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Perspectives on Nonpoint Source Pollution Pt. 1 of 5

US Enivironmental Protection Agency

PERSPECTIVES ON NONPOINT SOURCE POLLUTION

Proceedings of a National Conference

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FOREWORD

A cursory scan of this book will tell the reader that this is no ordinary proceedings of a conference. Indeed, the papers published here reflect a conference that was neither ordinary nor routine. These papers are very dissimilar—in length, in format, in tone. But they are alike in one vital way: each represents a slightly different perspective on the problem of nonpoint source pollution of our Nation's water.

And that was the intent: to gather together all those organizations and individuals concerned with this problem and to draw from them the most practical ways to deal with it.

As Assistant Administrator for Water at the U.S. Environmental Protection Agency, Jack Ravan conceived this conference as an integral part of the Agency's approach to nonpoint source pollution. The other three components are discussed in this volume: ASIWPCA's survey of the States (being completed this fall); the Federal Nonpoint Source Task Force (which concluded its initial policy and strategy development at the end of 1984); and the Chesapeake Bay study now underway by the National Association of Conservation Districts.

Ravan's instructions for this conference were fourfold: (1) focus on drawing information from everybody involved with the problem; (2) find out how people throughout the country, at the local level, perceive the nonpoint source problem and how they believe it should be handled; (3) make the information flow from the grass roots upward—the Federal role was to listen and learn and exchange information, not to dominate; and (4) make it practical.

The conference steering committee took this charge very seriously, designing a structure that stimulated this flow of information. The program committee fleshed it out, using both submitted and invited presentations.

The result was essentially a practical dialog. Of course, it cannot be fully covered in these presentations, but they will serve to remind participants of the equally valuable informal exchanges that took place during the week in Kansas City.

Four basic themes evolved as the conference developed.

Practical, affordable solutions not imposed by Federal authority but worked out at the local level was the message of the keynoter, Congressman Pat Roberts of Kansas' First District.

The knowledge exists, participants reiterated throughout the sessions. Putting it to work is the next step.

Nonpoint source pollution is best solved at the local level, concluded Robert I. Broadbent, Assistant Secretary for Water and Science at the Department of the Interior, as he moderated the closing plenary session. Broadbent's conclusion was drawn from two days of listening to sessions and to individuals—and is repeated throughout this volume. Discussions of new State programs in Missouri and Maryland reinforce this belief.

Cooperation is the key. Ravan sounded that note at the opening plenary—and it continued to be apparent throughout the conference. Nearly 40 organizations came together to cosponsor this conference—many others were represented among the attendees. In the real-life capitals of this country, these organizations often find themselves at odds; many had never talked over their mutual concerns.

This conference certainly began such a dialog. And, as a session chairman, Roger Bollinger, observed, there was evident a willingness to talk, a maturity "that may allow us to truly begin solving our water quality problems."

If a mature optimism and diversity of perspective were its hallmarks, then this conference's true success can be measured only by how we move forward from here. We have the information—in this volume, from this conference—but the communication established must translate into working together to improve the quality of our Nation's waters.

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The Honorable Arlan Stangeland
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The Policy Perspective—A Look to the Grass Roots

WELCOME TO CONFERENCE

LEE M. THOMAS
Administrator
U.S. Environmental Protection Agency

We have made steady progress toward attaining the Nation's water quality goals since the passage of the Clean Water Act of 1972. Much of this forward movement has been accomplished by controlling industrial and municipal point sources. Further achievement will require accelerated implementation of nonpoint source management programs in addition to our ongoing point source control efforts.

Many States and local governments have already taken steps to address their nonpoint source challenges. Given the nature of nonpoint source pollution, State and local management is a key. Only at this level does enough flexibility exist to make site-specific and source-specific decisions that really work.

Of course, EPA and other Federal agencies have an important role as well. Our nonpoint source pollution control program is getting increasing attention as we implement recommendations of our interagency Nonpoint Source Task Force established a year ago. The Task Force's national policy provides direction for future initiatives by Federal, State, and local agencies, and, most importantly, by the private sector.

We intend to incorporate nonpoint source concerns into all aspects of water management. It is EPA's job to provide national coordination and oversight, give practical assistance for nonpoint program development, and promote innovation. We are intensifying our efforts in each of these areas. We will continue to work with other Federal agencies, such as the Department of Agriculture, to better use their existing programs to address nonpoint source needs.

In a report to Congress in 1984, EPA summarized what is known about nonpoint source pollution, concluding that it is among the leading causes of the Nation's remaining water quality problems. Specifically, the report said that in six of 10 EPA regions nonpoint sources are the principal remaining cause of water quality problems. Half of the States say that nonpoint pollution is a significant source of their difficulties, and virtually every State reports some kind of water quality problem related to these sources. Research suggests that lakes, reservoirs, and estuaries, like Chesapeake Bay, are particularly vulnerable to nonpoint pollutants.

The report identified agricultural operations as the most pervasive nonpoint source in every region. Nonpoint source impacts from urban areas, mining, forestry activities, and construction sites also deserve attention.

As you well know, managing nonpoint source pollution is not easy, institutionally or technically. Nonetheless, effective steps can be taken to control it. The basic approach under the Clean Water Act for managing point sources—technological controls for classes of dischargers—is not appropriate for nonpoint sources. Instead, flexible site-specific and source-specific decisionmaking is the key to success.

States must take the lead in managing nonpoint sources because they have the adaptability, perspective, and intimate knowledge to develop such site-specific solutions. They can easily reach individual landowners and operators and help them change the way they manage their land.

Experts at this level are in the best position to determine which surface or ground water problems are related to nonpoint sources, establish which waters will receive priority attention, determine what type of control strategy is needed, and evaluate progress.

Substantial, cost-effective water quality improvements have been made by carefully targeting control activities. Targeting schemes need to identify the principal sources of nonpoint pollutants as well as determine which waterbodies are most likely to benefit from intensive work.

Recent studies indicate that off-site impacts of erosion cost the Nation an estimated $6 billion a year, with over $2 billion accounted for by cropland erosion alone. These costs include:

- waterways polluted by sediment and agricultural chemicals,

- destruction of breeding grounds for fish,
- increased expenses for dredging harbors and treating wastewater,
- higher riverbeds leading to greater flooding, and
- reservoirs and lakes silting up more quickly than anticipated.

Although it takes resources to address nonpoint problems, direct and indirect costs are clearly associated with *not* coming to grips with this problem.

An area of growing concern is toxics, from pesticides and other chemicals applied to the land, entering ground water. A new study of pesticides in drinking water drawn from ground water, now in the design phase, will provide a national picture of the extent of the problem. We are also working on policies to reduce this potential threat to drinking water supplies.

A new report to be completed this fall by the Association of State and Interstate Water Pollution Control Administrators will provide an important baseline of data on State nonpoint problems and the status of current State management efforts. This information will be used to better assess nonpoint problems and as a basis for policy decisions.

The challenge for this conference is to exchange knowledge of the nature of nonpoint problems and what control approaches work. I am hopeful that this conference will be a turning point for nonpoint source management—that the exchanges of ideas here will result in a surge of awareness and commitment to nonpoint implementation efforts at all levels.

On a final note, I want to emphasize that nonpoint source control is at the top of EPA's agenda; it is clearly identified as a priority issue in EPA's Agency Operating Guidance for FY 1986–87. We are committed to work with States to incorporate nonpoint control measures into their water quality programs. This issue must receive attention at all levels of government; but a more aggressive approach at State and local levels, in concert with the private sector, is absolutely essential for substantial progress. With that commitment we will eventually get a grip on this persistent and growing problem and begin to bring it under control.

PAT ROBERTS

U.S. House of Representatives
First District, Kansas

I noticed from the program that this conference's co-sponsors are a very diverse group. I think that is very appropriate and in keeping with the purpose of the conference—to gather practical information from the grass roots level. Too often in Washington we create laws and programs without listening to those back home who know better.

I thought today I would try to bring you up to date on what is happening in Washington in regard to the nonpoint source pollution issue and make a comment from my perspective on what needs to be done. In terms of precedence the budget and the farm bill come first.

But let me give you a little background. I represent a district that produces more wheat than any other State. My district, the First District of Kansas or as we call it "the Big First," is larger than the State of Virginia. From the time that our pioneer forefathers brought "Turkey Red wheat" to Kansas in the 1870's, we have excelled in producing hard red winter wheat. In addition to wheat, however, my district is number one in the production of grain sorghum and the cattle industry is a vital segment of our economy. As a matter of fact, I noticed the other day a "Washington Post" story on the 20 counties in the Nation that are most dependent on farming as a source of income. In that list of 20 counties, I have the privilege of representing five. Needless to say, the difficult times we are experiencing in farm country have had a severe impact on my district and the high plains.

As a footnote, my district during the "Dirty 30's" was always on the move. One day it might be blowing into Nebraska and the next day back into Oklahoma. That was back in the days before we called the Kansas wind a nonpoint source of pollution. Perhaps air coming from Washington is a point source!

Our number one priority this year is writing a farm bill that will put a profit back into agriculture. Without profit any rural management plan be it local, county, State or Federal will not be successful! The very existence of the farmer-stockman, agribusiness and main street rural America is threatened today by the continuing problems of the budget deficit, low commodity prices, and the high interest rates. I won't go through the long list of problems that have plagued the farmer. Instead I am going to try to outline some solutions.

First the budget. Two weeks ago the Senate passed a budget resolution that does represent a ray of hope. The budget package calls for $56 billion in cuts in 1986 and about $295 billion over the next 3 years. It effectively freezes defense spending, and provides for a one year cost of living adjustment freeze on Social Security, Veterans, and Military/Civilian Retirement. It does not call for tax increases.

The package has a long way to go. it is our turn now in the House, but it is a good start towards reducing the deficit, bringing interest rates down, and keeping the economy on a steady path.

Specifically for agriculture, the budget was very positive. It added $3.5 billion back to earlier agricultural budget proposals. It provides for a 2 percent matching interest rate buy-down for credit-strapped farmers, restored some funding to soil and water conservation, provided $1 billion per year for farm credit guarantees and a new export incentive program using a billion dollars worth of CCC stocks to counter foreign subsidies and get our grain competitive in world markets. While this budget is not the across the board freeze I have been supporting, it is a major step in getting our Nation's fiscal house in order.

SEEDS OF RECOVERY

Let me turn now to the farm bill. Because of the budget battle, work on the farm bill has been delayed. The farm bill we write will have to be budget responsible. Given the limited budget, one of the major hurdles we face is how to be competitive and regain export markets without bankrupting a whole generation of farmers.

In spite of the tight budget, there seems near unanimous support in Congress this year for some type of long-term land retirement program to take highly erodible cropland out of production. I predict that the farm bill signed into law later this year (I hope it gets done this year) will have a long term land retirement program that will take up to 20 million highly erodible acres out of production for 10- to 15-year periods. I also predict that the farm bill will contain strong "sod buster" language to end the current policy of rewarding farmers who plow up fragile land.

These two programs will go a long way in reducing soil and water erosion and hopefully in controlling nonpoint sources of pollution from agriculture.

This is not to say that agriculture's role regarding nonpoint pollution will not be significant or without controversy. In their 1984 report to Congress, EPA identified agricultural operations as the most pervasive nonpoint source in every region of America. As a result of this report and our substantial gains in controlling point source pollution, attention has once again focused on nonpoint pollution as a problem that must be addressed.

It is the opinion of this member of Congress that the most effective control of nonpoint source pollution can best be accomplished with Federal help at the State and local level. States must take the lead in managing nonpoint sources because they have the adaptability, perspective, and knowledge to develop appropriate site-specific solutions. The last thing the farmer needs in these difficult economic times is a massive new set of Federal regulations to tell him how to control runoff. Let's get the problem solved—let us not repeat EDB.

On May 2, the Senate Environment Committee rejected a provision during consideration of the Clean Water Act to set specific limits for pesticides, fertilizers, and other point source pollutants. However, the Senate Committee did adopt a provision to require States to establish a management program and authorized $300 million in grants to help States set up the programs. Action on the Clean Water Bill is still pending in the House.

Farmers are faced with the challenge of surviving in a very competitive industry. In an effort to reduce costs, the use of conservation and minimum tillage is on the rise. However, this has the downside risk of increasing pesticides and herbicides use to control what tilling used to control. One of the best nonpoint pollution controls is promoting sound conservation practices.

I have always felt that the farmer is the true conservationist. But in these perilous economic times, the farmer is often forced to choose between building terraces and paying the mortgage. I urge this conference to bear in mind throughout your discussions that the farmer is undergoing a cost-price squeeze bear hug! Any new policies for controlling nonpoint pollution must not impose heavy financial burdens on the agricultural community. You must keep in mind the cost versus the benefits of nonpoint control.

And, you cannot expect the farmer to bear the entire cost of controlling nonpoint sources of pollution while most of the benefits will accrue to society as a whole. If we must have expensive new control methods, society must share in the cost. With the record budget deficits we have in Washington, the money may not be there to help. Again, that is why we must make this effort one of a partnership.

Once again, thank you for the invitation. My final thought is best summed up by a statement from EPA Administrator Lee M. Thomas:

> Nonpoint pollution . . . must receive the attention it deserves at all levels of government, but a more aggressive approach at State and local levels is absolutely essential for substantial progress. With that commitment, the Nation will eventually get a grip on this persistent problem and ensure that continued progress is made towards meeting our water quality objectives.

NONPOINT SOURCE POLLUTION—A PROBLEM FOR ALL

JOHN R. BLOCK
Secretary
U.S. Department of Agriculture
Washington, D.C.

On May 20, 1927, a young American aviator took off from a New York airfield—alone—and headed for Paris, France. That historic flight across the Atlantic by Charles Lindbergh helped set the stage for a technological revolution in space that still goes on today. But equally important, it reminds us that American know-how, American initiative, and American success, are based on one important ingredient: the determination that makes Americans willing to take a chance.

I prefer to think of those chances as challenges. And when it comes to nonpoint source pollution, I suspect that many of those challenges will require as much determination as Lindbergh needed if we are to really succeed in our role as stewards of our natural resources.

It's no secret that we have serious water quality problems all across this country. The sources of these problems cut across every segment of our society, including agriculture and governmental policies. But nothing can be gained by each of us pointing a finger at someone else. Likewise, nothing will be accomplished toward correcting these problems by complaining that someone else is not doing enough. Rather, the true measure of success will come only after we have cast aside such judgmental temptations and have joined together to make maximum use of our limited resources.

The Department of Agriculture is celebrating the 50th anniversary of the soil and water conservation movement this year. Over the years, we have faced many challenges as stewards of our Nation's soil and water resources. And we are understandably proud of the accomplishments made through USDA programs in meeting those challenges.

Nonpoint source pollution control is one specific challenge that has come to the forefront in recent years. Contrary to what some may believe, we have not shied away from this challenge in the Department of Agriculture. We have been providing financial and technical assistance—as well as a proven educational delivery system—all along. Those efforts are part of our mission. We call it conservation. And we shall continue to fine tune our efforts and adjust to meet new goals as they are established.

Certainly, preserving and protecting the quality of our water resources is now, and shall continue to be, an important part of this overall effort. We know about the challenges. We know about the limitations on available resources. And, we know that we need your cooperation—and your ideas—to implement a workable strategy that will contribute to raising the quality of our water supplies.

The President's 1982 National Soil and Water Conservation Program established nine priorities for the use of USDA soil and water conservation program funds. Our commitment to solving water problems is second only to erosion control. In 1984, our USDA conservation agencies spent $66 million to improve water quality alone. We are indeed committed to improving the quality of our Nation's water supplies—within the limits of our financial resources and our traditional responsibilities.

Currently we are looking at the off-site effects of soil erosion, particularly as it concerns water quality. We are also funding special studies to look at nonpoint source pollution relationships to ground water quality. We have our work cut out for us. Where State and local officials have identified water quality to be more important than gross soil erosion, we stand ready to target our resources into nonpoint source pollution from agriculture.

Winston Churchill once said: "You can always count on the Americans to do the right thing...after they've tried everything else." Well, I think this is the time and the place to prove Mr. Churchill wrong. Let's not wait until we've each tried everything else.

Let's begin working closer together now, joining forces, to find out what does and does not succeed; and then let's draw upon that combination of good, old-fashioned American determination and modern technology to solve our water quality problems.

A CONGRESSIONAL VIEWPOINT ON NONPOINT SOURCE POLLUTION

ARLAN STANGELAND

U.S. House of Representatives
7th District, Minnesota

I commend the organizers of the conference on nonpoint source pollution for scheduling 3 days of intense study and discussion of what is a growing and increasingly visible problem. With the mechanisms for point source pollution largely in place, although certainly not without flaws, a major thrust is needed to address nonpoint source pollution. The beginnings of that thrust are reflected to a significant degree in the 1985 amendments to the Clean Water Act, which are receiving committee action in Congress now.

The Senate Environment and Public Works Committee has reported its version of the Clean Water Act amendments, and the Water Resources Subcommittee of the House expect to mark up our own bill with full committee action to follow. The bill is designed to significantly improve the effectiveness of the Nation's water pollution control program, and nonpoint source pollution control is a very Important part of this legislation. And well it should be.

We have been at this procedural point before, of course, with a very similar legislative vehicle. I am hopeful that this year, unlike last year, clean water legislation will reach the floor in both houses. However, while the Senate committee has indeed reported its bill, filed its report, and scheduled a tentative date for floor consideration, some 20 holds have been placed on the bill as reported, mostly becaose of disagreements over the allotment formulas.

Despite our disappointment in not finalizing Clean Water Act amendments last congress, I think it is fair to say that the time spent on this issue has been time well spent. As a quick summary, our subcommittee has developed over the past 3 years an extensive record on possible amendments to the Clean Water Act. Following the signing into law of the Municipal Wastewater Treatment Construction Grant Amendments of 1981, the subcommittee held 5 days of hearings on the Clean Water Act in 1982; approximately 2,400 pages of testimony were received. During the 98th Congress, we held an additional 15 days of hearings on the same subject, receiving more than 3,700 pages of testimony.

With that very substantial hearing record, we reported a bill and brought it to the House floor, where it passed on June 26, 1984, by the overwhelming bipartisan vote of 405 to 11. However, the Senate failed to bring its bill to the floor before adjournment.

This year, Chairman Jim Howard has introduced H.R. 8, of which I am a cosponsor, and which could reauthorize the Clean Water Act into the next decade, including a number of significant new programs and improvements in many existing ones. Although this bill is quite similar to that which our committee reported and which the House passed in the last congress, substantial changes have been made. In fact, as the result of weeks of study, including 2 days of hearings, our subcommittee has developed new language taking into account recommendations of the Administration and affected interest groups as well as provisions in the Senate bill.

Consequently, the bill we will be marking up in subcommittee reduces the authorizations for the Construction Grants Program from the $3.4 billion annually contained in last year's bill to $2.4 billion per year in FY 1986-90, retaining the Federal share at 55 percent rather than raising it to 85 percent as the House bill proposed earlier.

Grants for State water pollution control revolving funds would be cut from $1.6 billion annually to $600 million annually for FY 1986–90. Then, when the construction grants cease, $6 billion would be authorized for the revolving fund program over the next 4 fiscal years.

NPDES permits would continue for a maximum of 5 years, except in those cases where nontoxics are involved, or only insignificant amounts of toxics and no adverse effects on the environment. For these cases, permits could be for 10 years, but quality standards would still apply.

The 4 percent set aside of construction grant funds for rural areas would be increased. States that have 25 percent or more of their population in rural areas will be able at the Governor's request, to use from 4 percent to 7.5 percent of their State allotment under the Program for Alternatives to Conventional Treatment. The Senate bill would make no change in the current 4 percent set aside.

Fundamentally different factors (FDF), at a facility, variances from the best available technology based on the presence of *fundamentally different factors* from those considered by EPA in developing the best available technology (BAT) effluent guidelines, could continue to be granted, but only in those cases where the facility involved furnished information to EPA *during the rulemaking* or did not have a reasonable opportunity to do so.

Of course, when we get to subcommittee and full committee markup, amendments could be added to our subcommittee's preliminary deliberations on the bill. We have a number of new programs with large price tags in this bill, and even though we have pared funding back in a number of programs, some programs may not survive in conference. Moreover, even if this legislation authorizes funding at higher levels, the budget process might impose additional limits on the appropriation committee's ability to appropriate funds above current levels.

The legislation now before our committee, like its predecessor in the 98th Congress, reflects what has become the conventional wisdom that the uses desired for our Nation's rivers and streams will not be achieved without control of nonpoint sources of pollution. We have not lost sight of the fact that the 1972 act had as one of its goals the achievement by July 1, 1983, wherever attainable, of fishable and swimmable water quality in all of the rivers, lakes, and streams of this Nation. In the past, the primary thrust to achieve this goal has been through the discharge of pollutants from point sources. We are rapidly learning, however, that point sources are not the whole problem, and unless the problem of nonpoint pollution is solved, many rivers and lakes will not be able to meet this fishable–swimmable goal.

Nonpoint source pollution is an enormous problem for our farmers, just to cite one example, both in terms of the loss of billions of tons of topsoil and the degradation of water quality in nearby streams and lakes. Millions of acres of productive farmland are removed from cultivation each year because of eroded soils. By the same token, the herbicides, pesticides and nutrient-rich fertilizers that flow in streams along with the eroding topsoil destroy aquatic life. It poses a strong land management challenge, and one which must be met.

This problem underlines the urgency of seeking methods of controlling nonpoint source pollution to provide the desired environmental benefits without placing intolerable operational cost burdens on the agricultural community.

In many areas, throughout this country, nonpoint sources are the major cause of water pollution. In fact, estimates are that more than half of all the pollution in the Nation's streams comes from nonpoint sources. More specifically, the Environmental Protection Agency testified a few years ago that of the Nation's 246 river basins, 68 percent were affected wholly or in part by agricultural runoff, 52 percent by urban stormwater runoff, and 30 percent were by mine runoff.

The threat posed by nonpoint sources, as well as point sources, makes it clear that we need a balanced approach to the problem of water pollution control in general. H.R. 8 underlines the point well at the outset by expressing that the National policy plans for the control of nonpoint source pollution be developed and implemented in an expeditious manner, so that the goals of the act may be met through the control of both point and nonpoint sources of pollution. In other words, as a National policy, we should control point and nonpoint sources in a balanced manner.

