should all be on the same topics, but limited to a round table discussion of 25-30 people. Attendees should be prepared to discuss their specifics related to each topic so that problems that EPA, States, dischargers, environmentalists face can be dealt with and regional solutions can begin to be proposed. Once WQ solutions are proposed, there must be interaction with solid waste and air quality groups before implementation.

ECOLOGICAL RISK ASSESSMENT COMMENTS

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Ecological risk assessment for the water quality program should in no way, shape, or form resemble that developed for the Superfund program. There are several reasons for this. First of all, the division of areas in Superfund sites for study has little to do with natural divisions of these sites, such as habitats or ecosystems. Sites are divided into Operable Units, perhaps based on types of facilities such as landfills or storage tanks. Sites have to be redivided to conduct ecological studies. Often Operable Units are studied by completely different contractors using different methods. Coordination is not often achieved.

Second, the organisms selected for study are not the most important or representative species. Rather, species for which there is the most toxicological and physiological information are chosen. A "big worm" might be selected (usually by an engineer and not a biologist) over a "little worm," although the "big worm" is a completely different organism and not relevant to the ecosystem being studied.

Third, ecological risk assessments, if carried out completely according to the Superfund guidance, are very complicated and expensive studies. The money is available in the Superfund program for studies at the sites that require multiple models and risk calculations for several different chemical compounds and species. Dischargers or regional management agencies for water projects cannot afford these kinds of assessments.

My recommendations for development of ecological risk assessment, therefore, are as follows: (1) before developing guidance, EPA should put money into getting a lot more physiological/toxicological information on a variety of species that are "out there" in the environment; and (2) ecological risk assessments should not even be considered at a "point source" or "water project" level; they should be done at a waterbody or watershed level such that several agencies or groups can coordinate methods and results, and contribute to funding.

Two panel participants responded to my comments. Dr. Spyros Pavlou said that he felt the Rocky Mountain Arsenal studies were coordinated and used representative species. He agreed that the studies for this Superfund site were very sophisticated and expensive, well beyond what even a smaller Superfund site would require. Joshua Lipton said that the panelists had discussed funding options earlier that day and that these included the following: have the Office of Water fund it all, have municipalities or groups thinking about site-specific objectives pay for assessments, have the States pay, or have industries pay . . . or win in Vegas.