And once nonpoint source pollution is given its proper priority, it is important that the States play a role in the planning and implementation of the required nonpoint abatement measures. Land use management has traditionally been a State role, and, while the Federal Government has a legitimate interest in addressing certainly a National problem, the States should be permitted to develop their own programs and management practices.

In H.R. 8, we give them that responsibility. We require States to set up programs to take a look at the problem of nonpoint source pollution, to examine the courses of action that might be taken and the alternatives available to deal with the problem.

The bill provides some important funding authorizations for programs dealing with the control of nonpoint sources. It reauthorizes the existing section 208 areawide planning and clean lakes programs and provides some major new initiatives.

One such new initiative is a program of grants to States to control nonpoint sources of pollution, for which $150 million would be authorized through 1990. States would be required to develop and implement nonpoint source pollution control plans on a watershed-by-watershed basis, with the Federal Government providing grants of up to 50 percent to States to implement their plans.

The Federal share could rise to as high as 60 percent if a significant number of nonfederal and nonstate interests in a watershed agree to participate in nonpoint source pollution control measures. In developing and implementing its plan, a State would be required, to the maximum extent practicable, to use local, public, and private agencies and organizations of expertise in control on nonpoint sources of pollution.

In a similar fashion, the bill reported by the Senate committee provides 75 percent grants to assist in the implementation of approved management programs. The Senate bill authorizes somewhat lower funding levels: $70 million for 1986, $100 million for FY 1987, and $130 million for 1968. In addition, the Senate bill contains a new set aside of 1 percent of a State's allotment or $100,000, whichever is greater, for the purpose of carrying out a State's nonpoint source pollution program.

The cause of nonpoint source pollution control is certain to be advanced further by a significant change our bill makes in the discretionary funding provided under the Construction Grants Program.

The 20 percent of a State's annual allotment is now available at the Governor's discretion for otherwise ineligible categories and is specifically available for control of nonpoint source pollution, including innovative and alternative approaches.

Another important nonpoint source provision in H.R. 8 authorizes $100 million annually through 1990 in grants to States for priority projects designed to control nonpoint sources of pollution that contribute to the degradation of water quality in lakes. In addition, the Clean Lakes Program would be made applicable to saline, as well as to fresh water lakes. Federal funding could provide up to 70 percent of the cost of a project implemented under this provision. This amounts to a major expansion of grant authority for restoration of the water quality of lakes.

Our House bill also addresses the problem of acid deposition in our lakes and streams. It authorizes $25 million per fiscal year for each of the FY1986 through 1990 for grants to States to carry out approved methods and procedures to restore water quality, which has deteriorated because of high acidity. We also provide $25 million annually over the same period for a demonstration program to restore the biological integrity of acidified lakes and watersheds through liming. The purpose would be to determine the effectiveness of liming in reducing the acidity of lakes and watersheds, and in restoring their biological integrity.

The bill also extends the Rural Clean Water Program at a level of $50 million per fiscal year. This program is administered by the Department of Agriculture and provides valuable assistance to farmers to control pollution runoff from agricultural land.

As a means of improving the water quality of estuaries, the bill adds a new provision to the Clean Water Act authorizing the EPA administrator to convene an interstate management conference where he or she determines that control of point and nonpoint sources of pollution is needed in more than one State. The provision is founded on the definition of the term "estuarine zone," which is intended to include an entire basin of watershed.

The management conferences would develop a comprehensive master plan for the estuary, coordinate the implementation of that plan by participating States, recommend corrective actions to be taken against the most serious point and nonpoint sources of pollution, and finally, monitor the program's effectiveness.

To fund these management conferences, H.R. 8 as introduced would have authorized $195 million over the next 5 years. The bill we expect to mark up will reduce this amount to $75 million. The Senate's bill has a similar provision but at an even lower funding level. Under our bill the Federal grants to participating States or interstate agencies would amount to 55 percent of a State's or agency's cost of implementing the master plan for each fiscal year.

Estuaries have all too often been the dumping grounds of much of our National waste. Estuarian habitats are disappearing, and we need to act swiftly to protect these natural ecosystems while there is still time to act. The provisions in H.R. 8 help meet that need by providing important protections for our estuaries.

The problem of ground water contamination from both point and nonpoint sources is also addressed in H.R. 8. It authorizes $150 million for each of 1986–86 to provide grants to public water system operators and units of local government, to make alternative water supplies available to users whose water from nonpublic water systems is made unfit for consumption because of ground water contamination.

The grants can be used for providing these alternative water supplies on a temporary basis, and for permanent remedies, including drilling new wells and installing new pipes.

The Federal share will be 50 percent, with an annual maximum grant of $2 million per applicant. EPA will report to Congress each year on progress made under the grant program.

The Agency would also be authorized to make grants to assist States in carrying out ground water quality protection activities as part of a comprehensive nonpoint source pollution control program; $7.5 million each year for 5 years is authorized for this purpose. The activities eligible for the grant program include research, planning, ground water assessments, demonstration programs, enforcement, technical assistance, and education and training to protect the quality of ground water and to prevent contamination of ground water from nonpoint sources of pollution.

The importance of controlling ground water contamination has been given special emphasis with the establishment of a National Ground Water Commission, which actually was approved as part of the Resource Conservation and Recovery Act passed in the 98th Congress and signed into law last November.

Although the administration has not recommended funding, the 18-member commission would be responsible for inventorying the Nation's ground water resources and the extent of contamination, projecting the future availability of usable ground water, examining methods for the abatement and containment of ground water contamination and for aquifer restoration, and assessing the roles of government (State, local and Federal) in managing ground water quality and quantity.

All in all, our proposed bill is another strong response to the need to preserve and enhance the quality of our Nation's precious water supplies. Of special importance to those at the nonpoint conference, it expands the scope of its coverage to address many of the issues raised by nonpoint source pollution.

In many respects, it is a new beginning, but a strong beginning, as we seek to develop the most cost-effective and politically feasible ways of dealing with this problem.

I think that the clean water bills under consideration in the House and the Senate are coming together. The Senate clearly has a major problem to iron out concerning a new and highly controversial allotment formula based on logarithms and logarithms cubed. If they can resolve the allotment formula and agree to take the bill to the floor, I believe the chances of enacting meaningful reauthorization legislation—legislation that will introduce new directions in the field of nonpoint source pollution—would be greatly enhanced.

Perspectives on Nonpoint Source Pollution

NONPOINT SOURCE POLLUTION—THE ILLINOIS APPROACH

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The 208 Water Quality Management Plan, completed in January 1979, designated the Illinois Department of Agriculture as the lead agency in dealing with nonpoint source pollution. As major strides are made in reducing industrial and municipal waste pollution of our rivers, streams, and lakes, progress in controlling nonpoint pollution appears to have stagnated and perhaps even been set back.

Today, we are told that soil erosion is worse than in the 1930's. After 50 years of the conservation movement in this country, we surely should have been able to make a difference. We have made a difference. The soil erosion problem is not as severe as it would have been if left unattended.

Several reasons account for our current depressing situation, including a lack of financial resources, existing farm crises, duoculture agriculture, and existing conservation philosophy.

In response to the national clamor to clean up our rivers, lakes, and streams, the Federal and State governments have devoted vast financial resources to eliminating industrial and municipal waste for those waters. At the same time, funding for soil conservation has been sorely neglected. In fact, the Federal government's role in soil conservation has been slowly shrinking for the past two decades, and State government participation in the effort to fight erosion has been miniscule.

During the late 1970's and early 1980's, the agricultural community has put into production considerable amounts of highly erodible land. These lands were brought into production in response to the boom years of the 1970's and the need to produce more to lessen income decline during the 1980's.

The dependency of farmers on the duoculture of corn and soybeans has eliminated, in a lot of areas, the old system of crop rotations. This process has increased erosion.

Frequently, conservationists say, "I want to leave my land in better shape than I found it," or "I need to maintain production so that I can contribute to feeding the world." While very noble, this does not explain the benefits of conservation to the urban populace. We need to emphasize off-site benefits such as improving water quality, and extending the life of lakes by reducing sediment, by reducing ditch-cleaning activities, by reducing dredging, and so forth.

Having discussed some of the problems confronting us in battling nonpoint source pollution, I will describe what we are doing in Illinois. Initially, assistance to soil and water conservation districts by State government was limited essentially to technical and educational assistance. However, in FY 1985, the State provided approximately $2.2 million for the districts to operate programs and employ technical staff. Also, the State has increased funding for soil surveys from $200,000 in FY 1981 to $614,000 in FY 1986. As you can see, the State has made a financial commitment to soil conservation that will increase in the future.

Since water quality became a national issue and the 208 Water Quality process has been completed, nonpoint sources of pollution have received much attention. As a result, the Illinois General Assembly passed the State Soil Erosion and Sediment Control Guidelines. The State's guidelines set forth the following:

January 1, 1983: soil loss at or below 4T

January 1, 1988: land 5 percent or less slope—T, land greater than 5 percent slope—2T

January 1, 1994: land greater than 5 percent slope—1.5T

January 1, 2000: all land at T

Additionally, the State program required each of the 98 districts to prepare and enact their own set of guidelines by April 18, 1982; however, these could not be less restrictive than the State guidelines.

Unfortunately, many viewed these standards as the plan to reach T by 2000. However, the standards are goals or benchmarks to be achieved by 1988, 1994, and 2000.

Consequently, the Department of Agriculture requested that each of the 98 districts prepare a T-by-2000 Plan to provide a road map for reaching T by 2000.

These local plans have been synthesized to form the State T-by-2000 Plan. The plan is divided into two parts: (1) statistical, and (2) action. The statistical part of the plan details information on technical staff years needed, education staff years needed, cost of required resource management systems, and the number of acres needing treatment. The action part of the plan details programs to be instituted and members of the local conservation team responsible for various parts of implementation.

The plan has brought to light some startling information concerning manpower and financial resources needed to reach T by 2000 in Illinois. Some of the findings are as follows:

- Contrary to popular belief, conservation tillage is not a panacea for our erosion problems. Only 199,315 ha (498,288 acres) of the 4.64 million ha (11.6 million acres) needing treatment can be treated solely by conservation tillage.
- In addition to existing Soil Conservation Service and district personnel, 197 new staff positions are needed to provide the necessary technical assistance to reach T by 2000.
- $1 billion needs to be expended on enduring practices by 2000 to meet T.
- 72,392 farms will need some conservation practices.
- 1,186 Cooperative Extension Service staff years will be needed for educational purposes between now and 2000.

As a result of the T-by-2000 planning effort, the Illinois General Assembly is considering a 5-year $20 million cost-share program. These monies will be cost-shared with farmers on the construction of conservation practices. The program will be divided equally between a traditional Agricultural Conservation Program approach, where every county receives an allocation, and a watershed approach, in which lakes supplying water will receive the highest priority. The purpose of the watershed approach is to improve water quality and extend the life of lakes used as water supplies.

The SCS in Illinois is developing a conservation plan based on hydrologic units to complement the State's effort. The hydrologic unit approach will not only allow us to enumerate on-site benefits but it will enable better documentation of off-site benefits.

The SCS response comes on the heels of efforts in Washington to seriously shrink the budget commitment to the Soil Conservation Service. The logic of cutting funding when the needs are obviously becoming greater is beyond me. To cripple the efforts of SCS by reducing funding to the levels proposed by the Reagan administration seems to me a serious mistake.

I believe that most everyone in Washington realizes the problem, with the possible exception of the people at the Office of Management and Budget. Details are pending on the mandatory soil erosion control levels recently introduced as amendments to the Clean Water Act in the Senate. Point source pollutants have faced such regulations for more than 15 years. However, voluntary compliance has been our preferred approach for nonpoint source pollution control. Obviously, we have not accomplished what we might have hoped. If we reduce our commitment to this effort instead of increasing it, we will face failures more frequently.

Even though these mandatory soil erosion control amendments have been offered, I am told the support will not be ample to see enactment in 1985 . . . we may have 1 or 2 more years to demonstrate the ability to voluntarily comply before we face a serious threat of mandatory regulations. We will avoid such regulations only if we become very serious in addressing this problem soon.

A few weeks ago, the Conservation Foundation released a study called Eroding Soils . . . the Off-farm Impact. The report estimated that the degradation of water as a result of soil erosion costs the Nation $6 billion each year. According to the report, fishery yields have been reduced, recreational opportunities have been hindered, drinking water supplies and quality have diminished, and navigational channels have experienced heavy sedimentation.

I do not feel that agriculture is the sole offender. As the Conservation Foundations' report explained, runoff from construction sites, mining operations, and other areas are strong concerns. But, we cannot deny that a tremendous amount of the concern falls within agriculture. We cannot begin to address such a problem without adequate support.

I would challenge anyone to do whatever is within his or her means to generate support for controlling nonpoint source pollution . . . at whatever level. It is my strong belief that a much stronger commitment is necessary from the Federal level; however, we should not rely on the Federal government to carry the entire burden. State and local governments should also become involved. The situation is serious and the needs are immediate.

THE FERTILIZER INDUSTRY'S PERSPECTIVES ON NONPOINT POLLUTION

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ABSTRACT

The fertilizer industry, through its national association, The Fertilizer Institute (TFI), is taking a very positive role in helping reduce the amounts of nutrients that make their way into our Nation's waterways. TFI has launched an extensive educational campaign to make the fertilizer industry aware of nonpoint pollution problems and to encourage voluntary use of agricultural best management practices (BMP's). Industry views the nonpoint pollution issue as a legitimate concern, despite the lack of information pinpointing sources of the problem. Broad educational efforts already reaching retailers, producers, and growers throughout the country have highlighted the need for action to curb possible nutrient losses. In addition to BMP's, actions include judicious applications of fertilizer (based on soil test recommendations), soil conservation measures, and proper timing of field operations. Reduced nutrient losses are also seen as a means to help maintain a viable and efficient farm economy, since sound management of nutrients can maximize productivity and ease farmers' financial burden. By working with farmers to help them design fertilizer management programs, industry can help farmers increase profit per acre while at the same time reduce the amounts of nutrients lost to the environment. Continued educational efforts with State and regional industry groups, national and local legislation, and other concerned groups will help to find responsible solutions to the nonpoint runoff problem.

My fertilizer retail business serves customers who raise crops in the Chesapeake Bay watershed, an area obviously affected by nonpoint runoff, itself an issue of concern to me and to my farm customers. As a businessman, I take very seriously the potential loss of nutrients through runoff, because such losses are costly. My customers can't afford to pay for nutrients not efficiently used by their crops. They look to me for sound fertilizer management recommendations, and certainly I must give those recommendations in the context of a shared concern about runoff.

I could tell about the importance of fertilizer—that its continued use is essential to assure an abundant food supply for our Nation—that 30–50 percent of the food and fiber produced by U.S. farmers is attributed to the use of fertilizer. But I think you already know that. The fact is, we will continue to need fertilizer to meet present and future demands. We will also, however, need to be aware of the potential effects fertilizer may have on the environment, and to employ those techniques that keep fertilizer on our fields and out of our streams, lakes, and rivers.

Among the best tools that the fertilizer industry and its customers can use to reduce nutrient runoff, and reduce plant nutrient losses, are Best Management Practices (BMP's). These practices seek to reduce water runoff and soil erosion from farmland. Practices such as conservation tillage, soil testing, timing and placement of fertilizer application, strip cropping, cover crops, terracing, and buffer strips are highly effective in cutting losses of plant nutrients. The fertilizer industry has, for a number of years, been promoting research on the use of BMP's to increase efficiency of fertilizer use and reduce nutrient losses. The future of essential crop production, farm production efficiency, and soil and nutrient conservation depend on the ability of our Nation's farmers to expand their use of sound management practices. The fertilizer industry's position, therefore, is to support and encourage the voluntary adoption of BMP's for agriculture.

Our industry leaders have realized that we can play a positive role in reducing losses of nutrients to the environment. This role is not a defensive one, not one designed to dispute someone else's facts on the sources of nutrients found in our Nation's waters. Our role is not to bury our head in the sand and hope that the issue of nonpoint pollution or nutrient losses will somehow go away. As an industry, we have from the beginning taken an active leadership role to stem the runoff problem, regardless of the source. We actively share in this very real concern.

The board of directors of The Fertilizer Institute adopted a Plant Nutrient Use Resolution this past year stating that our industry policy will be to support the judicious use of plant nutrients, with three considerations in mind:

1. protection of the environment
2. enhancement of farming profitability
3. Improvement of food and fiber productivity.

To carry out this directive, The Fertilizer Institute has undertaken a massive educational effort to inform industry, farmers, Congress, and the public about nutrient runoff, and about BMP's. The first such information was distributed through a cover story in Fertilizer PROGRESS magazine. Over 30,000 readers, most of whom are fertilizer retailers, receive this publication. The article explained the consequences of nutrient runoff to fertilizer businesses and stressed the voluntary use of BMP's to reduce nutrient runoff. More than 10,000 reprints of this article have been disseminated since the story appeared last June.

To complement the article, PROGRESS also began a regular series called Best Management Practices, which details various BMP methods for dealers to share with farm customers. Reprints of this series are also distributed widely.

A further step has been the Institute's publication of a brochure on clean water, explaining the nutrient runoff issue, our industry's efforts to curb the problem, and a brief description of the fertilizer industry. Already, we've distributed over 15,000 copies to State fertilizer associations, fertilizer dealers, Cooperative Extension Services, and others throughout the Nation. The Fertilizer Institute has also participated in EPA's Nonpoint Task Group; we served as a major cosponsor of USDA's first National Conference on Conservation Tillage; we are cosponsoring EPA's National Nonpoint Pollution Conference; we're members of the Conservation Tillage Information Center; and we are sponsoring our own Nutrient Use and The Environment Symposium. All these efforts position our industry as a leader, rather than as a reactor, to this issue.

Why would the fertilizer industry care to help solve the dilemma of nutrient losses? There are several reasons.

First, the industry (and its association, The Fertilizer

Institute) has always based its case, regardless of the issue, on facts. It's a fact, for example, that fertilizers are an essential input, that fertilizer is the farmer's single best production investment, and that fertilizers do not carry with them the same problems so often associated with pesticides. In the case of nonpoint, runoff, however, the facts are scarce. Elevated levels of nitrates have been found in some lakes and streams, but who or what caused it? Livestock? Decaying leaves? Human or industrial wastes? Or farmland runoff?

Since the answers don't yet exist, we as an industry feel an obligation to act now rather than wait for those answers. If runoff occurs, and if we may be one of the sources, we feel our business obligations extend to civic and ecological responsibility as well. We want and expect clean water as much as anyone.

Second, we feel that nonpoint pollution can be stopped only if all of us, every potential contributor—and I stress the word *potential*—would voluntarily take steps to curb the problem. My industry believes that we're all served best when we work together in the same direction, rather than at cross-purposes.

Finally, the fertilizer industry has another reason for being involved. My business—and the entire industry—can only be as strong and viable as the customers we service. You are all aware of the tremendous financial challenges faced by today's farmers. Commodity prices are weak, interest rates high, land values falling, and credit extremely tight. Farmers can't afford to put excess fertilizer on their land, can't afford to apply nutrients in a manner exceeding the crop's ability to use them, and certainly can't afford to see his rich topsoil wash away along with the valuable nutrients it contains.

Businessmen like me can and do help the farmer reduce his fertilizer losses by making recommendations based on soil and tissue testing, by encouraging his understanding of the agronomic aspects of soil conservation, and by reminding him of BMP's that help reduce runoff potential.

The fertilizer industry is determined to continue its responsible role to help solve nutrient runoff problems. Fertilizer producers and retailers are getting involved with legislation and planning on national, State, and local levels in an effort to do just that.

PERSPECTIVES ON NONPOINT SOURCE POLLUTION CONTROL: SILVICULTURE

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Considering the other land uses affected by the nonpoint source issue, silviculture has one important inherent advantage—the long rotation age of a forest. This means there are lengthy periods between major disturbances in a managed forest. When forest soils are disturbed, opportunities occur for erosion, sedimentation, and nonpoint source pollution. As a result of this and several other factors, silvicultural activities generally do not contribute as much nonpoint source pollution to the Nation's waterways as other land uses.

Silvicultural activities cause nonpoint source pollution problems that are mostly localized, and of short duration. Infrequent disturbance means there are only limited opportunities for erosion and sediment production from forest land. One possible exception to this involves an activity associated with forest land management—forest roads and access systems—which can be a considerable source of nonpoint pollution throughout an entire rotation. Because of this potential for nonpoint pollution, and given the fact that most streams naturally drain forested watersheds, foresters as land managers have the opportunity and inherent responsibility to protect our valuable water resource.

Silviculture is a unique land use in many ways: Like agriculture, silviculture encompasses a broad land base; but as previously outlined, intensive activity on forest land is much more infrequent. Small private landowners, government, and corporations, both large and small, own and manage forest land. In consideration of these diverse ownership patterns and varying potential pollution problems, different areas of the country have taken specific approaches to controlling silvicultural nonpoint sources. With the support of the Environmental Protection Agency, the South, Northeast, and Midwest have generally elected to control nonpoint source pollution through nonregulatory programs, while the West has leaned toward the regulatory route. Neither approach appears to be right or wrong; both can work with appropriate conditions and good management.

Since our experience in Florida has been with the nonregulatory approach and the Florida Division of Forestry is the designated management agency for implementing the silvicultural element of the State Water Quality Plan, we should review the concepts behind these programs more closely.

Nonregulatory means something more than voluntary. Nonregulatory implies an *expectation* that landowners and land managers will follow best management practices (BMP's). Encouraging compliance with a nonregulatory program requires a sustained effort.

Creative, new approaches to nonpoint source pollution problems should be developed if nonregulatory programs are to succeed. States using a nonregulatory approach should support an initial training phase, as most have enthusiastically done, followed by a continuing implementation process.

If a nonregulatory approach is to succeed for silvicultural activities, then the years following the initial training phase are critical. These crucial years will demonstrate whether the States are willing to make a commitment to continue the sustained effort necessary to achieve successful implementation. Certainly the lack of Federal assistance available to the States in these continuing implementation efforts is a clear problem, but not a legitimate excuse. The resource involved—water—deserves our high priority for obvious reasons.

Educating landowners and land managers in BMP's can have a positive and rippling effect to encourage participation in eliminating nonpoint pollution problems. For example, in Florida's Panhandle it is generally acknowledged that roads and access systems represent a potentially significant source of sediment from forest lands. To help address this economic and environmental problem, our agency cooperated with the forest industry to develop a Forest Road Demonstration Area on industrial land in the Central Panhandle.

After an appropriate site was selected, Florida Division of Forestry personnel worked with Southwest Forest Industries land managers on the road layout and design. Division staff then guided the road construction crew to include appropriate erosion control features. The area was logged, and the site prepared and planted to illustrate the benefits of a good access system to typical silvicultural operations. During the past year we have used this area for field workshops aimed at a variety of groups:

1. Society of American Foresters chapter meeting,
2. Division Foresters and other personnel,
3. Forest Industry personnel,
4. Personnel from State regulatory agencies, and
5. Other individuals and small groups.

We are convinced of the value of demonstration areas in a nonregulatory program; these will continue to play a major role in the Florida implementation effort.

Communication techniques such as brochures, slide series, films, displays, public meetings, road signs, and compliance surveys can be used to inform landowners of nonpoint source pollution and encourage participation in eliminating these problems.

Regional meetings involving agency personnel responsible for implementing nonpoint source pollution control could help generate new ideas needed to keep these programs active. Also, implementing agencies need to work to achieve a satisfactory, sustained level of effort.

Failure to satisfactorily implement nonregulatory silvicultural pollution control plans will result in the development of regulatory programs for more States. Regulatory programs in the South will be expensive, difficult to enforce considering the widespread small private ownerships, and not foolproof by any means.

The forestry community has the opportunity to test the nonregulatory approach. Most forestry interests realize that a program of this kind requires a long-term commitment. Its success will depend on whether these same forestry interests have the determination to sustain the effort that is needed over a period of years.

George Reinert, Chief, Bureau of Resource Planning, Florida Division of Forestry, presented this paper at the conference.

NONPOINT SOURCE CONTROL, A CONTINUING CHALLENGE

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There continues, in our part of the country, a major interest in controlling nonpoint sources of pollution. Evidence continues to mount on the significant role such sources of pollution play in the bacterial and toxic contamination of marine and freshwater bodies in Washington State. Closed shellfish beds, silted salmon spawning grounds, fishkills in rural streams; and toxic hot spots in urban bays all indicate a growing need for nonpoint source pollution control. In response, our legislature has passed several new laws; most notable is a new authority for managing Puget Sound.

My perspective is heightened as a result of recent actions involving Puget Sound. It has become clear that a major cleanup of contaminated areas will not happen until both point and nonpoint sources of pollution are controlled, particularly the nonpoint sources. Cleanup is unlikely to occur until major sources are under control because no one wants cleanup projects ruined by recontamination, and natural "cleansing" may obviate the need for very expensive cleanup.

The Washington State Legislature has just gone through a debate over pollution control priorities, much like the one Congress waged in 1972 when adopting a uniform national treatment standard. Given our limited funds, we debated the priority of funding nonpoint source and point source controls and cleanup actions. Controlling sources emerged as the undisputed thrust of our State's pollution control efforts for the remainder of the 1980's.

Nonpoint sources of pollution are undoubtedly the most difficult to control because the variety of sources is large and their dispersion extreme. But more importantly, they are difficult to control because the controls involve changing individual and corporate behavior patterns. In agriculture it involves changing how a farmer cultivates and irrigates his land; in the city it involves the homeowner's habits when changing oil in the car, or disposing of household chemicals and solvents. In either case, government becomes directly involved in how people carry out individual actions. This situation does not lend itself well to what we have come to accept as the mode for environmental protection—namely, permits and structured compliance monitoring. EPA and State regulators are having to employ more innovative ways to search for pollution sources and control them. (We call it search and control.)

The emphasis on deadlines, enforceable provisions in permits and orders, and technology-based enforcement standards led to great frustration during the late 1970's when State and local governments were developing areawide waste management plans. Most planners and environmental agency directors found themselves trying to introduce and implement cooperative actions, best management practices, and educational programs within a legal and political framework of environmental protection based on permits, schedules, enforcement orders, fines, and penalties. This confused the public and created mistrust among land managers and resource agency personnel. My own observations were that it took as much energy and time for personnel in various government agencies to understand how these BMP's would work as it did for the public.

Unfortunately, once the momentum was established to deal with nonpoint sources of pollution, our Nation's economy faltered, trimming our efforts toward nonpoint control. Nonetheless, a great deal was accomplished and we are well positioned to continue the task of controlling nonpoint sources.

Major steps have been taken to control nonpoint sources of pollution in Washington, including but not limited to forest practices, dairy wastes, urban stormwater runoff, and construction activities. With the rebuilding of our environmental programs I believe the progress made in these areas will be applied more widely, and will result in action to control other serious nonpoint sources, such as failing septic tanks, leachate from contaminated industrial areas, runoff from small noncommercial farming activities, and illegal dumping of commercial and household waste.

It is worth highlighting two areas of progress: forest practices control and urban stormwater runoff. Forest practices regulation meant bringing control to that part of an industry known for its rugged individualism, high risk, and economic boom and bust conditions. Many legislative debates and protests were waged over legislation aimed at regulating forest practices, and both sides threatened serious litigation over the regulation issue.

In the end, a workable program was created to achieve best management practices in harvesting timber from State and privately-owned lands, and to relieve the industry from double jeopardy under the dual requirements of meeting best management practices and water quality standards. (The standards are not enforceable if approved best management practices are employed.)

The success of these BMP's was shown in subsequent field audits that found water quality violations occurred most often where best management practices were not used or not enforced. This was a milestone for nonpoint source control in Washington. Despite some continuing arguments over various BMP's for forest practices, the real success was in developing a control program that works for an industry of this size and nature.

Urban stormwater runoff control in the Seattle area is a good example of the value of 208 planning. Many consider 208 planning a bust. But King County, our largest urban county, is now formally considering creating a stormwater utility to control and finance projects for drainage and water quality improvements. King County has benefited from the areawide planning done under section 208 of the Clean Water Act. The County has already implemented critical stream reach designations where more stringent land development codes are imposed.

Puget Sound is an example of where State and local authorities are cooperating to control water pollution. In Washington we have just enacted a law creating a planning authority to prepare an areawide management plan for Puget Sound and its adjacent marine waters. The goal is to bring our State and local government agencies (resource management as well as regulatory) together in a coordinated effort to control all sources of pollution to the Sound, particularly fecal coliform and toxics contamination from nonpoint sources. Moreover, the authority is to develop a perspective for managing Puget Sound, or more precisely, a management plan with priorities for controlling both nonpoint and point sources of pollution. This plan will dramatically affect local land use programs as well as EPA and State agency compliance efforts.

This Water Quality Authority, more than anything I can point to today, illustrates the strength of public concern over the diffuse and varied sources of pollution. The public understands that until nonpoint sources are controlled, we will not see measurable improvements in the Sound's contaminated areas.

Major difficulties must be overcome, particularly as nonpoint source control affects land use decisions and individual actions. Innovations such as those used in developing best management practices will have to be made. But, like forest practices, other equally difficult nonpoint sources of pollution can be controlled.

PERSPECTIVES ON NONPOINT SOURCE POLLUTION CONTROL: A CONSERVATION VIEW

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INTRODUCTION

As immediate past president of the National Wildlife Federation, the Nation's largest conservation organization at 4.5 million members, I can give some conservation perspectives. I would articulate the same positions if I were here as an environmental engineer, as a researcher, or as a university professor—all of which I am.

Our resources—precious soils, forests, lakes and freeflowing streams, energy and other mineral resources, scenic vistas, wild flowers, and fish—are interrelated in the watersheds. Through managing our watersheds, we also manage our aquatic wild and natural resources wherever they occur, out in the Big Hole basin in Montana, in the Cache River Basin in Arkansas, in Alaska, on the Great Plains, in little trout streams in the East like the Thompson in the Carolinas and Penn's Creek in Pennsylvania, or in the urban areas that dot our national countryside.

PUTTING NONPOINT POLLUTION IN CONTEXT

The Council on Environmental Quality's 1979 Annual Report stated that nearly all drainage basins were affected in some locations by pollution from agriculture and urban runoff. In 1982, six States reported nonpoint sources as the primary causes of water degradation.

This year, 15 of 20 States reporting progress towards the Clean Water Act's fishable/swimmable goal listed nonpoint pollution as a significant pollutant source in their remaining problem waters. Finally, nonpoint sources are being identified as the major contributors to pollution in large waterbodies such as the lower Great Lakes and Chesapeake Bay as well as the bays, surface water, and ground water of Long Island, New York.

Since 1974, hundreds of millions of dollars have been spent on studies, plans, and demonstration projects. Our failure to substantially reduce nonpoint source pollution in the last decade is attributable to our failure to implement what we've learned, or in many cases what we have all suspected.

The perception has prevailed that the problem of nonpoint pollution is enormous and a solution politically and technically difficult to devise and put in place. That perception is, I believe, not entirely correct. If we examine two of the major sources—agriculture and urban runoff—we find that many effective techniques are already known and used on a small scale and that, by applying the better techniques to the critical areas nationwide, we can substantially reduce nonpoint source pollution.

AGRICULTURAL NONPOINT POLLUTION

In terms of mass, sediment is the major water pollutant from agricultural activities. Approximately six billion tons are lost from farmlands each year. This soil loss seriously affects not just productivity of the land, but also the quality of the waters into which most of the soil flows and the bottom habitat in our aquatic ecosystems.

Scientists estimate that 75 percent of the sediment entering streams, rivers, and lakes comes from cropland erosion. If you don't believe this is serious, then I suggest you look at a stream that gets the runoff from a soybean field without adequate conservation practices in place, and then think about the millions of acres of prime bottomland overflow hardwood habitat that's been cleared and put into row crops in recent decades in the Mississippi flyway.

In Illinois, about 2 bushels of soil wash from cropland for each bushel of corn produced in the State. The Illinois Natural History Survey has found that the backwater lakes along the Illinois River are half filled with mud because of siltation from neighboring farms, produced in the last 15 years. The Government Accounting Office has reported that soil losses resulting from poor agricultural practices are 25 percent worse today than in 1934.

It's important to realize, however, that less than 3 percent of the land contributes over a third of the total annual siltation loss. Controlling erosion from a surprisingly small number of areas, and some of them rather small in size, can result in most of the pollutant reduction needed to protect water quality and habitat for fish and wildlife. This applies to small river basins, as well as to the Nation as a whole.

And we have to remember that, in addition to soil, we have lots of toxic materials, nutrients, and other materials adsorbed onto the soil particles. The nonpoint source pollutants that wash off the land can be loaded with all sorts of bad actors.

Some nonpoint programs and individual projects have been real bright spots, but some have had very modest water quality accomplishments. These programs—208, Model Implementation, Rural Clean Water, and Clean Lakes—have resulted in plans and management practices on a relatively small scale. A nationwide program with appropriate management practices is needed now to provide substantial water quality benefits in all the areas where nonpoint pollution is a critical water quality and aquatic habitat problem.

URBAN RUNOFF

The other major source of nonpoint pollution is urban runoff. Pollution in urban runoff includes air pollutants that have settled in streets, erosion from construction sites, salt and other deicing chemicals, litter, and animal refuse. Of the bacterial loading in the bays of Long Island, 95 percent comes from urban runoff and has resulted in the closing of many shellfish areas. Most of the lakes selected for study under the Clean Lakes Program are urban park lakes adversely affected by urban runoff.

Similar to agricultural nonpoint pollution, most of the urban runoff pollution comes from limited areas, such as the industrialized and highly urbanized sections of a city. Appropriate management practices targeted at those areas can control the pollution. Such practices include more frequent street cleanings, use of porous pavement, and suitably designed and maintained sedimentation and catchment basins to reduce the amount of soil and adsorbed toxic and other nonpoint source pollutants carried in runoff.

The National Urban Runoff Program is studying 28 metropolitan regions, with Baltimore identified as having the most contaminated runoff among them. The few areas in Baltimore that contribute most of the pollution are the heavily industrialized and urbanized sections.

HISTORICAL PERSPECTIVE

With Congressional passage of the Clean Water Act and other laws in the early 1970's, sanitary engineers and environmental scientists took aim at problems identified now well over a decade ago. Today, I believe we all can take well-deserved credit for the remarkable progress in addressing some of the most conspicuous water quality, resource, and pollution problems.

But today, as a Nation and as resource management professionals, we find ourselves facing some very difficult water quality challenges—much tougher than we faced a decade ago. Part of this is due, in my opinion, to our having focused too much on "treating wastes" as opposed to achieving or maintaining desired water quality in our streams and lakes, and looking out for the rest of, indeed most of, our environment—which is outside the chainlink fence of the wastewater treatment plants. Many of my colleagues, the water pollution control experts, have too long concentrated on treating wastewater that comes to us in a pipe, rather than on the larger scale and much more important issue, albeit much more complex and fuzzy, of achieving the water quality goals mandated for us by society through the political process.

A common mindset must have been passed on to us, because this problem is prevalent. For example, it led us to devote tremendous effort and funding to nutrient removal in municipal waste treatment plants and to changing our laundry detergents. But at the same time, the water pollution experts in our regulatory agencies, design firms, and research and development shops paid comparatively little attention to controlling the massive quantities of nutrients entering our streams, lakes, and wetlands from other diffuse sources, such as fertilizer runoff.

From today's perspective, it's hard to understand why we tried to achieve a very low suspended solids concentration in municipal wastewater treatment plant effluents but, at the same time, pretty much ignored the more massive quantities of turbidity-causing and habitat-smothering solids entering the surface waters as nonpoint source pollutants. The game plan seemed to be to insist on rational design and high tech for wastes in pipes, but accept low-tech rules of thumb and conventional wisdom for controlling nonpoint source pollutants.

The GAO's 1977 report telling us we weren't going to meet the Nation's water quality goals if we didn't come to grips with nonpoint source pollutants helped focus our attention on this so-called "new" water pollution problem. Nonpoint pollution is probably the most important water quality issue today, especially considering the interrelationship with the management—and frequently mismanagement—of hazardous wastes, ground water contamination, abandoned toxic waste dumps, and the like. Nonpoint pollution contributes not only conventional pollutants like sediments, oxygen-demanding wastes, coliform bacteria, and nutrients, but toxics like heavy metals, pesticides, herbicides, and lots of others.

Congress is appropriating $750 million annually for soil conservation, yet this has reduced soil loss very little. Most of the soil and, even more important in many situations, the assorted witch's brew of adsorbed toxic chemicals, is still ending up in our Nation's surface waters: lowering water quality, damaging fish habitat, and generally impairing the beneficial uses of others off-site. Since nonpoint pollution was acknowledged to be the biggest impediment to achieving water quality standards as of a couple of years ago in six of EPA's 10 regions, the argument is compelling for Congress to establish a regulatory program, and hopefully a meaningful one.

HOW BIG IS THE PROBLEM?

In 1977, the GAO estimated that over half the pollution entering the Nation's waterways was from nonpoint sources, and the most important nonpoint sources were agricultural activities, urban stormwater runoff, silviculture, and poorly designed and managed septic systems. In 1984, the Association of State and Interstate Water Pollution Control Administrators found that 1.4 million acres of surface lake water had been degraded by nonpoint pollution over the last 10 years.

The tangible costs to society of letting nonpoint pollution continue for the most part unchecked are very high. The Nation loses productivity from its land, killing and smothering fish and wetlands, contaminating fish and shellfish so they're inedible, and spending over $300 million a year dredging the resultant silt from our rivers, lakes, and harbors. The list could go on. And the less tangible, but very real, costs to the American public are also great.

CURRENT PROPOSALS IN CONGRESS AND EPA

Congress and EPA are setting a new course for controlling nonpoint source pollution. A year-long effort by an EPA task force under the direction of Jack Ravan culminated in a national nonpoint policy, which hopefully will help to focus local, State, and Federal agency attention on implementing meaningful control programs in priority waterbodies. However, it falls short of committing EPA to any strong action, of assuring that controls are actually used.

In Congress, both the House and the Senate have legislation pending that would encourage States by means of a grants program to institute runoff pollution controls. Given the massive Federal deficit, the National Wildlife Federation believes such a program may not be funded for some time to come. We continue to press the Congress to adopt sanctions, or enforcement mechanisms, rather than simply relying on more Federal money. Otherwise, we may see very little progress in cleaning up the Nation's number 1 surface water quality problem.

ON-THE-GROUND IMPLEMENTATION

States should be required to identify, develop, and actively promote the use of appropriate and effective best management practices for pollution sources. And I emphasize the words "appropriate" and "effective" because many so-called BMP's are neither very appropriate nor very effective in actually protecting off-site surface water quality and aquatic habitat.

Based on my experience, both research and very practical, I know that available BMP's—if properly selected, designed, constructed, operated, and maintained, individually and as coherent systems of BMP's—can effectively reduce the export of soil, nutrients, herbicides, pesticides, oxygen-demanding materials, bacteria, heavy metals, and other toxics off-site and into the Nation's surface waters. This can be done cost effectively if a genuine commitment is made to cope with this serious, long-standing problem and to move on toward protecting our Nation's streams, reservoirs, and wetlands.

A good bit of money can be spent on so-called BMP's that don't actually reduce much erosion or soil mobilization at the source or remove sediment, especially the fine sediment. At Clemson, I've been directing Federal-agency-supported and industry-supported research and development work for over a decade dealing with effects of nonpoint source pollution on surface water quality and aquatic habitat, erosion from disturbed lands, row-crop agriculture and heavy construction, and evaluation of individual nonpoint source pollution controls and systems of controls.

The EPA, the water-quality-oriented committees of the Congress, and the State agencies with water quality responsibilities simply have to be more active players. They have to insist that water quality be *the*—or at least *a*—real focus and that the right BMP's be specified more often and operated properly.

We can't continue to leave it primarily to the agricultural committees in Congress, USDA, and Soil Conservation Service county offices, and the land- and agriculture-oriented State agencies whose focus is properly the agricultural producer, not off-site water quality. We can't leave it all—or most of it—to these agencies simply "because they know how to work with the farmers." The rest of us have to do our part. Many of the nonpoint source problems involve other than farmers. Too often the approach that seems most politically palatable is to exempt or grandfather all the agricultural activities, administratively declaring them no longer a part of the problem. In my opinion, this completely begs most of the substantive water quality and environmental protection questions facing us.

And I think my own environmental engineering discipline simply has to recognize the problem and use the latest in proven cost-effective process design approaches and procedures for dealing with nonpoint pollution. Congress and the American taxpayers should expect the same level of reliability, effectiveness, and performance for nonpoint source control facilities as we all expect of well-trained modern environmental engineers in dealing with industrial and municipal wastes that are piped into a modern and well-operated wastewater treatment plant. This can be done, and as far as I'm concerned there's absolutely no reason for it not to be both expected and accomplished.

A LIVESTOCK INDUSTRY PERSPECTIVE ON NONPOINT SOURCE POLLUTION CONTROL

LESTER COY
Elmore, Minnesota

Our family corporation has a cattle-feeding and farming operation on 486 hectares (1,200 acres) in Kossuth County, Iowa. We annually feed 2,500 to 3,000 head of cattle in confinement and open lot facilities and raise seed corn and soybeans. I am currently chairman of the National Cattlemen's Association's 208 Water Quality Subcommittee, and chairman of the Lands, Water, and Environment Committee of the Iowa Cattlemen's Association. I also serve on the board of that State organization.

Soil erosion and water runoff have been occurring on this planet since time began. The most productive agricultural areas of this country were formed by erosion and sediment from the huge ice caps that melted millions of years ago. Such erosion produced soils up to more than 1 meter deep in the Midwest. And the loess that covers much of North America to a depth of several hectometers is the result of wind erosion over thousands of years.

Man, of course, has aggravated erosion (now called nonpoint source pollution) although not to the extent that some groups and government agencies would have us believe. Certainly, we ought to be concerned about such erosion and I would like to mention some actions that I think will help abate erosion resulting from agricultural activities.

"There is a legitimate public interest in water pollution abatement. The condition of our Nation's waters is important to all of us and we need national laws dealing with water pollution. These laws, however, should be based on understanding and common sense, not on emotion and unsupported clichés."

These laws should recognize that there is no single, nationwide solution to the problem of nonpoint source pollution. There is no panacea that will prevent nonpoint source pollution in every place under all circumstances. What works best in one area may not be the best in another area.

The laws must be flexible enough to allow people to devise effective solutions that fit the unique circumstances of individual areas. A cooperative program involving local people familiar with local resources and conditions is the best way to effectively abate water pollution.

Furthermore, farmers and ranchers are the most environmentally conscious group in the United States. As people who deal daily with our environment, we do know something about local topography, climate, and other elements of Mother Nature. We are acutely aware of environmental problems because, among other things, such problems bring us enormous economic costs. Regulation increases these economic costs. Environmental degradation poses a threat to our livelihood so we have a selfish interest in preventing and abating pollution.

In addition to the right kind of laws, we need the right kind of scientific research—not the kind that we have had so far. Current research consists of stacks and stacks of research reports identifying types and amounts and locations of pollutants. What we do not have is research that tells the effects of these pollutants on man or on activities vital to mankind, such as food production. It may be good to know which substances cause cancer when exposed or fed to mice at rates many times greater than man would ever face in a normal lifetime, but such experiments do not answer the question of how many substances man can tolerate without harm.

We will probably never eradicate all pollutants from our environment, even if we have the money. Therefore, we need to identify those pollutants that have the most adverse impacts upon man and determine what can be done. We also need to distinguish between pollutants originating from natural causes and those originating from man's activities.

We need carefully controlled research telling us how pollutants arrive at a particular place, exactly how far they move in the soil or water in a given time, and, above all, what levels of these pollutants man can tolerate with no side effects.

Research finds coliform in a western mountain stream—but it does not indicate whether this came from livestock grazing, elk, or other wildlife in the area. Did the material enter the stream recently or was it something that was deposited years ago and then stirred up from the river bottom during the last storm?

Nitrate is found in a midwestern stream. Did it originate from fertilizer applied nearby or from decaying vegetation from a city, or maybe from a wilderness area many thousands of miles away? Research often does not attempt to provide an answer, but this does not prevent some people from blaming agriculture.

If we are simply guessing at the answers to such questions, we may not be addressing the real causes of pollution.

It also appears that research is often used for purposes other than factual enlightenment. For example, in recent years, a barrage of articles in the media and a number of government reports have given the impression the United States is in imminent danger of losing all of its topsoil.

A 1980 Federal document indicates that sheet and rill erosion on cropland in the Mississippi River Basin, and in many other Eastern States carries off 1.8–5.1 metric tons per hectare (5 to 13.9 tons per acre) each year (U.S. Dep. Agric. 1980). If that much silt got into the Mississippi, the river would no longer flow!

That same document says that wind erosion in several States exceeds more than 1.8 metric tons per hectare (5 tons per acre) per year (U.S. Dep. Agric. 1980). I have visions of huge amounts of soil piled like snow drifts in every road ditch and at every wind break.

I suspect such reports are aimed more at generating political support for government funding than at giving a true picture of the current situation.

Of course, it will take more than research to curb nonpoint source pollution. Even if we know all the answers, it doesn't do any good if that information does not reach those who can do something with it. I am referring not just to the policymakers or government administrators, for it should be recognized that—especially in regard to nonpoint pollution—much can be done through voluntary efforts. As previously stated, a cooperative approach involving the farmer and rancher can accomplish more to reduce runoff or erosion from agricultural lands than a program solely dependent upon mandatory actions.

But the success of any effort—mandatory or voluntary—depends upon knowledge and understanding. We not only need research to find out how to control erosion but we need to transmit that how to the landowners and operators who can use the information. Agencies and organizations need to do a better job of communicating such knowledge.

I am pleased to say that the National Cattlemen's Association and affiliated State livestock organizations are making such an effort. We have taken a constructive approach to the nonpoint source pollution issue. We are telling our members what cattlemen have done about this problem in the past, what they are doing now, and what they can do in the future.

One of our first efforts was the preparation and release in the 1970's of a slide program entitled "208 Planning and the Cattle Industry." This program explained the law and what the States needed to do. More importantly, it demonstrated what cattlemen could do to minimize nonpoint source pollution.

Some 45 organizations affiliated with the National Cattlemen's Association have shown these slides to over a quarter million cattlemen at various meetings. in addition, over 75 universities and colleges have used the slides in curriculum or special program courses.

The updated version of this slide program is being shown during this conference. We hope you will take the time to view it, as it demonstrates the positive actions cattlemen are taking, voluntarily, to address water quality programs. The slides depict many of the so-called best management practices used by cattlemen. They reveal the diversity of the industry nationwide—cattle raised on the range, in pasture, and in small confinement facilities.

Another example of an educational effort that our association is conducting is a book entitled A Cattlemen's Guide to Water Pollution Control and 208 Water Quality Planning. The writing of this book, a few years ago, was more of a massive job than you might imagine or, frankly, than we had anticipated.

When we gathered all of the government laws, rules, and publications on nonpoint source pollution, we had a stack of books several feet high. Not one, however, gave a succinct explanation of nonpoint pollution laws or what cattlemen could do to curb such pollution. Obviously, no individual cattleman could read all that material.

So we summarized the law and rules, ignoring the jargon that makes most government and academic language incomprehensible to the average person. Also, we were not simply concerned with what cattlemen and States are required to do about nonpoint source pollution. We were more concerned with what could be done. This book provides the latest information on livestock management practices to control nonpoint source runoff, and it includes a self-evaluation form for cattlemen. It also lists government agencies a person can contact for more information.

In 1983, Profit Potential of Environmental Protection Practices of Cattlemen was published by the Environmental Management Committee of the National Cattlemen's Association. This handbook describes ways cattlemen can prevent water pollution from cattle grazing or feeding operations. Based on a seminar at which technical experts in animal wastes and pollution spoke, this publication has an interesting focus. instead of regarding animal wastes as an expensive disposal problem, it shows that when handled properly, such byproducts can be substituted for chemical fertilizer, and be profitable to cattlemen. The soil is the best garbage disposal in the world.

These are examples of what cattle industry organizations are doing to educate our members on best management practices that will curb water pollution and help preserve water quality.

We intend to continue these efforts, because we recognize mandatory government regulations are not the answer. We will continue to cooperate with government agencies and others to improve technology and processes that will help achieve the goal that I think all citizens want—a clean glass of water.

In summary, I make the following points:

1. Agriculture, including animal agriculture, has been unfairly accused as the major pollutor of water.
2. Laws and rules should be based on facts and common sense.
3. More unbiased scientific research is needed to provide answers we must have if we are to have an effective program to minimize nonpoint source pollution.
4. We need to improve communications among government agencies, scientists, farmers, and the general public.
5. We need to emphasize a cooperative approach to solving pollution problems, because a lot more can be accomplished that way than through government dictum.
6. We need to foster the concept of best management practices.

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Monitoring and Assessment Techniques

THE ST. ALBANS BAY WATERSHED RCWP: A CASE STUDY OF MONITORING AND ASSESSMENT

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ABSTRACT

Excessive nutrients from a municipal point source and agricultural nonpoint sources have impaired the use of St. Albans Bay of Lake Champlain in Vermont. A comprehensive monitoring and evaluation approach is evaluating the effects of agricultural Best Management Practices (BMP's) on the quality of bay and tributary waters as part of the Rural Clean Water Program (RCWP). Monitoring techniques include edge-of-field paired watersheds, instream trend stations, bay trend sampling, and land use tracking. Related short-term studies are investigating bay circulation patterns, bay sediment phosphorus content and release, biological indicators, and the role of a wetland in treating both point and nonpoint source nutrients. Each monitoring technique and its associated assessment methods are described through project results. The comprehensive monitoring approach is designed to identify overall programmatic effects in complex watersheds.

INTRODUCTION

The St. Albans Bay Watershed is one of the experimental Rural Clean Water Programs (RCWP) projects designed to improve water quality through agricultural best management practices (BMP). St. Albans Bay has been degraded by excessive algal and macrophyte growths and elevated coliform counts (Vt. Agency Environ. Conserv., 1977). Abundant nutrients in the bay, which are causing the accelerated eutrophication, come from both point and nonpoint sources. Recently, Johnson (1985) estimated that at least 37 percent of the phosphorus and 48 percent of the nitrogen originated from nonpoint sources. Improper animal waste management and cropping practices have been identified by the Soil Conservation Service (1981) as being primarily responsible for excessive nonpoint nutrient loading to the bay.

In 1981, implementation of agricultural BMP's began with Federal cost-sharing through RCWP to control nonpoint sources of nutrients and sediment. Concurrent with the agricultural nonpoint source control strategy is a comprehensive water quality monitoring and evaluation project to determine the effects of BMP's on water quality.

Numerous techniques have been used to assess the effect of land treatment on water quality. Listed in order of increasing distance from the source, these techniques include: runoff plots; fields; single, paired, and multiple watersheds; and larger, mixed land use watersheds (Striffler, 1965; Hewlett et al. 1969; Ponce, 1980; Clausen and Brooks, 1983). Advantages and disadvantages of these techniques have been described (Striffler, 1965; Hewlett et al. 1969; Clausen and Brooks, 1983). One of the greatest challenges facing water quality data analysts is the interpretation of water quality changes in streams receiving nutrients from large complex watersheds.

This paper describes the monitoring and assessment techniques being used in the St. Albans Bay RCWP and discusses current findings.

STUDY AREA

The 13,500 ha St. Albans Bay watershed is located in northwestern Vermont, 40 km north of Burlington (Fig. 1). Agriculture is the dominant land use in the watershed (68 percent); corn and hay are the principal crops. Forests cover 22 percent of the area, and urban areas and roads account for the remaining 10 percent. There are 100 dairy farms in the watershed averaging 134 ha and 95 animal units.

Watershed soils include loam (51 percent), half of which is poorly drained, silt and clay (27 percent), rock outcrop (15 percent), and sand (7 percent) (Soil Conserv. Serv. 1979). These soils formed on glacial till or lacustrine deposits.

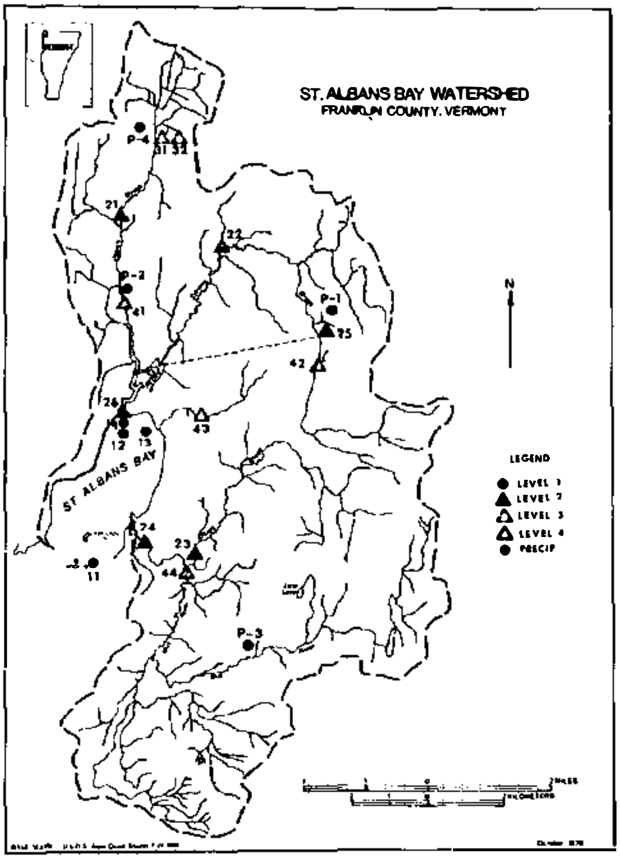

Figure 1.—Map of the St. Albans Bay watershed showing sampling locations.

The mean annual precipitation is 845 mm, and occurs mainly in the summer. The climate is considered to be the cool, continental type with a mean annual temperature of 7.3°C. Average annual snowfall is 1,560 mm (Soil Conserv. Serv. 1979).

Four major tributaries drain the watershed into St. Albans Bay: Jewett Brook, Stevens Brook, Rugg Brook, and Mill River (Fig. 1). The city of St. Albans' secondary wastewater treatment plant discharges to Stevens Brook wetland at the head of the bay.

METHODS

Sampling Design

To document water quality changes, several levels of water quality sampling have been conducted since 1981. Level 1 involves bay sampling at four stations, 20 times each year (Fig. 1). At each station, samples are collected at the 0.5 m depth and 1.0 m from the bottom. Level 2 includes instream sampling at the four tributaries and the St. Albans' wastewater treatment plant. At each of the five Level 2 stations, samples are automatically collected at 8-hour intervals using ISCO refrigerated samplers and combined into two 48-hour and one 72-hour composites each week. During stormflow periods, each 8-hour sample is analyzed discretely. Flow is measured continuously at each station using ISCO bubbler-type stage recorders. Three standard, weighing-bucket gauges are used to measure watershed precipitation.

Level 3 involves edge-of-field sampling to evaluate changes in the quality of runoff associated with best manure management. A paired watershed design was used where two field watersheds received best manure management during a 2-year calibration period, and then one field received winter-spread manure during the treatment period. The control field was 0.9 ha and the treatment field was 1.9 ha. The treatment field received 8,925 kg/ha of liquid manure spread during winter 1984. Calibration and treatment regressions were based on paired daily concentration, discharge, and mass export values.

Level 4 sampling is conducted at four other stream locations in the watershed (Fig. 1) to characterize additional tributaries and to isolate subwatersheds. Grab samples are collected an average of once every 20 days on randomly selected dates.

Sample Analysis

All samples are analyzed for turbidity; total and volatile suspended solids; total and orthophosphorus; and total Kjeldahl, ammonia, and nitrate + nitrite nitrogen, according to standard methods (U.S. Environ. Prot. Agency, 1983). In situ measurements are made at all bay stations of temperature, dissolved oxygen, and Secchi disk. Weekly grab samples are analyzed for pH, conductance, fecal coliform, and fecal streptococcus. St. Albans Bay samples are also analyzed for chlorophyll *a*.

Related Studies

In addition to the long-term monitoring there have been separate investigations of stream biological characteristics (LaBar, 1984), bay circulation (Laible, 1983), and bay and wetland sediments (Drake, 1984). An extensive land use monitoring effort is described in detail in a companion paper (Hopkins and Clausen, 1985).

RESULTS AND DISCUSSION

BMP Implementation Status

The goals of the RCWP were to manage 75 percent of the 6,174 critical hectares in the watershed (lands receiving animal waste or fertilizer), and to treat a number of critical sources by using animal waste and fertilizer management, conservation cropping systems, and stream protection. Currently, approximately 90 percent of this goal has been achieved (Table 1). The major BMP is to provide for animal waste storage during the winter months to prevent daily manure spreading on snow covered or frozen soils. Under the Agricultural Conservation Program (ACP), two manure storage structures have been built and additional areas in conservation cropping supplement the RCWP.

Table 1.—BMP implementation status for the St. Albans Bay watershed RCWP.[1]

Year	Contracted Farms (No.)	Critical Areas Contracted (ha)	Manure Storage (No.)	Conservation Cropping area (ha)
1981	21	1,577	7	357
1982	18	1,314	21	1,200
1983	11	908	9	161
1984	6	398	5	550
Total	56	4,197	42	2,268
Goal	84	4,831	64	2,590

[1]This is a sample for a typical footnote in 6 point helvetica by 19 picas.

St. Albans Bay

A horizontal gradient in concentration is evident in St. Albans Bay. The north end of the bay has much higher concentration of sediment and nutrients as compared to the south end which opens into Lake Champlain (Fig. 2). This gradient is related to mixing between the main lake and the bay (Laible, 1983). Chlorophyll *a* concentrations follow these nutrient gradients. The inner bay averages 31 μg/l chlorophyll *a* and the outer bay averages 9 μg/l. The total phosphorus to total nitrogen ratio in the bay ranges from 6:1 to 33:1, indicating that the limiting nutrient may at times be either nitrogen (TN:TP < 10) or phosphorus (TN:TP > 17) (Smith, 1982).

Detection of trends in the bay will have to consider these gradients, and both the chemical and biological characteristics of bay waters. Time trends may be confounded with hydrological variability. However, the outer bay station may serve as a control for comparison with the inner bay station. Trends could then be identified as differences between regressions, using the inner bay data as the dependent treatment variable.

Tributary Streams

Mean concentrations of solids, phosphorus, and nitrogen for the Level 2 tributary stations show both annual variability and differences among watersheds (Fig. 2). Annual precipitation for the 1982–83 water year was near normal (859 mm) while precipitation during 1983–84 was 30 percent above normal (1,094 mm). Although trends over 2 years of sampling mean little in water quality interpretations, observed concentrations do identify critical watersheds. For example, Jewett Brook, which has 87 percent agricultural land use, has elevated concentrations of phosphorus and nitrogen compared to other watersheds (Fig. 2). Mass exports in Jewett Brook are also quite high; during 1983–84 total phosphorus export was 6.7 kg ha^{-1} yr^{-1}, over 20 times the average export from agricultural watersheds in the eastern United States (Omernik, 1976). The Jewett Brook Watershed has the most BMP's and therefore the potential for showing the greatest water quality changes during the project.

Edge-of-Field

The effects of winter-spread manure on field runoff concentrations are summarized in Figure 3. The dark bars represent the differences between the concentrations predicted by the calibration equation and the mean concentration observed during treatment. Winter spreading increased the concentrations of total P, ortho-P, total Kjeldahl-N, and ammonia-N, but total suspended solids decreased significantly (p = 0.001). After spreading manure in the winter, increased concentrations of phosphorus and nitrogen have been reported previously based on plot studies (Hensler et al. 1970; Minshall et al. 1970; Klausner et al. 1976). The reduction in suspended solids concentrations has also been reported (Young and Holt, 1977; Young and Mutchler, 1976), presumably resulting from a mulching effect of animal wastes.

Winter manure application decreased surface runoff from the field (Fig. 4). Runoff may decline because applied manure increases soil infiltration (Khaleel et al. 1981; Zwerman et al. 1970). The decrease in runoff together with reductions in suspended solids resulted in a decreased mass export of total suspended solids by one-half (Fig. 4).

Even though runoff decreased, phosphorus and nitrogen increased in runoff after winter manure applications (Fig. 4). Total phosphorus export increased 11 percent (p = 0.08), but orthophosphorus export increased by a factor of 15 (p = 0.03).

Based on the amount of manure applied to the field in the winter, 15 percent of the phosphorus and 17 percent of the nitrogen was lost in surface runoff. These losses are somewhat greater than the 95 percent retention of phosphorus and nitrogen of winter-applied manure reported by Klausner et al. (1976).

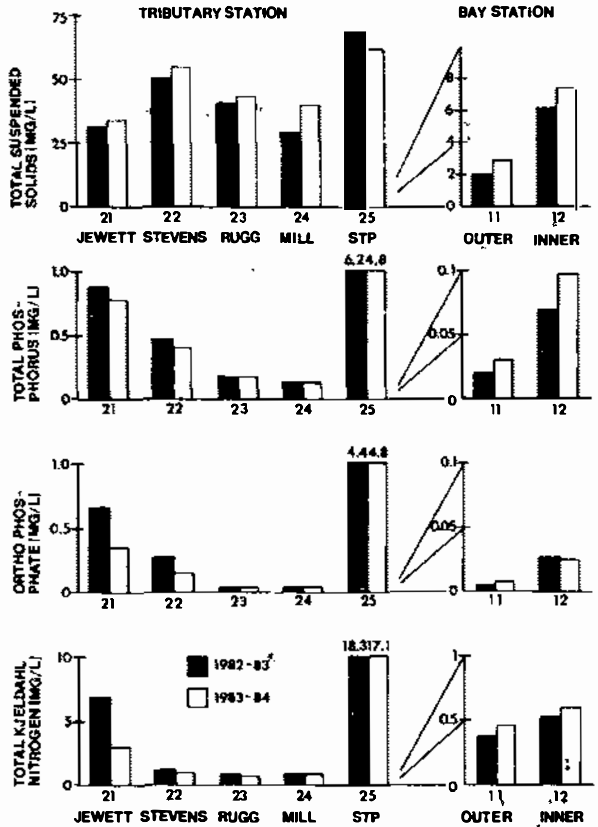

Figure 2.—Mean concentrations of solids, phosphorus, and nitrogen at the tributary and bay trend stations for 2 years.

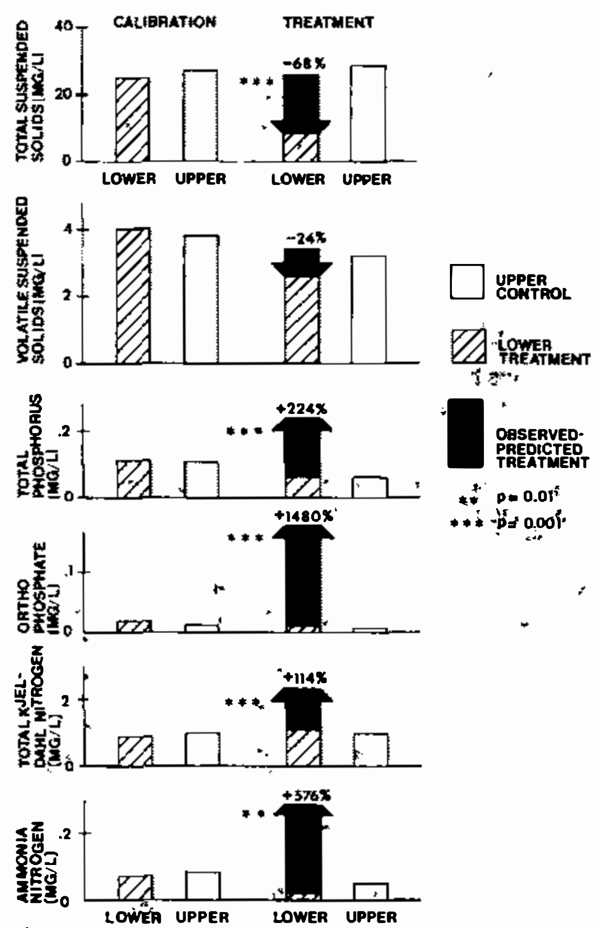

Figure 3.—Mean concentrations in runoff from the Larose farm paired watersheds.

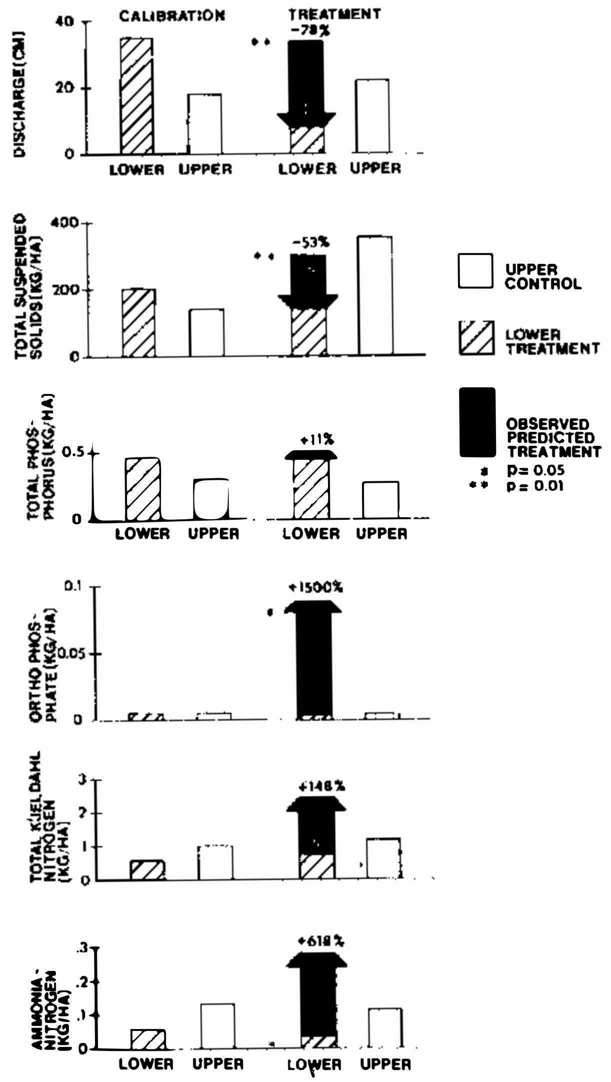

Figure 4.—Runoff and mass export from the Larose farm paired watersheds.

CONCLUSIONS

There has been insufficient time to evaluate water quality trends in the bay or its tributaries. However, the edge-of-field paired watershed experiment has shown, in a relatively short time, that proper animal-waste management can reduce phosphorus and nitrogen concentrations and exports to receiving bodies of water.

Monitoring of water quality and agricultural activities will continue. Several techniques are available for water quality trend detection for long-term studies: (1) Time plots, (2) least squares regression, (3) comparisons of annual means, (4) Q-Q plots, (5) probability distribution functions, (6) paired watershed regression, (7) spectral analysis, and (8) time series analysis. Good descriptions of these methods appear in UNESCO (1978), Hirsch et al. (1982), and Montgomery and Reckhow (1984). As additional data become available, these trend assessment techniques will be applied to determine the changes in water quality associated with BMP implementation.

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LAND USE MONITORING AND ASSESSMENT FOR NONPOINT SOURCE POLLUTION CONTROL

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ABSTRACT

Varying soil characteristics, land use patterns, the relative timing of agricultural practices, and hydrologic events complicate quantifying relationships between agricultural land use and surface water quality. In two Vermont watersheds where the effects of best management practice (BMP) implementation on water quality are continuously monitored, land use and agricultural activities are being monitored on a field-by-field level. The land use data are entered in a computerized Geographic Information System (GIS), and the results mapped. Correlation and stepwise regression techniques related weekly land use activities for one subwatershed to surface water quality. Comparisons of water quality to agricultural land use were based on proximity to surface drainage and whether activities had occurred on runoff-producing zones. Manure application on Soil Hydrologic Group D was significantly related to stream total phosphorus concentration (r = .62) when manure was accumulated between runoff events. A predictive equation developed explained 55 percent of the variation in total phosphorus concentration. GIS offers the potential to inventory critical sources of nonpoint source pollution and identify changes in water quality from agricultural land use and BMP's.

INTRODUCTION

The relationship between land use and water quality has been the subject of much research in the last 10 years. It is generally accepted that as the percent of agricultural land in a watershed increases, concentrations of sediment and nutrients in streams draining these areas also increase (U.S. Environ. Prot. Agency, 1974; Dillon and Kirchner, 1975; Smolen et al. 1975; Omernik, 1976, 1977; Hill, 1981). The proximity of agricultural lands to streams within a watershed may also influence nutrient contributions in runoff (Kunkle, 1970; Uttormark et al. 1974). Dunne (1969), and Lake and Morrison (1977) report that large nutrient losses in runoff may originate from areas of low infiltration potential or high soil saturation. These areas have been termed runoff-producing zones.

Greatest stream nutrient concentrations have been linked to spring stormflow periods when cultivation is active and vegetative cover is poor (Dornbush et al. 1974; Dendy, 1981; McDowell et al. 1981), but this relationship may be caused solely by increased discharge in the spring, rather than agriculturally induced.

Agricultural activities (e.g. nutrient applications, cultivation) should influence stream water quality, with activities in runoff-producing zones and near streams having a greater effect than those elsewhere. These relationships have not been temporally or spatially examined. The primary purpose of this study is to relate the location and timing of agricultural activities to stream water quality.

STUDY AREA

The 1,333 ha Jewett Brook watershed in northwestern Franklin County, Vermont, was selected for the study (Fig. 1). Land use is predominantly agricultural (87 percent) with the remainder woodland or residential. The 16 dairy farms in the watershed average 65 ha, with herds ranging from 32 to 260 animals. The average herd size is approximately 125 animals.

Within the Champlain Lowland physiographic unit, the Jewett Brook watershed has irregular topography with rolling hills. Over two-thirds of this area has soil formed on lacustrine deposits; other soils formed on glacial till. Approximately 50 percent of the watershed has poorly drained silt and clay soils; another 42 percent has poorly drained loam or sand; and only 8 percent of the area has well-drained loam or sand (Soil Conserv. Serv. 1979).

The climate of the watershed is influenced by the presence of Lake Champlain to the west and south and by its northern latitude (44°47′ 26″). Long-term average winter temperature is −7°C, and average summer temperature is 20°C. The average last spring freeze is expected May 2 and the first autumn freeze by Oct. 13. Approximately 61 percent of the total yearly precipitation falls in April through September, with August the wettest month

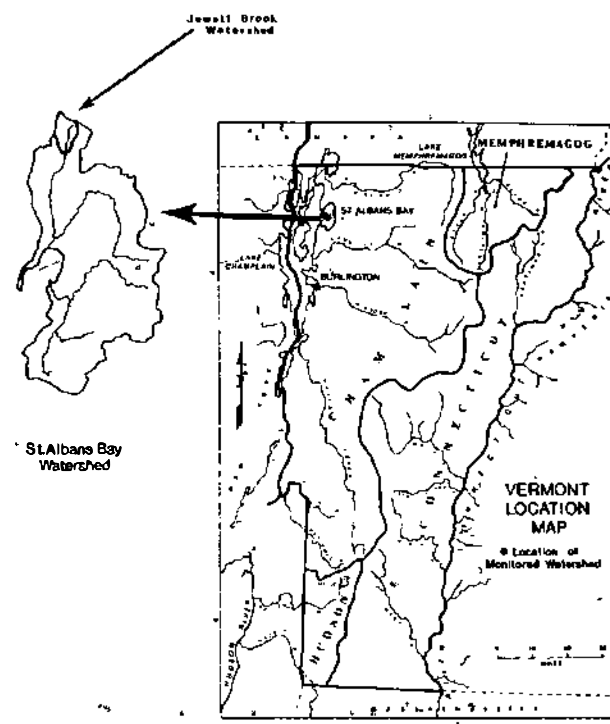

Figure 1.—Vicinity map for project location.

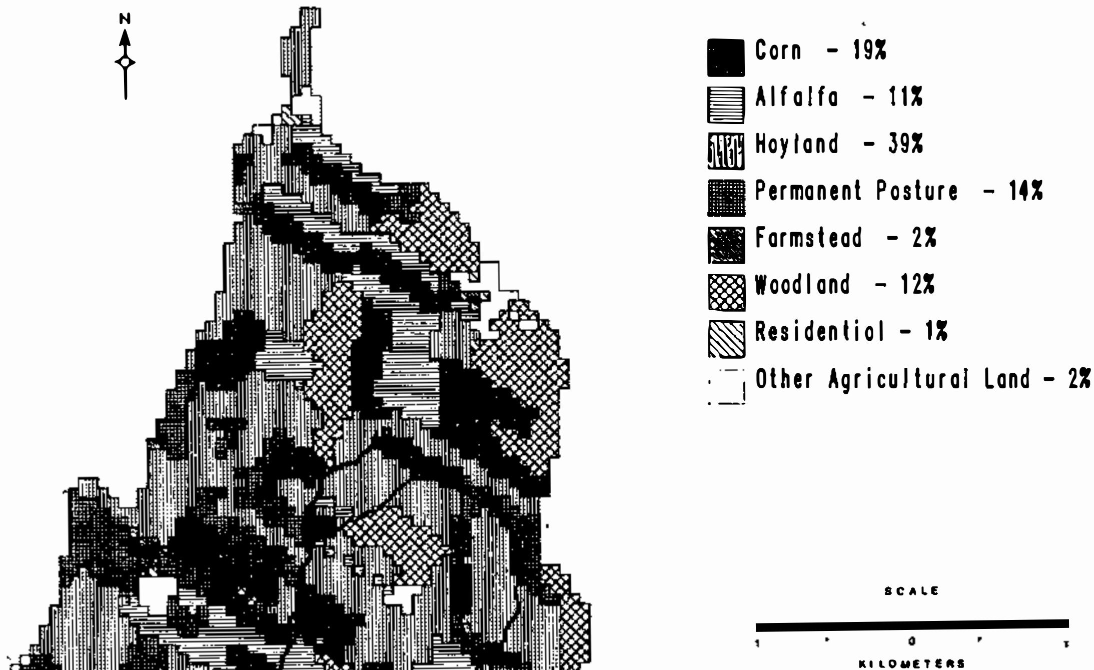

Figure 2.—Land use for Jewett Brook watershed.

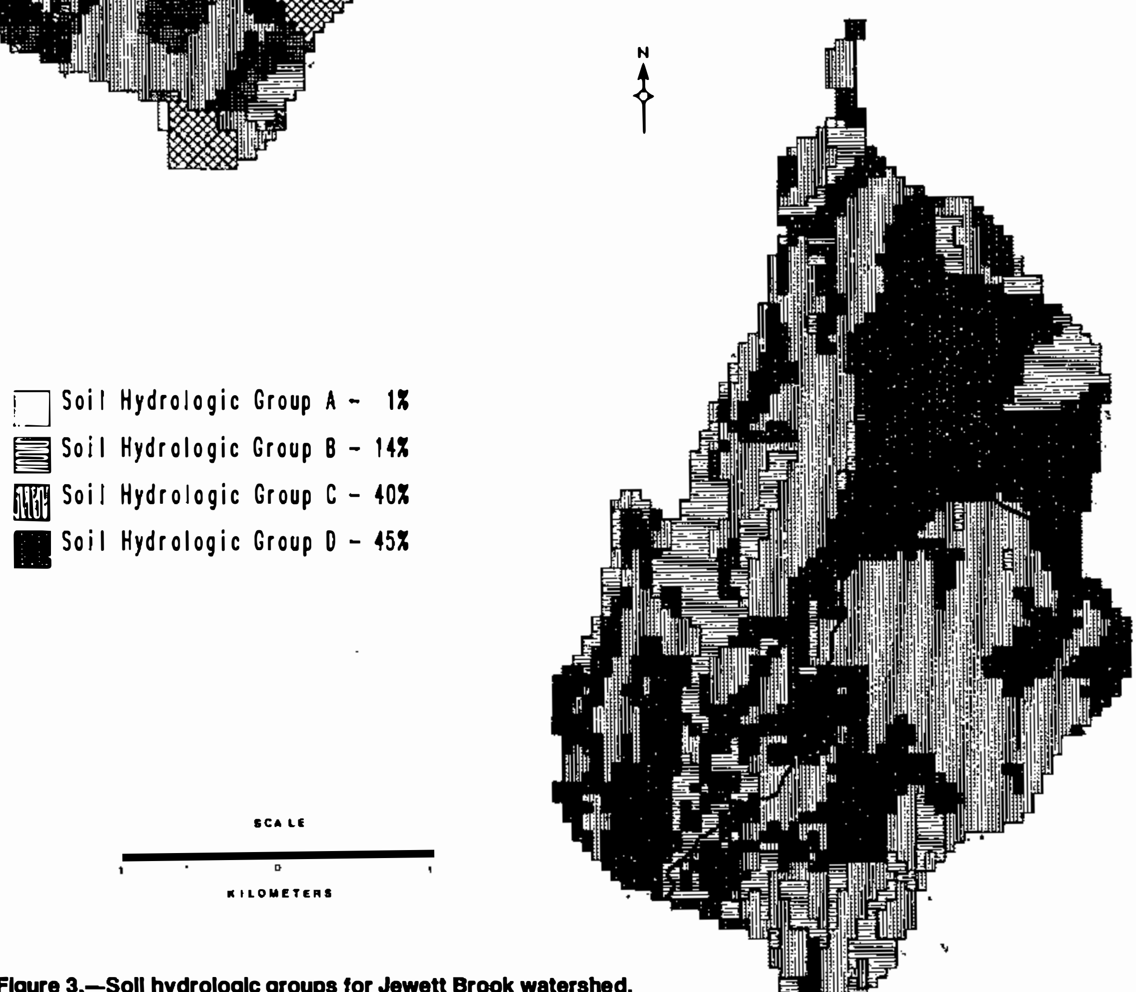

Figure 3.—Soil hydrologic groups for Jewett Brook watershed.

(10.0 cm). On the average, December receives the greatest amounts of snowfall (49.2 cm) (Soil Conserv. Serv. 1979).

METHODS

Maps of the watershed were prepared at a scale of 1:10000. Land use and farm and field boundaries were identified during interviews with each landowner. Soil types and characteristics were obtained from the Franklin County Soil Survey (Soil Conserv. Serv. 1979). Streams and drainage ditch locations were identified using topographic maps and aerial photographs. Elevation and watershed boundaries were obtained from USGS 7.5′ topographic maps (U.S. Geolog. Surv. 1972). Data were entered into a computerized Geographic Information System (GIS) using a 0.404 ha cell grid overlay. Figures 2 and 3, generated by the GIS, show watershed land use and soil hydrologic classifications, respectively.

Land Use Monitoring

Land use and areas receiving agricultural activities were recorded onto field logs that had been distributed to each landowner within the watershed. Agricultural activity data were recorded from January to December, 1983. Data included the date, amount, location, and method of commercial fertilizer and animal waste application, areas that had been plowed and cultivated, and fields where crops had been harvested. Information was gathered during January, June, and December. Data were mapped using the GIS.

Computerized geographic overlays were performed using the GIS. Overlays were created with weekly land use data, soil hydrologic classifications, and the area within 63 meters of the brook and drainage network. Runoff-producing zones were areas associated with Soil Hydrologic Group D (those soils having high runoff potential and low infiltration rates).

Table 1.—Correlations (r) between mean weekly runoff concentrations (mg/l) and weekly hydrologic variables.

Water Quality Parameters	Total precipitation (cm)	Mean discharge (m^3/sec)
Total phosphorus	.07	.37[2]
Orthophosphorus	-.06	.48[2]
Total Kjeldahl nitrogen	.06	.44[2]
Ammonia nitrogen	.02	.33[1]
Total suspended solids	.32[1]	.61[2]
Volatile suspended solids	.24	.68[2]

[1]Indicates significance at P = 0.05
[2]Indicates significance at P = 0.01

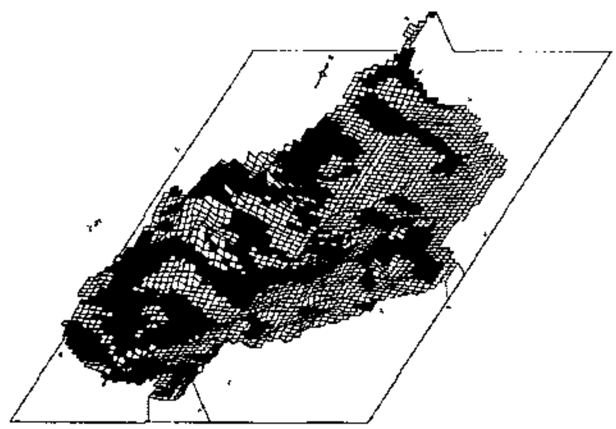

Figure 4.—Manure applications (in black) in Jewett Brook watershed during 1983.

Water Analysis

Streamflow quantity and quality were continuously monitored at the watershed outlet. Two 48-hour and one 72-hour composite water samples were collected each week for 52 weeks. Samples were analyzed for total suspended solids, volatile suspended solids, total Kjeldahl nitrogen, ammonia nitrogen, total phosphorus, and orthophosphorus according to Standard Methods (1980; U.S. Environ. Prot. Agency, 1983). A detailed description of the comprehensive water quality monitoring program can be found in Cassell et al. (1983).

RESULTS AND DISCUSSION

Weekly Activities

Weekly mean stream concentrations were positively correlated with weekly mean discharge but were not generally related to total weekly precipitation (Table 1). Suspended solids concentrations were strongly related to discharge. This positive relationship between discharge and streamflow concentrations is characteristic of diffuse sources of nutrients and sediment (Novotny and Chesters, 1981).

Weekly mean total phosphorus concentrations in streamflow were positively correlated with weekly manure applications within the watershed (Table 2). In Figure 4, the darkened areas represent manure applications in the watershed during 1983. Correlations generally decreased when considering smaller components of the watershed as compared to applications throughout the watershed. Considering manure applications on the greatest runoff-producing zones (soil hydrologic group D) did not improve correlations. Manure applications in closer proximity (63 m) to stream courses were not as well related to

Table 2.—Correlations (r) between mean weekly runoff concentrations (mg/l) and weekly manure applications (mT).

	Applied to: Total watershed	Hydrologic group D	Within 63 m	Within 63 m on D
Total phosphorus	.47[2]	.38[2]	.39[2]	.20
Orthophosphorus	.26	.15	.16	.10
Total Kjeldahl nitrogen	-.04	-.11	-.15	-.12
Ammonia nitrogen	-.18	-.23	-.26	-.32[1]
Total suspended solids	.18	.23	.18	.15
Volatile suspended solids	.14	.20	.14	.21

[1]Indicates significance at P = 0.05
[2]Indicates significance at P = 0.01

streamflow total P as were overall watershed manure applications.

Generally, poor correlations between land use changes and water quality were observed. For example, the correlation between total phosphorus concentrations and the percent of corn land was only −.19. A possible explanation may be that only 3 percent of the watershed changed land use between corn, alfalfa, and hay during this 1-year study. Also, poor correlations were generally obtained between areas receiving field management and total phosphorus concentration (e.g., cultivation, r = .26). This lack of correlation resulted partially from the timing of activities. For example, 81 percent of the cultivation occurred during a 9-week period in the spring. During the remaining 43-week period, little or no cultivation occurred, whereas weekly stream concentrations fluctuated greatly.

Lagged Activities

Mean daily discharge rates were examined to estimate the weeks of stormflow. Weekly land use activity data were accumulated between stormflow periods and then compared to stream concentrations. This method of comparison assumes primary nutrient and sediment movement during stormflow.

When manure applications were accumulated between stormflow periods and compared to in-stream concentrations, stronger correlations resulted (Table 3). Total and orthophosphorus and total Kjeldahl nitrogen were positively correlated to applied manure using this lagging technique. Generally, manure applied throughout the watershed correlated better with stream concentrations than manure applied to runoff-producing zones. Proximity did not appear to greatly influence these relationships. The relationship between total phosphorus and accumulated manure applied is shown in Figure 5.

Since both stream discharge and manure applications were related to stream phosphorus concentrations, multiple regression was used in an attempt to explain more of the variation in stream concentrations. The best prediction of total phosphorus concentration ($P = 0.01$) resulted from using manure applied on Group D soils and total suspended solids concentrations in runoff (Log total P = 0.15 Log Manure on D + 0.34 Log total S.S. − 1.09; multiple $r^2 = 0.55$). This relationship suggests that manure applications to low infiltration rate soils combined with suspended solids in runoff are the primary variables influencing stream phosphorus concentrations. On the average, 38 percent of the instream total phosphorus concentrations were in particulate form. During storm events, up to 90 percent of the total phosphorus was particulate. Surprisingly, discharge did not significantly add to the regression.

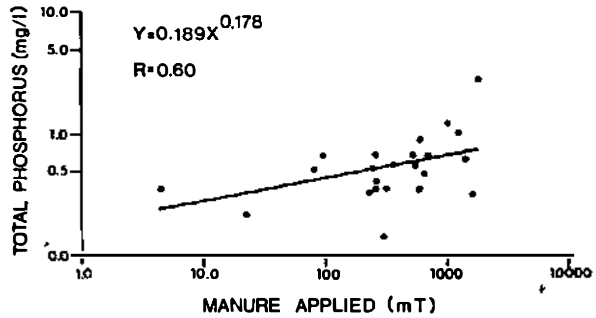

Figure 5.—Total phosphorus (mg/L) and manure applied (mT) between runoff events for the Jewett Brook watershed.

CONCLUSIONS

The concentrations of weekly total phosphorus in Jewett Brook were positively related to mean weekly stream discharge and the weekly amounts of manure applied to the watershed. Considering manure applications adjacent to the brook did not improve simple correlation relationships.

Accumulated manure applied between stormflow events improved correlations with stream phosphorus concentrations. However, the proximity of these applications did not greatly improve relationships.

Multiple regressions suggested that manure applications on low infiltration rate soils and suspended solids in runoff explained variation in stream phosphorus concentrations more than other land use and hydrologic variables.

To better link land-use activities to stream water quality, one might consider mass export rather than just mean concentrations using the lagging techniques described. Shorter time intervals than weekly might also improve relationships. Finally, quantify differences between seasons, land use should be monitored for more than 1 year.

ACKNOWLEDGEMENTS: This research was supported through funds supplied from the Rural Clean Water Program and by the Vermont Water Resources Research Center. Cooperative agreements are with U.S. Department of Agriculture, Soil Conservation Service and the Agricultural Stabilization and Conservation Service, Franklin County Natural Resources Conservation District, Vermont Extension Services, and the Vermont Agency of Environmental Conservation, Department of Water Resources. The cooperation and generosity of the Jewett Brook farm operators are sincerely appreciated.

Table 3.—Correlations (r) between mean weekly runoff concentrations (mg/l) and accumulated manure between runoff events (mT).

	Applied to: Total watershed	Hydrologic group D	Within 63 m	Within 63 m on D
Total phosphorus	.60[2]	.62[2]	.60[2]	.57[2]
Orthophosphorus	.44[2]	.43[1]	.43[1]	.38
Total Kjeldahl nitrogen	.52[1]	.50[1]	.51[1]	.48[1]
Ammonia nitrogen	.35	.34	.30	.25[1]
Total suspended solids	.16	.24	.19	.19
Volatile suspended solids	.19	.28	.19	.28

[1]Indicates significance at P = 0.05
[2]Indicates significance at P = 0.01

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APPROPRIATE DESIGNS FOR DOCUMENTING WATER QUALITY IMPROVEMENTS FROM AGRICULTURAL NPS CONTROL PROGRAMS

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ABSTRACT

Appropriate experimental designs are a function of the question to be answered. In the case of agricultural NPS control programs, the question is usually: How does BMP implementation affect the magnitude of pollutant concentrations or loads? This paper discusses the assumptions, analysis techniques, and advantages and disadvantages of three basic experimental designs that can be used in practical terms. Monitoring above and below an implementation site is generally more useful for documenting the severity of an NPS than for documenting BMP effectiveness. Time trend designs may be helpful; however, water quality trends are a result of complex interactions between land treatment, hydrology, and meteorologic factors. Accounting for these variables will therefore greatly increase the probability of documenting water quality improvements associated with BMP's. Paired watershed designs have the greatest potential for documenting improvements from BMP implementation because of the ability to control for meteorologic and hydrologic variability.

INTRODUCTION

A vast amount of information exists about best management practices (BMP's) for control of agricultural nonpoint sources (NPS). Most of this information, however, is from research efforts that considered only field plots or small watersheds. The investment of public funds to control nonpoint source pollution from agriculture requires that there be some assurance that nonpoint source pollution control programs be effective in protecting water quality. Hence, monitoring programs have been incorporated into many of these programs to verify that their application to the real world is, indeed, effective.

To evaluate the effectiveness of large-scale programs, such as the Rural Clean Water Program projects (12,000–40,000 ha), requires a great deal of money. Therefore, data analysis should be planned and executed carefully following a clearly specified experimental design. Lack of an experimental design often results in wasted data collection efforts, and inconclusive results.

In this paper, we present and discuss three alternative experimental designs that are applicable to most nonpoint source control projects. The methodologies are applicable to surface and ground water studies that deal with BMP effects on pollutant concentrations, loads, or the frequency of standard violations. Most of our examples are presented in terms of surface water concentration, but only for convenience. This treatment is not rigorous statistically, but we have attempted to present useful suggestions and lay out some of the advantages, disadvantages, and assumptions associated with each design.

MONITORING DESIGNS AND ANALYSES

Before and After (Time Trends or Time Series Analyses) Uncorrected for Meteorological Variables

Definition, Advantages, and Disadvantages: The before and after design is generally characterized by monitoring one or more sites in a watershed over time to determine whether a change in water quality conditions has occurred. Agricultural nonpoint source control programs generally involve water quality monitoring over a period of several years below the agricultural nonpoint source to assess the concentration or loading changes associated with BMP implementation.

This design is the easiest to conduct with limited funds and personnel. Little coordination between land treatment and water quality monitoring personnel is required. In nearly all cases the entire project area can be monitored. There are no physical limitations to applying this basic design to any watershed.

A disadvantage is that sensitivity is low unless meteorologically related variables are measured (stream flow, precipitation, lake levels, ground water levels). Thus, it is difficult to attribute water quality changes to land treatment measures. A long monitoring period is needed to assess whether significant changes in water quality have occurred. This is due to the extreme hydrological and meteorological variability in most systems.

Appropriate Hypothesis, Data Requirements, and Assumptions: For conceptual clarity, all the hypotheses will be stated in the alternative rather than the null form. When meteorologic variables are not measured, the appropriate hypothesis is:

> **Ha:** Mean annual (or seasonal) pollutant concentrations will decrease over time as BMP's are implemented.

The data needed to test this hypothesis are important. The sampling regimes should be similar for pre- and post-BMP implementation periods. Samples should be collected at equally spaced intervals or other predetermined schedules. It is important that sampling not be taken more frequently than scheduled. This allows pre- and post-BMP data to be compared with a minimum chance of sampling bias.

One assumption associated with this hypothesis is that every sample can be classified as belonging to either the pre- or post-BMP implementation period. If statistical tests are performed that divide the data into only these two groups, it is assumed that the level of BMP implementation is similar in each of the post-BMP years. Since this is often not the case, these tests may produce conservative estimates of effects.

Hypothesis Test, Conclusions, and Interpretations: The hypothesis can be tested using the Students t-test:

$$t_{sample} = \frac{(\bar{C}_{pre} - \bar{C}_{post})}{\sqrt{\left(\frac{1}{y_{pre}} + \frac{1}{y_{post}}\right)\frac{s_p^2}{n}}}$$

where n = the number of samples taken in each year or in each session if stratified, assumed constant

$$s_p^2 = \text{Pooled variance} = \frac{\sum_{i=1}^{Y} s_i^2}{Y}$$

y = the total number of years or seasons of monitoring

y_{pre} = the number of years or seasons pre-BMP

y_{post} = the number of years or seasons post-BMP

$\bar{C}_{pre}$ = the mean of the pre-BMP concentrations.

$\bar{C}_{post}$ = the mean of the post-BMP concentrations.

This t-sample statistic is compared to a t-table with (Y+n–Y) degrees of freedom. It should be noted that it may be advantageous to delete the interim time period if it can not be classified as pre- or post-BMP for this particular analysis.

An analysis that takes into account the cumulative nature of land treatment is the regression of concentration versus BMP application level. A significant negative slope suggests an improvement of water quality associated with BMP's. This approach does not require deleting data from intermediate years.

A third analysis that can be useful is generation of a Quantile-Quantile (Q–Q) plot. This analysis requires several steps. First, one generates a cumulative distribution of concentration for each site. This involves ranking by magnitude the concentration data and grouping it into percentiles. The mean for each percentile is calculated for both the pre- and post-BMP periods. These pairs are then plotted and the slope is tested to determine if it is significantly less than 1. An example of this plot is given in Figure 1. In this example a slope of less than 1 suggests a downward concentration trend.

Because uncontrolled variables such as flow have such a pronounced effect, often a downward concentration trend will not be observed. Even if a decrease in concentration is seen, no cause and effect relationship with BMP implementation level can be made. In a physical sense, there are four possible scenarios that may occur.

1. Mean flows increase; concentrations increase.
2. Mean flows increase; concentrations decrease.
3. Mean flows decrease; concentrations decrease.
4. Mean flows decrease; concentrations increase.

Of these four scenarios, there is generally only one (2) that provides strong evidence that BMP applications improved water quality. Also, without flow measurements, it is not possible to determine which of these four situations has occurred. Hence, without flow measurements, it is inevitable that a long-term monitoring program will be required to average out the fluctuations caused by stream flows, and to determine true effects of land treatment.

Before and After Time Trends Corrected for Stream Flows

Definition, Advantages, and Disadvantages: This design involves monitoring both concentration and flows over time at one or more sites in a watershed. Based upon

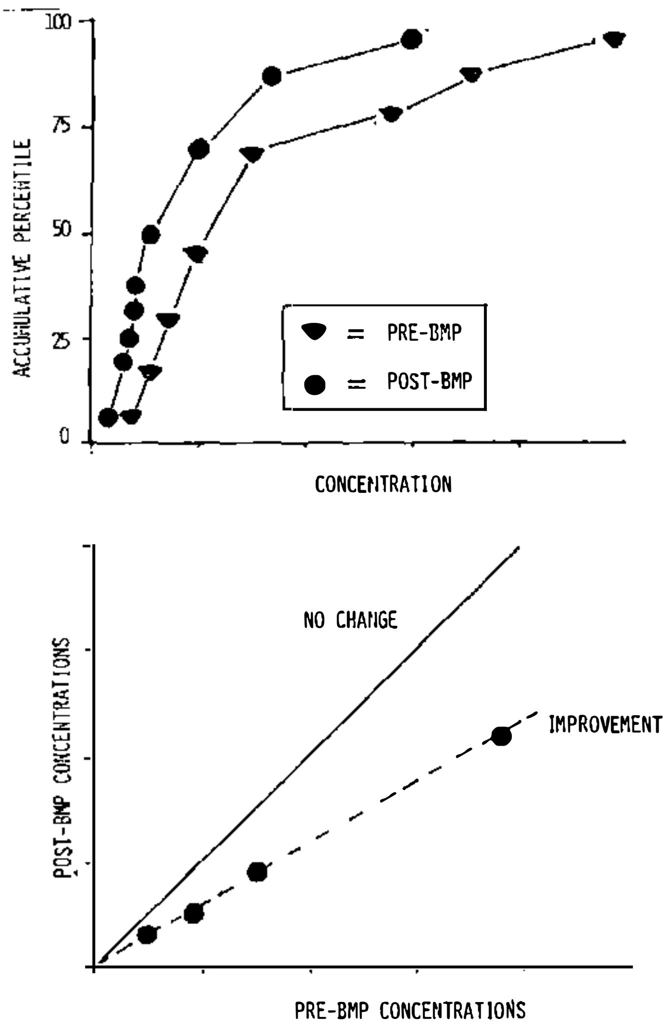

Figure 1.—An example of a Quantile-Quantile (Q–Q) plot derived from a plot of cumulative frequency distributions of concentration data from a pre- and post-BMP period.

previous studies, the variable with the greatest influence on surface water loads and concentrations is stream flow volume. (Froehlich, 1976; Johnson et al. 1974; McCool and Papendick, 1975). Thus, stream flows will be used in this and all subsequent examples that attempt to correct for meteorologic variations.

The basic advantages are the same as for the case just described. In addition, a stronger association with land treatment can be made. A long monitoring period is still needed to determine whether significant changes in water quality have occurred. Disadvantages are reduced, but unknown or unmeasured factors that occur during the project may still greatly reduce sensitivity.

Appropriate Hypothesis, Data Requirements and Assumptions: The hypothesis tested in this experimental design is:

> **Ha:** Mean annual (or seasonal) pollutant concentrations will decrease over time when corrected for stream flows.

Flow-concentration pairs (concentration and flow measurments) need not be taken at equally spaced or predetermined time intervals. In fact, it can be seen from Figure 2 that the required data can be generated more efficiently if the monitoring is weighted toward periods of high flow. A wide range of flows is needed to establish a flow-concentration relationship, and the potential effects of BMP's are often greatest at high flows. Since the flow-concentration relationship often depends greatly upon whether the sample is taken during the rising or receding limb of the hydrograph (Baker, 1985), it may be advisable to partition the data on this basis.

All the assumptions stated for the uncorrected, before and after design still hold. In addition, this design assumes that the BMP's will decrease pollutant concentrations more than they will reduce stream flows. In general, the assumption will hold for sediment and sediment-adsorbed pollutants, but may be in error for pollutants lost primarily in the dissolved phase of runoff. The pre- and post-BMP flow-concentration sample pairs need to reflect similar ranges in flows. If not, only the post-BMP data taken in the flow ranges present in the pre-BMP data should be used in the analyses.

Hypothesis Tests, Conclusions and Interpretations: Separate linear regressions of concentrations versus flows for the pre- and post-BMP periods can be performed. The slopes are compared for equality for the two periods as shown in Figure 2. From this analysis we can determine whether concentrations have changed over time for a given flow rate. With the establishment of a good flow–concentration relationship, the effects of BMP's can be distinguished under all four of the scenarios described. There may be a significant seasonal influence on the concentration–flow relationship. This source of variability in the data can be eliminated by partitioning the data by seasons. The cost of this partitioning, however, is a loss in the number of degrees of freedom (effective sample number), which decreases the sensitivity of the subsequent statistical tests.

Above and Below (Upstream–Downstream)

Definition, Advantages and Disadvantages: This experimental design involves sampling a flowing system over time above and below a potential nonpoint source. This has classically been the design used to monitor the effects of nonpoint source discharges to flowing systems.

The primary advantage of this approach is that it can account for upstream inputs to the area of interest. For agricultural nonpoint source projects, this will often be important for watersheds where the upper portions are in nonagricultural land uses. In addition, some irrigation management projects receive irrigation water that varies greatly in quality on an annual or seasonal basis. Perhaps the most common use of this design, however, is to document the location and magnitude of sources. As with the before and after design there is also the advantage that little or no coordination is required between the land treatment and water quality monitoring components of the project.

If the surface or ground water system originates within the nonpoint source area, there will be no suitable above sites. Also, the design provides only limited control for meteorologic variables, unless stream flow is monitored as described in the before and after design. In addition, it requires twice as many sampling sites as the before and after design to monitor an equivalent amount of the watershed area. The procedure may have low sensitivity because individual nonpoint source inputs are often small compared to background.

Appropriate Hypotheses, Data Requirements, and Assumptions: This design will generally provide information for testing two hypotheses: one concerning problem identification, and another concerning the effects of BMP's over time.

Ha a. Agricultural pollutant concentrations will be higher downstream from a suspected agricultural nonpoint source as compared to upstream.

Ha b. The difference between upstream and downstream pollutant concentrations will decrease over time as BMP's are applied.

Testing hypothesis a. requires paired concentration data above and below the potential nonpoint source over time during the pre-BMP period. For hypothesis b. the same paired data are needed for both the pre- and post-BMP periods.

The most important assumption for this design is that sampling is timed so that the same parcel of water is being sampled at the above and below sites. This requires some understanding of the hydrology system.

Hypotheses Tests, Conclusions, and Interpretations: For hypothesis a. to determine whether there is a significant concentration increase, a simple one-sided Student's t-test is used to determine whether the means of the paired differences between the upstream (C_{up}) and downstream (C_{down} concentrations are different from zero.

$$t_{calc} = \frac{\bar{D}}{s_D},$$

where $\bar{D}$ = the average of the paired differences,

$$= \frac{\sum_{i=1}^{n} (C_{up} - C_{down})}{n}$$

$$s_D = \frac{s_d}{\sqrt{n}}$$

In many cases, it is desirable to know what percentage of the pollutant concentration is attributable to the nonpoint source. The best estimate of this can be calculated from:

$$\text{NPS Percentage} = \sum^{n} [(C_{i\,down} - C_{i\,up}) / C_{i\,down}] * 100/n$$

To test hypothesis b., paired differences (D_i) must first be calculated for pre- and post-BMP periods ($D_i = C_{i\,down} - C_{i\,up}$). Then, each of the four analyses described for the before and after design can be used to test for water quality improvements associated with BMP implementation. Briefly, these include: (a) Student's t-test for determining

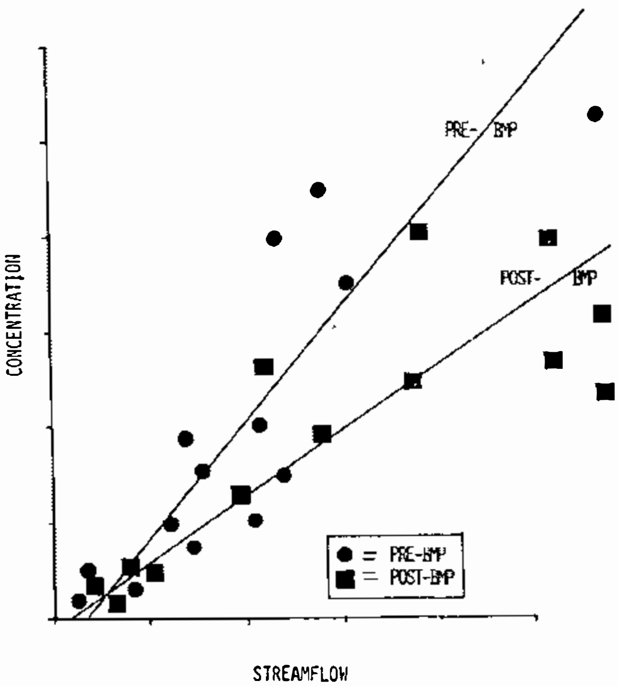

Figure 2.—An example of separate linear regression of concentration versus streamflows for a pre- and post-BMP period. Note that in this hypothetical example the data show a significant decrease in post-BMP concentrations when corrected for streamflow, even though the actual concentration mean is higher for the post-BMP period.

whether pre- and post-BMP mean concentrations are different, (b) Q–Q plots, (c) linear regression of D_i versus BMP implementation level, and (d) linear regressions of D_i versus flow for pre- and post-BMP periods to test for equality of flow-corrected D_i's.

From testing hypothesis a. we can conclude whether the suspected agricultural nonpoint source is actually a significant contributor to an identified water resource impairment. From this, we can estimate the upper limit of how such improvement can be accomplished using BMP's.

For hypothesis b. the interpretations are very similar to those that can be made for the before and after design. In the cases where not all the water originates within the project area this experimental design allows trends to be established with more certainty than the before and after design, because of the corrections for incoming concentrations.

Paired Watersheds Design (Controlled–Experimental Design or Treated–Untreated Design)

Definition, Advantages, and Disadvantages: The design consists of monitoring downstream from two or more agricultural drainages where at least one drainage has BMP implementation, and at least one does not. This design ideally possesses the following characteristics: (a) simultaneous monitoring below each drainage, (b) monitoring at all sites prior to any land treatment (calibration period) to establish the relative responses of the drainages, and (c) subsequent monitoring, where at least one drainage area continues to serve as a control through the land treatment period, i.e., receives significantly less land treatment than the other drainage areas.

This design controls for meteorologic (and to some extent hydrologic) variability, minimizing the need for monitoring meteorological parameters. In most cases, water quality improvements related to BMP implementation can be documented within a much shorter time frame. In addition, this design provides stronger statistical evidence of the cause–effect relationship between agricultural nonpoint source control efforts and water quality changes.

A disadvantage of this design is that land treatment and water quality personnel must coordinate closely to match implementation efforts with monitoring and data analysis needs. For some projects it may be difficult to find adequately similar drainages. Close physical proximity is essential. Another disadvantage is the fact that control basins cannot receive as much land treatment, thus reducing the potential water quality improvement for the overall project area. This design is not intended to determine the location or severity of the nonpoint source.

Appropriate Hypothesis, Data Requirements, and Assumptions:

> **Ha:** An agricultural drainage with BMP's applied will exhibit a decrease in pollutant concentrations over time, relative to an untreated agricultural drainage.

Site selection is crucial to this design. A similarity in hydrology and land use is desirable. Sampling from the watersheds should be conducted consistently (either simultaneously or separated by a constant time interval). Because concentration–flow relationships vary with rising or falling hydrograph limb, it is desirable to partition data on this basis.

It is assumed that paired watersheds have similar precipitation patterns, because of their geographic proximity. The hydrologic response of the paired watersheds should be consistent, even if actual concentrations are quite different because of differences in slope, soil type, cropping patterns, and other factors. It is assumed that BMP implementation levels can be measured accurately. Finally, the precipitation, stream flows, and cropping patterns should be at least somewhat similar for the calibration and treatment periods.

	CONTROL BASINS	EXPERIMENTAL BASINS
CALIBRATION PERIOD	NO BMPs	NO BMPs
TREATMENT PERIOD	NO BMPs	BMPs APPLIED

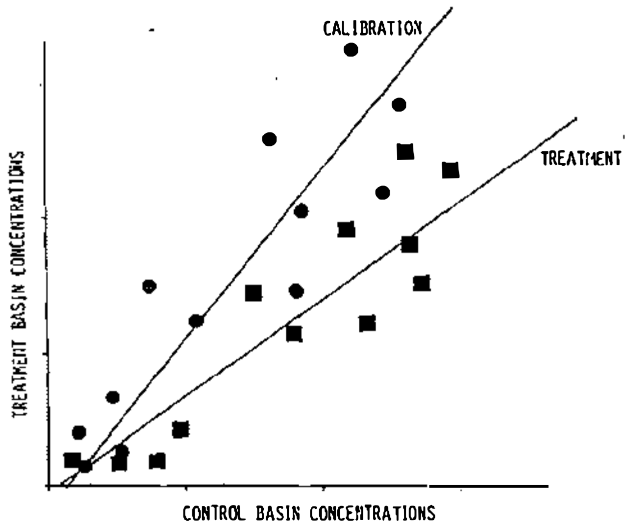

Figure 3.—An example of data analysis for the paired watersheds experimental design. If the predicted watershed value is significantly less during the treatment period as compared to the calibration period, a significant improvement in pollutant concentrations is indicated.

Hypothesis Tests, Conclusions, and Interpretations: Linear regressions of the concentrations (or log concentrations) for the treatment versus the control watersheds for the calibration and land treatment periods can be performed (Fig. 3). A Student's t-test is performed to determine if the predicted treatment watershed values at the mean control watershed concentration decrease over time.

A decrease in the predicted treatment watershed values suggests a positive effect of BMP's on the water quality. This is stronger evidence of a cause–effect relationship than that derived from any of the designs previously discussed because of greater control over the complex meteorologic, hydrologic, and temporal factors. Although this design compares only a treated drainage with an untreated drainage, the results can be interpreted to indicate that the BMP's have improved water quality in the treated subbasins relative to the condition that would have existed without treatment. It should be noted that this design documents water quality improvements only in the treated subbasins; the accuracy of extrapolating results from the test basins to other portions of the project areas will remain untested. This experimental design may develop from a project area by chance, as BMP implementation progresses in subbasins with varying levels of success.

SUMMARY

For documenting water quality improvements resulting from BMP's within the shortest possible time period we believe the paired watershed design is clearly superior, because of its control of meteorologically-related variables. To document the magnitude of nonpoint sources prior to implementing BMP's, the above and below design has advantages over the other designs. The before and after design is often the easiest design to follow, and can yield useful results provided that streamflows or some other surrogate measure of meteorologic variability is incorporated. Without correction for flow variability, it is unlikely that the before and after design can document BMP effects at the watershed level within any practical program time frame. It should be noted that for many of the experimental designs the time period required to observe BMP-related changes will depend upon how large a change is actually being made. For example, a 30 percent concentration reduction will take much longer to observe above the noise (variability) of the system than will a 90 percent reduction.

At least one of these experimental designs should be evident in any nonpoint source control project with water quality monitoring. The most appropriate monitoring strategies may include more than one of these experimental designs. The choice of the most appropriate design will depend upon the nature of the water resource impairment, the water quality objectives of the project, the anticipated level and timing of land treatment, the topography of the project area, and the financial resources available for monitoring.

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MONITORING FOR WATER QUALITY OBJECTIVES IN RESPONSE TO NONPOINT SOURCE POLLUTION

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ABSTRACT

The broad application and continued use of herbicides and pesticides have resulted in a major diffuse source input of toxic material into aquatic ecosystems. The most common present water quality assessment practices cannot account for the entry of such compounds into the environment. Unlike point source input, where levels, quantity, and consistency of loadings are known, diffuse source input must be estimated using assessment procedures. Consequently, these assessment practices are not designed for the development or site-adaptation of water quality objectives—in Canada, water quality objectives are used for determining best land use practice and providing protection to the aquatic ecosystem. These demands on environmental assessments and the subsequent development of relevant water quality objectives can only be achieved by studies that provide insight into aquatic system behavior. The different environmental processes and fates that potentially regulate a compound's effect in the aquatic ecosystem emphasize the need for system behavior information. Examples from different systems illustrate the need for more comprehensive water quality assessment procedures to develop water quality objectives relevant to diffuse source inputs.

INTRODUCTION

Management of water quality within an aquatic ecosystem involves three facets: measurement, evaluation, and remedial action. Measurement pertains to the collection of physical, biological, and chemical water quality data. Evaluation necessitates a set of criteria with which the measured water quality can be realistically compared (in Canada these criteria take the form of water quality objectives—negotiated limits designed to protect and support designated water uses). These objectives provide the link between water quality information and the water uses to be protected and maintained within a given waterbody. Remedial actions, if required for use protection, are based on the measurement and evaluation information.

Approaches to the monitoring and assessment of water quality, as well as water quality management, will vary according to the relative significance of nonpoint and point source pollution. Specific water quality objectives that are used for evaluation do not vary similarly; however, their effectiveness depends upon the related data as well as the resultant management responses to them. Although water quality objectives have application for both nonpoint and point source pollution, the development of these objectives, their monitoring requirements, and the appropriate management strategies may differ significantly. The remainder of this discussion focuses on monitoring approaches, with regard to water quality objectives, and the assessment of nonpoint source pollution.

Point source inputs to an aquatic ecosystem are usually a consistent load of a given set of materials or chemicals. Data sets can be generated in specific areas of a river basin, and areas of noncompliance established with remedial actions confined to specific sources. Diffuse loadings from land use or atmospheric inputs tend to be more event oriented without a quantifiable area of effect in the aquatic environment. Basically, the complex nature of diffuse-source inputs results in the need for more comprehensive and extensive measurements and evaluation for development of a suitable management strategy.

Nonpoint source pollution in Canada most often results from agricultural practices, urban runoff, and atmospheric deposition. Aspects of these concerns are contained in three highly interrelated departmental priorities recently identified by Environment Canada: Toxic Chemicals, Long Range Transport of Airborne Pollutants, and Water Management (Environ. Can. 1983). To address these priorities, data must be assembled, an evaluatory mechanism initiated, and response programs implemented. Data collection necessitates an effective monitoring program; evaluation may correspond to the use of water quality objectives and the response usually consists of developing and implementing management options.

This discussion critically examines the measurements and evaluations required to develop water quality objectives specifically for nonpoint source inputs. Selected examples illustrate how such measurement might be used to determine the need and type of remedial action required to protect the aquatic environment.

MONITORING NONPOINT SOURCE POLLUTION

Water quality management requires a multiplicity of data to resolve the conflict of economic uses (industrial, agricultural) of water and the health of the aquatic environment (drinking water, fisheries, recreation). Historically, monitoring programs have been expected to yield information on many different aspects of water quality, and as a result data bases were established with many distinct and often incompatible rationales and designs. Generally, however, these measurement rationales and designs can be described in one of the following categories of environmental monitoring: (1) crisis response, (2) general monitoring, and (3) understanding aquatic processes.

Crisis Monitoring

Crisis monitoring, the oldest form of environmental data collection, includes observations such as the collapse of certain fisheries in the Great Lakes, loss of potable water supply because of an epidemic such as the typhoid outbreaks that took place at the turn of the century, or the number of beach closures occurring over a certain period of time as happened on the Ottawa River. Although criteria information indicates a need for environmental management, it does not help make decisions to avoid such situations or identify solutions to ameliorate the problem; therefore, it is not relevant to this discussion.

General Monitoring

To determine the state of the aquatic resource requires a general monitoring program that will yield data describing the presence, level, and change over time of specific chemicals entering the aquatic system as a result of man's activities. Such programs include the collection of water samples at regular intervals and usually over the course of a number of years. Data generated from these collections are used to describe an average water quality condition of the sites. An example of such a network has been the general water quality monitoring carried out by the Water Quality Branch of Environment Canada, which is based on fixed sampling sites and monthly sampling frequencies (Whitlow, 1985). Such a network emphasizes statistics to quantify the accuracy and precision of the baseline data generated (see Loftis et al. 1983; Sanders and Ward, 1978). When operated over a period of time, the program yields data suitable for long-term trend or intervention analyses.

Often, these data sets are also used to assess compliance with water quality objectives. Usually, these objectives are a simple concentration of a chemical in water, and the linking of the measurement and evaluation components of water quality management becomes little more than asking the perennial question, do ambient conditions comply with the objective? Because of our present reliance on fixed monitoring sites, considerable effort has been made to study the stochastic nature of general monitoring (Ward and Loftis, 1983) and determine the probability of exceeding a water quality objective or guideline at any particular point in time.

Compliance monitoring for water quality objectives in the Prairie Provinces is based on a two-level approach that provides a short- and long-term objective for each water quality variable of concern. The short-term objective is most commonly based on laboratory-derived criteria, whereas the long-term objective is developed from system variability (historic mean concentration ±2 Standard Deviations) to account for seasonal variations. Considering the episodic nature of diffuse source loadings, the long-term objective is more relevant for water quality management concerned with diffuse source inputs. For example, the use of herbicides and pesticides in the Prairie Provinces follows crop cycles; application and land runoff provide event-oriented inputs to the aquatic ecosystem. General water quality monitoring in the area has demonstrated the presence and levels of pesticides throughout the area and indicated some presence of lindane and alpha-BHC in locations well beyond the areas of use (Gummer, 1978). Although such a data set indicates the need for water quality objectives, it does not provide the information to site-adapt the objectives with respect to potential effects within the system.

Process Assessments

Designing environmental monitoring or assessment to provide scientific advice for a specific issue requires a third type of assessment—monitoring to characterize the behavior of the system. Specific questions must be addressed. Is the correct substrate being sampled? Is the hydrological regime of the system being taken into account? Are seasonal variations in concentrations and loadings being considered? These exemplify the need for a comprehensive multi-media approach to characterizing a system, if effective water quality objectives are to be developed and used to provide advice for sound water quality management. This requires a knowledge of the natural processes that regulate and often determine environmental quality within an aquatic system.

Environmental priorities such as acid rain or toxic substances make it critical to know both the environmental exposure and ecological effect of toxic chemicals. Exposure is a function of partitioning a chemical among the media under consideration (see Chapman et al. 1982); whereas, the effect is a function of the system's tolerance to the imposed stress. The need for process assessments was emphasized by Chapman et al. (1982). They concluded that a full understanding of the behavior of priority pollutants in the aquatic environment will require collecting considerably more information than chemical concentration in certain compartments.

By virtue of its diffuse nature, understanding of nonpoint source pollution relies more on monitoring and assessment than does point source pollution. Direct measurement of diffuse pollution sources is very difficult if not impossible; thus evaluation (using water quality objectives) depends upon a more careful monitoring of the system. General monitoring is often satisfactory for point source pollution because what and how much has been contributed to the system is known. However, without the benefit of accurate information on pollution inputs, more comprehensive monitoring is needed to evaluate nonpoint source pollution.

Process assessment requires measuring the system's variability and examining the physical–chemical and biological processes that determine environmental quality. Variability should consider statistical estimates of variance as well as include the comparison and analysis of the different sets of physical–chemical conditions. Understanding system behavior is an essential component of environmental management, and criteria, guidelines, or water quality objectives developed for good management practice must be adapted to system behavior. Process assessments provide the third step in developing relevant water quality objectives and implementing wise environmental management.

The value of process assessments is perhaps best described in the Great Lakes phosphorus management program. General monitoring provided estimates of total phosphorus loads within the lakes. From 1972 to the present, phosphorus loadings declined dramatically because of point source controls (1 mg/L), legislative controls (detergents), and nonpoint source controls (no till). To effectively manage phosphorus, and thus control the eutrophication of the Great Lakes, it was essential to determine what forms of phosphorus were most bioavailable and what sources should be emphasized for control programs.

Although it showed decreased loadings and concentration declines in Total Phosphorus, general monitoring could not provide the essential data to make such decisions. Process monitoring, such as bioassays of phosphorus availability and utilization, could distinguish the importance of the various sources. Consequently, appropriate decisions to target phosphorus loads for each of the lakes were made and agreement was reached on the most effective way to achieve the target levels.

During the 1960's, insecticides such as DDT and Dieldrin represented a major diffuse source input into Lake Michigan. Following the ban on the use and manufacture of these compounds in 1970, greater than 90 percent declines of DDT levels were measured in bloater chubs between 1970 and 1980, and concentrations approached the Great Lakes Water Quality Agreement Objective of 1.0 μg/L. Dieldrin, however, increased in bloater chubs over this time period, and concentrations continue to remain over the water quality objective of 0.3 μg/L.

The different environmental behavior of these two compounds following regulatory action emphasizes the need for process information. When developing water quality objectives it is essential to know if a specific water quality objective is achievable and how long it might take to meet this objective. A lack of diffuse source input information makes it difficult to discern if further controls are required. What is the process that regulates levels of dieldrin in the environment, and why is it different from DDT? Process information is not yet available but is essential to answer such a question.

For the Great Lakes, water quality objectives supported by general monitoring have helped determine the need, type, and priority of remedial effort required. They provided an indication of the general health and response of the system. However, to maximize the effectiveness of water quality objectives, both in terms of their validity and especially their management potential, process information has been needed. Process assessments better resolve how to obtain the specific levels represented by the water quality objectives. They also evaluate the significance of nonpoint sources of pollution to encourage more efficient water quality management.

This point became apparent during the 1970's general monitoring programs in the Qu'Appelle River Basin of Saskatchewan which revealed that Province of Saskatchewan water quality objectives (which are not site-specific) for nutrients were routinely being exceeded. On the basis of this monitoring and evaluation, it was assumed that point source pollution was primarily responsible for this situation. Management adopted the position that controlling point source pollution would alleviate the problem. Tertiary waste treatment for the upstream cities of Regina and Moose Jaw was installed. Subsequent monitoring revealed little difference in nutrient values and it was not until detailed process assessments took place that a significant source of nutrients was determined to be of nonpoint origin. Present water quality objectives, which are not site-specific, have limited potential for water quality management because of the overall significance of nonpoint contribution of nutrients to the system. Therefore, process assessment in this case indicates that water quality objectives are probably not achievable through point source controls but require comprehensive nonpoint source mitigative measures.

CONCLUSIONS

Water quality monitoring for nonpoint source pollution must be taken into account for developing and maintaining water quality objectives. Evaluating the significance of this pollution (through water quality objectives) and formulating management responses rely on more dynamic assessments than those provided by general monitoring. In some situations general monitoring that relies on describing average condition may be the most cost-effective solution to supporting (as opposed to developing) water quality objectives. However, nonpoint source pollution more often demands a detailed characterization of a system's water quality. A knowledge of the processes and interrelationships that regulate environmental quality within any aquatic system is usually required.

With Great Lakes eutrophication, the system forgave the immediate lack of process information. However, present day priority issues such as acid rain and the entry of toxic substances into the environment will not be as forgiving. In the interests of protecting and sustaining Canadian water resources, studies emphasizing the knowledge of the system must be carried out. These data are essential in developing relevant water quality objectives and designing networks to support them. Furthermore, as the use of water quality objectives grows, the information gained from such studies will provide some interpretable data, both in terms of information on the system and in assessing the health of these resources.

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USE OF BIOASSAYS TO DETERMINE POTENTIAL TOXICITY EFFECTS OF ENVIRONMENTAL POLLUTANTS

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ABSTRACT

Nonpoint source (NPS) runoff from mining, landfills, roads, croplands, grazing lands, and forests can contain chemicals harmful to aquatic organisms. Full scale biological surveys to determine their effects are difficult and costly. Bioassays of environmental samples integrate the effects of all toxicants contained in a sample. Biological organisms are being used more frequently to identify toxicant problems and to rank-order their severity. The Corvallis Environmental Research Laboratory (CERL) has developed a multi-media (aquatic/terrestrial) bioassessment protocol to assist in the identification of toxicity potentials associated with waste disposal. Similar techniques can be used to identify NPS pollutants. The bioassay response indicators are particularly useful in identification of field-site problems where complex mixtures of pollutants might be present. Use of the bioassessment protocol reduces the initial need for extensive chemical analyses, and produces data (toxicity LC_{50} information) in a form more readily understood by the public than bulk chemical concentrations. The CERL protocol has been used successfully to: (1) define and rank-order the effects of selected heavy metals, herbicides, and insecticides on microbes, earthworms, plant seeds, algae, daphnia, and fathead minnow larvae; (2) determine that rank-order of sensitivity differs with major toxicant groups; (3) detect the presence of bioactive organic and heavy metal mixtures in field site samples when concentrations of priority organic pollutants did not exceed EPA criteria levels; and (4) identify the basic chemical component of complex waste mixtures which produce environmental toxicological effects. These types of information should be useful in determining the potential effects of NPS pollutants and in designing measures for their control.

INTRODUCTION

Nonpoint sources (NPS) pollution problems are among the most pervasive, persistant, and diverse water quality problems facing the nation. This presents a definite problem to water quality decisionmakers who traditionally have addressed individual pollutants or site-specific sources of pollutants. The individual chemical-by-chemical approach requires a great deal of patience, time, money, and intellect to determine the pollutants adverse impact. Also, determining the substance producing the impact, the source of the substances, and the areal extent of the problem is difficult to address. Even extensive effort on a chemical-by-chemical basis does not assure an accurate ecotoxicological assessment, since one still has to relate environmental chemical measurements to biological/ecological impact. The approach most commonly employed is that of calculating potential toxicity based on chemical concentration of the 129 EPA consent decree chemicals (priority pollutants) (Keith and Telliard, 1979) with extrapolation to water quality criteria. The approach has been useful in providing relative toxicity guidance, i.e., the relative toxicity of various chemicals under laboratory conditions. However, it has become increasingly apparent that this approach has severe limitations concerning realistic and accurate ecotoxicity estimates. Some of the problems associated with calculation of toxicity potentials based on priority pollutant chemical concentrations are that:

1. The data bases for most chemicals are not complete enough to permit the development of reliable criteria;
2. Most of the chemicals for which complete criteria exist are not necessarily those most commonly found in complex NPS or waste site discharges;
3. Application of criteria to field situations usually results in highly conservative and, therefore, overly restrictive estimates of toxicity or misinterpretation of toxicity cause and effect relationships;
4. Criteria for single chemicals were not intended to be assembled additively and there is little evidence to support that use; and
5. For contaminated soil and sediment there are no criteria on which to base decisions for judging if a site constitutes a problem.

Biological assessment of environmental toxicity alleviates most concerns associated with the above problems and provides a direct indication of potential toxicity (Roop and Hunsaker, 1985). An example was cited by Samoiloff et al. (1983) when they discovered that the most toxic sediment samples were those containing none of the EPA consent decree chemicals. Miller et al. (1985) have demonstrated similar results with the bioassessment of hazardous waste site samples using a multimedia bioassay procedure. Brown et al. (1984) demonstrated the inability of chemical analyses to provide a comprehensive evaluation of the toxicity potential of hazardous industrial wastes. They demonstrated further that a combined testing protocol using bioassays and organic chemical analysis was effective in identifying the toxicity potential of such wastes. A recommendation from Brown et al. (1984) was that a battery of bioassays be used to define the toxicity of wastes. The purpose of this paper is to demonstrate that such a bioassay test battery and analysis of results can be used to (1) identify and rank-order toxicity hazard potential of waste site samples; (2) help define and quantify areal extent of toxicity potentials; (3) help identify what chemical fractions of a complex waste contribute significantly to their overall toxicity; and (4) suggest that similar procedures might be used to assess the impacts of a broad spectrum of NPS pollutants. This paper is based, in part, on recently published and ongoing research conducted or sponsored by the Hazardous Materials Assessment Team at the EPA Corvallis Environmental Research Laboratory.

METHODS

Biological organisms respond to the adverse effects of a variety of specific pollutants (Fed. Water Pollut. Control Admin. 1968; U.S. Environ. Prot. Agency, 1976). However, there has been relatively little comparative toxicology done on environmental samples using a broad spectrum of organisms comprising both aquatic and terrestrial compartments of the ecosystem. For this purpose, we have adopted a multimedia bioassessment protocol described by Porcella (1983). The bioassays in the Porcella protocol include assessments of water and soil leachate toxicity on seed germination/root elongation (lettuce, *Lactuca sativa* L.), earthworms (*Eisenia foetida*), algae (*Selenastrum capricornutum*), daphnia (*Daphnia magna*), and fathead minnow larvae (*Pimephales promelas*). In addition, we have conducted Microtox (*Photobacterium phosphoreum*) tests (Beckman, 1982). Our approach has been to conduct comparative toxicological studies on pure chemicals and mixtures of chemicals in the laboratory to increase our confidence that biological responses to these substances are predictable and relatable to environmental samples (Miller et al. 1985). All toxicity responses are expressed as EC_{50} or LC_{50} concentrations for comparison.

We have focused on substances in chemical extraction groupings. Metals, base neutral organics, acid organics, and pesticides were extracted with water (4 ml water to 1 g soil). Bioassays were performed using these aqueous extracts. The predicted bioassay response, based on chemical concentration and criteria for certain chemicals, was then compared with bioassay responses on environmental samples dominated by the mixture of chemicals in question. This approach has permitted us to test the hypothesis that bioassay of environmental samples will produce EC_{50} or LC_{50} estimates significantly different from those predicted by calculation based on chemical concentrations with extrapolation to water quality criteria. Also, we have examined the relative toxicity potential of various metals, priority organics, and nonpriority organics in samples, from the Western Processing Superfund site at Kent, Washington. This was accomplished by incremental inactivation of metals with EDTA (at an EDTA to metals molar ratio of 4:1, based on Cu inactivation) and methylene chloride extraction of priority organic chemicals (Eichelberger et al. 1983) followed by algal assay examination. Chemical quality control was assured by surrogate spike recovery analysis coupled with daily calibration of the GC/MS system.

Extent of chemical contamination was determined using a modified phytotoxicity test described by Thomas and Cline (1985). Lettuce seeds were used to test the toxicity potential of soils collected along four 90 m long parallel transects that were 15 m apart. Soils from 0-15 cm depth and 15-30 cm depth were used since they encompassed the root zone in the area. The site was located downwind, along a suspected concentration gradient perpendicular to an open ditch known to have transported liquid organic wastes associated with the manufacture of herbicides, insecticides, and neurotoxin gases at Rocky Mountain Arsenal, Colorado. Thomas et al. (1984) have described the statistical sampling design in greater detail. Phytotoxicity data from the site were analyzed using kriging. Kriging is a statistical technique developed in the mining industry (Clark, 1982). Only a limited number of samples are required to successfully define a contaminated area using kriging. The technique employs a weighted moving average that calculates point estimates or block averages over a specified grid. Output of the kriging analysis for this study is a contour map displaying areal variation in phytotoxicity.

FINDINGS AND DISCUSSION

Comparative Toxicology

Miller et al. (1985) conducted comparative toxicological studies on several known single and complex organic and metal contaminants in the laboratory using the Porcella (1983) bioassessment protocol plus the Microtox Test (Beckman, 1982). They concluded that:

1. The protocol test organisms responded differentially to various pollutants and their EC_{50} or LC_{50} results generally conformed to the range of values reported in the literature for individual chemicals and metals;
2. Test organism rank order of sensitivity differed with major toxicant groups, suggesting that certain bioassays are better suited than others to assess given chemical groups;
3. Algae (*Selenastrum capricornutum*) was the most uniformly sensitive test organism across a broad spectrum of pollutant groupings; and
4. Differences in sensitivity levels of the test organisms, relative to the toxicant assayed, can be used to identify those biotic components most susceptible to the presence of toxicants and to draw an educated conclusion as to the contaminant type producing the toxic effect.

Based on the conclusions drawn from bioassay responses to pure chemical substances in the laboratory and the assumption that bioassays integrate the toxicity effects of all sample components regardless of their composition, Miller et al. (1985) bioassayed soil and soil elutriate samples from seven diverse hazardous waste sites (Table 1). The samples were dominated by heavy metals, solvents, phthlates, phenols, pesticides, and herbicides.

Relative, integrated biotic toxicity of the sites and their rank ordering could be determined by calculating the arithmetic average toxicity across the different tests in Table 1. If one was concerned primarily with potential aquatic impacts, the algae, Daphnia, and Microtox tests probably would be the most applicable indicators. The sensitivity of algae appears to be much greater than the other bioassays for most of the samples.

Algae responded adversely to all but one of the samples. In that case, no aquatic test responded adversely. Toxicity rank ordering, such as that shown in Table 1, would be helpful in: (1) determining potential environmental impacts; (2) directing further chemical analyses within sites; and (3) ranking cleanup across or within various sites. Bioassay data might be used to monitor toxicity changes in samples before and after waste cleanup or the adoption of various NPS management alternatives, thus helping to determine the degree of treatment success.

Kriging of Bioassay Data

Another means of assimilating bioassay data into a format useful for problem solving and remedial design relative to chemical hazard assessment is that of kriging. Phytoassay responses for soil samples from Rocky Mountain Arsenal were subjected to kriging as described under methods. Kriging the 0-15 cm phytotoxicity data, with the resultant toxicity potential contours is shown in Figure 1.

Thomas et al. (1984) compared kriged phytotoxicity bioassay estimates (Figure 1) with sample site-specific plant mortality data (Figure 2). This type of graphic interpolation could be very useful in making waste site cleanup decisions or in designing NPS watershed or ecoregional contaminant source controls. For example, if it was determined that the 30 percent mortality contour should be used as the criterion for remedial action for the conditions shown in Figure 2, the area below the 30 percent solid contour line would be targeted for acton.

Table 1.—EC_{50} response for percent in soil (earthworm) or soil elutriate with associated complex chemical contaminants from selected hazardous waste sites.

		Bioassay Response (Percent of soil or elutriate required) to produce an EC_{50}					
Waste Site	Major Chemical Group	Algae	Daphnia	Microtox	RE[1]	Earth-Worm	Arithmetic Average
Holder Chemical West Virginia	Pesticides, herbicides	2.1	3.6	18.0	3.6	70.0	19.5
Western Processing Kent, WA #17	Heavy metals, phenols, solvents, pesticides	0.2	5.6	2.2	37.0	55.0	20.0
Big John Houldt West Virginia	PAH[3], unknown organics	5.4	87.0	28.0	NE[4]	<10.0	46.1
Hollywood Memphis, TN	Pesticides	24.0	22.0	>90.0	NE	>25.0	52.2
Sharon Steel Fremont, NY	Heavy metals, tar, PAH	0.6	30.0	99.0	NE	>75.0	40.4
Sapp Battery Cottondale, FL	Heavy metals	41.0	70.0	NE	NE	NE	22.2
Thiokol Chester, WV	Diphenylamine	NE	NE	NE	NE	35.0	87.0

[1]Root elongation test.
[2]Earthworm 14 day soil contact test (LC_{50}).
[3]PAH = polynuclear aromatic hydrocarbons.
[4]NE = No affect observed at 100% of the soil or soil elutriate. Therefore, NE is factored into the arithmetic average as 100%, i.e., 100% of the soil or elutriate produced no effect on the test organisms; the greater the percent soil or elutriate required to produce the EC_{50}, the less toxic is the sample.

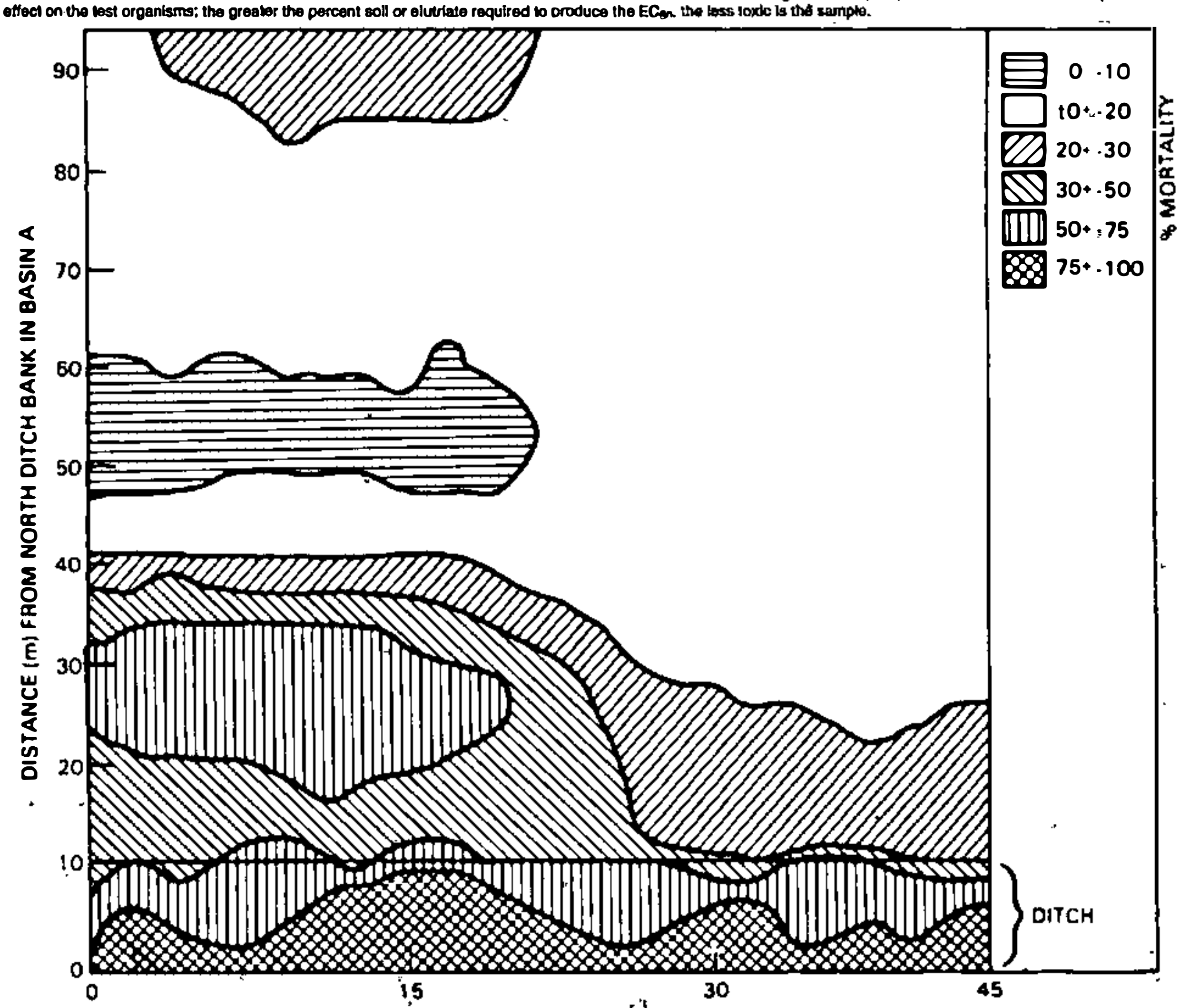

Figure 1.—Estimated lattuce seed mortality (based on kriging) for the 0-15 cm soil fraction from the Rocky Mountain Arsenal (from Thomas et al. 1984).

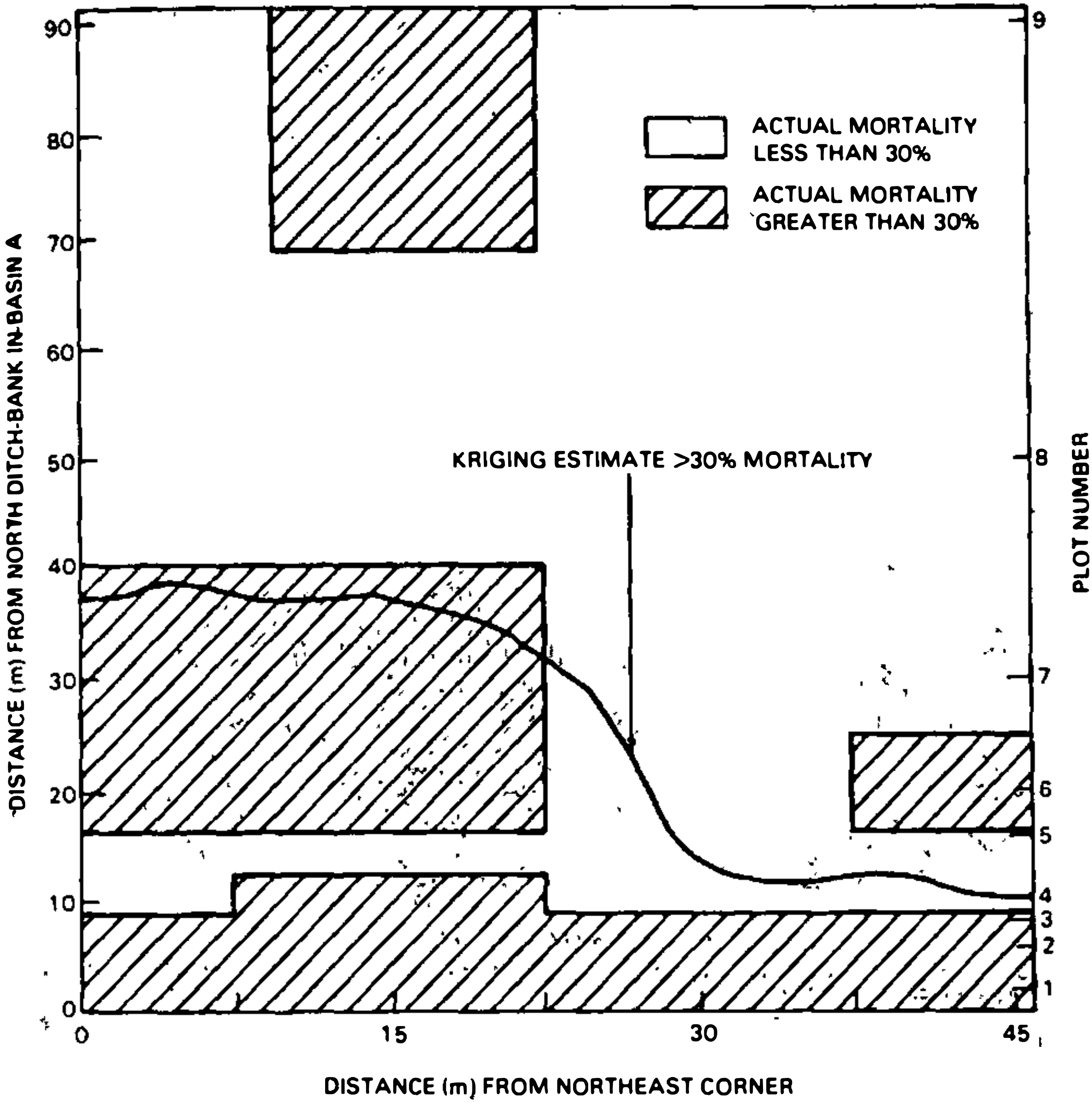

Figure 2.—A comparison of greater than 30 percent lettuce seed mortality (estimated from kriging) to observed lettuce seed mortality for the 0-15 cm soil fraction from the Rocky Mountain Arsenal (from Thomas et al. 1984).

Unfortunately, the hazardous waste site situation is more complex than the kriged phytotoxicity surface data (0-15 cm deep) would indicate. Samples from the 15-30 cm depth at the same site produced the results shown in Figure 3. Comparison of kriging estimates with plant mortality data at this depth is shown in Figure 4. It is evident that site cleanup based on the surface sample greater than 30 percent mortality results would omit significant areas of contamination. This information makes the remedial action plan more complicated, but it adds significant realism to the site assessment. A final remedial action decision that includes consideration of chemical bioavailability as determined by integrative bioassay endpoints should greatly enhance the probability of contaminant cleanup success. Chemical information alone cannot assure an accurate assessment of toxicity potentials and in some instances might lead to misinterpretation of toxicological cause and effect relationships.

Chemical Analysis and Bioassay

Hazardous waste assessment and NPS pollution problems are similar in that each has traditionally been assessed from a chemical perspective. Severity of the problem has been assessed relative to the concentration of a given chemical producing a given type and degree of response under laboratory conditions. Controlled condition laboratory response tests have been used extensively to develop water quality criteria for various chemicals. Problems associated with the extrapolation of these criteria to assess field conditions were mentioned in the introduction. In addition, combinations of pollutants and different attenuating characteristics of a site are difficult to assess when calculating toxicity estimates.

Direct bioassay of samples tends to minimize many of these problems. Bioassays integrate the toxicological effects of all sample components regardless of their type

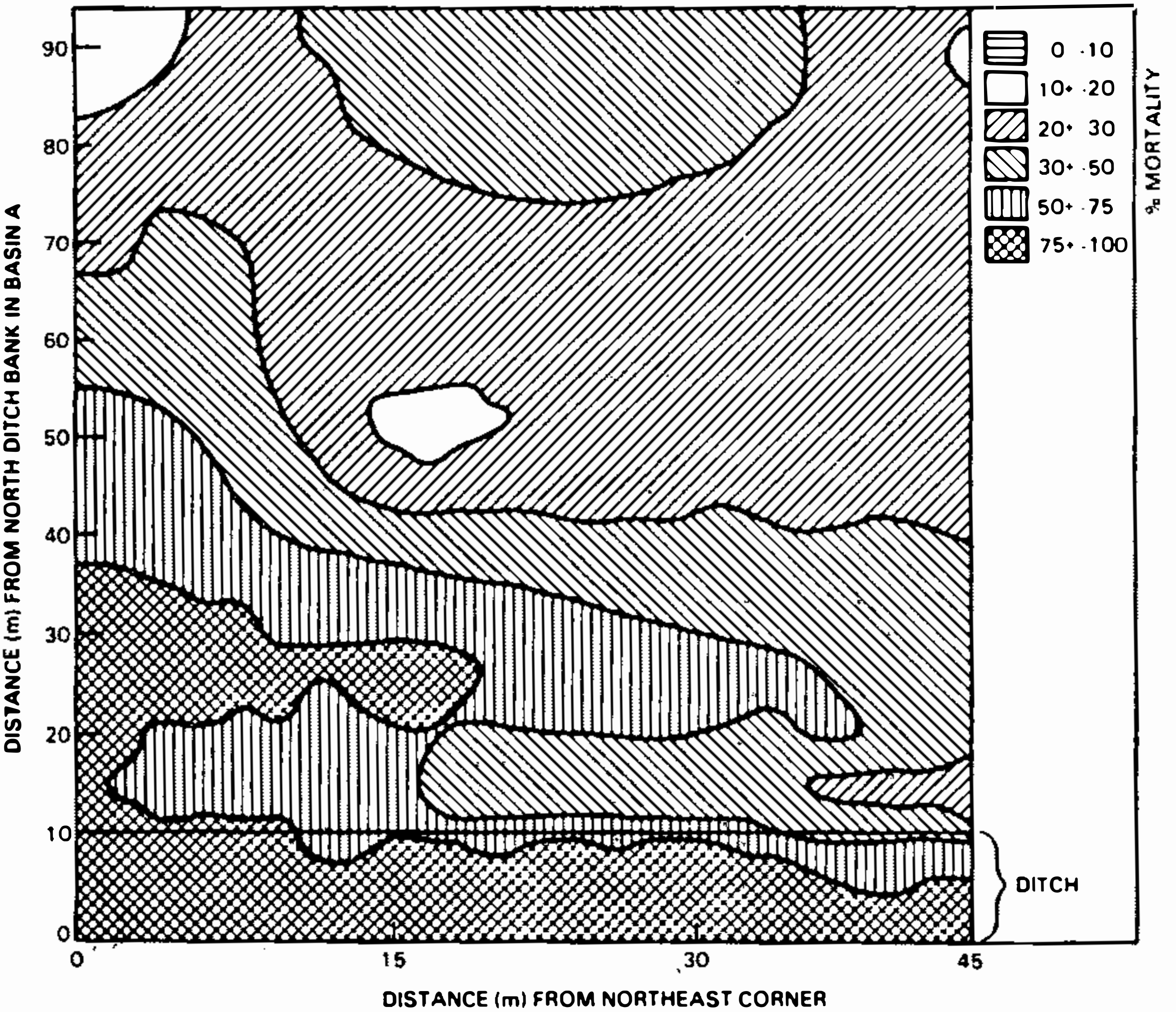

Figure 3.—Estimated lettuce seed mortality (based on kriging) for the 15-30 cm soil fraction from the Rocky Mountain Arsenal (from Thomas et al. 1984).

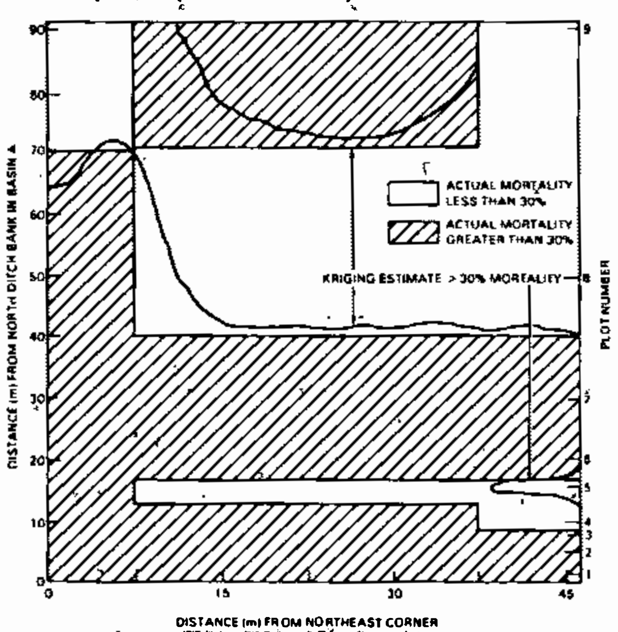

Figure 4.—A comparison of greater than 30 percent lettuce seed mortality (estimated from kriging) to observed lettuce seed mortality for the 15-30 cm soil fraction from the Rocky Mountain Arsenal (from Thomas et al. 1984).

and amount. Chemical presence is of limited concern, but bioavailability of the chemical and its effect on the test organism are of great concern. Bioassay of the waste samples provides a direct estimate of the chemical's toxicity potential.

Hazardous waste cleanup decisions have relied heavily on analysis of the EPA 1965 consent decree chemicals (the 129 so-called priority pollutants). Concentrations of these pollutants in excess of water quality criteria values have been used to justify various cleanups, but in many instances environmental criteria do not exist. In these cases the chemical information may be more misleading than it is helpful since one suspects there may be some hazard, but there is little information for determining the degree of hazard based on the chemical analysis.

Herein lies the benefit of the bioassay procedure. Soil and water bioassays in the Porcella (1983) bioassessment protocol will provide an indication of toxicity to various compartments of the system. Also, it will provide a quantitative (EC_{50} or LC_{50}) ranking of the toxicological impact potentials among those compartments.

We believe that reliance on chemical criteria alone, and particularly those for priority pollutants, could lead to erroneous decisions concerning remedial actions. The general chemical analytical protocol for hazardous waste site samples calls for priority metal and organic identification and quantification. In some instances the next 10 most prominent GC/MS peaks beyond the priority organic might be "identified." Data bases for many of these pollutants are too limited to allow one to develop rigorous water quality criteria. This is especially true for nonpriority organics. Where toxicity data are not available, it might be necessary to "estimate" the potential toxicity of chemicals based on their similarity to other chemicals for which toxicity data does exist. This introduces yet another uncertainty factor. At present there seems to be no satisfactory method of estimating toxicity for organic contaminants short of direct bioassay of environmental samples.

Figure 5 illustrates how difficult it might be to estimate environmental toxicology or the cause of toxicity based on chemical analyses of priority pollutants. The figure represents a typical GC/MS scan of a waste site sediment leachate sample. Results in Table 2, with the exception of the onsite ponded water, represent sediment leachates from an offsite reference control (East Ditch), an onsite reference (005, thought to be uncontaminated) and two offsite stream sediment samples (017 downstream and 020, upstream). Sample 005 contained four identifiable priority organics, nine identifiable nonpriority organics, and fourteen unidentifiable nonpriority organic substances.

Concentrations of phthalates, ethylbenzene, nitrosamines, and phenol priority pollutant fractions for the various samples collected at Western Processing are shown in Table 2. The table also shows the nonpriority organic fractions and the total organics. Among the four identifiable priority pollutants, an environmental criterion exists only for phenol (3.4 mg/L). Assuming that priority pollutant concentrations are among the most important consideration of hazard potential at a site and that water quality criteria are paramount in assessing hazard potentials, sample 017 should be highly toxic due to the presence of phenol at a concentration of 18.3 mg/L. Chemical concentrations and water solubilites of the other priority pollutants would suggest that the other samples might be nontoxic. Bioassay of the samples did not support the conclusion (Table 3). Comparing the mean EC_{50} or LC_{50} value for the different test organisms it can be seen that the toxicity of sample 017 was quite similar to the East Ditch Control sample. The upstream reference sample was not toxic. The onsite ponded water was highly toxic as was sample number 005 (thought to be uncontaminated). Toxicity of the samples increased as the nonpriority organic fractions increased.

To test the apparent relationship between toxicity and the nonpriority organic component of the Western Processing Samples we conducted algal assays on 0-1.0 m integrated soil core samples taken on site at locations 1, 11, and 17 (the latter should not be confused with sediment sample 17 above). Results of the algal assays are shown in Figure 6. The results indicated that soil cores from site 17 were the most toxic and that toxicity increased across the three samples as the concentrations of soluble metals, soluble priority organics, and total soluble organics increased. It was not readily apparent from this which toxic component was dominant in the system.

There was some evidence that toxicity increased with depth in the soil column (not shown in these data). Therefore, we elected to use leachate from the 3 m (integrative depth from 2-3 m) depth at site 17 to further evaluate the toxic components of the samples. Bioassays were run sequentially on untreated sample, EDTA chelated sample (metals inactivated) and on combined chelation/priority or-

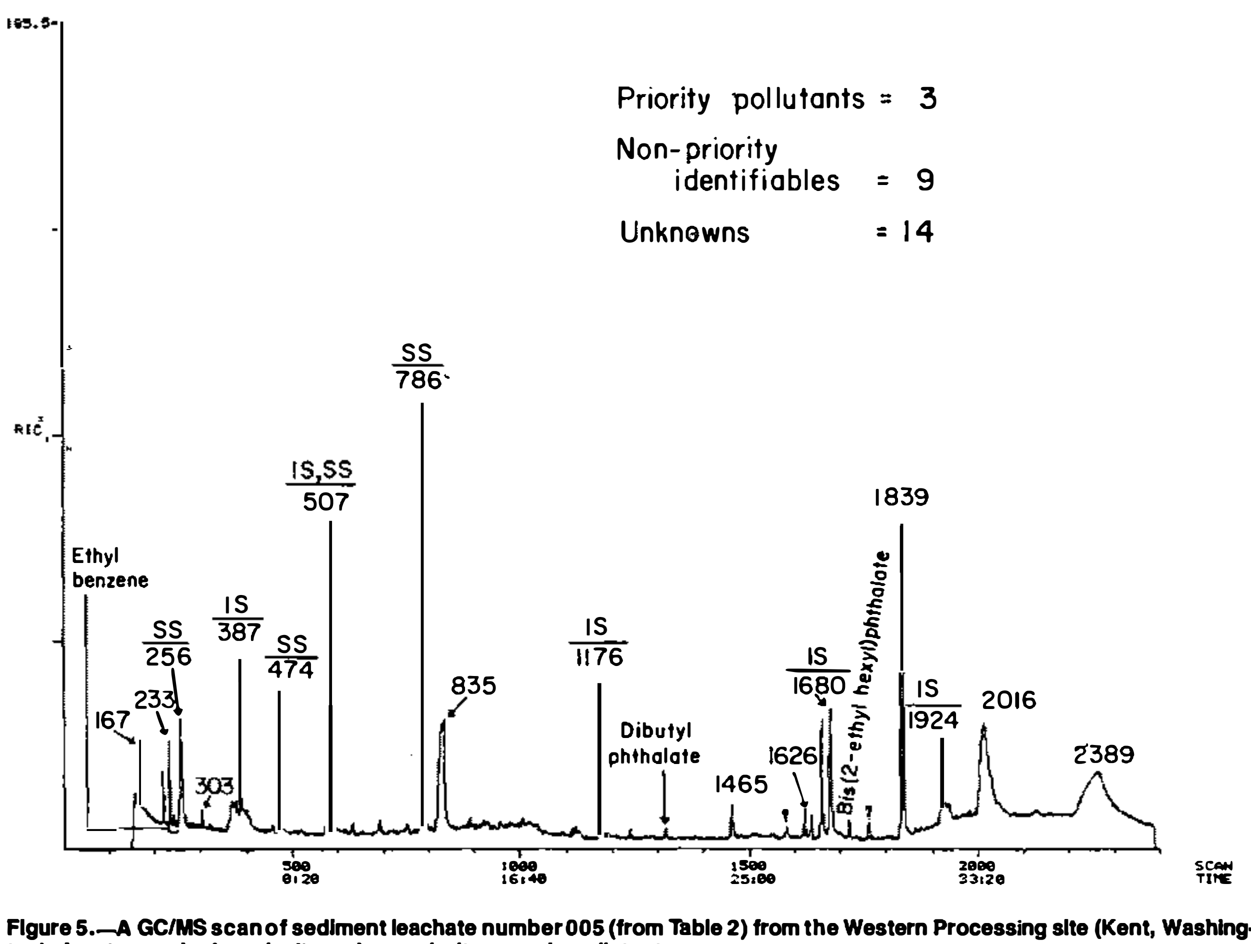

Figure 5.—A GC/MS scan of sediment leachate number 005 (from Table 2) from the Western Processing site (Kent, Washington) showing peaks for priority and nonpriority organic pollutants.

Table 2.—Concentration (mg/L) of priority and nonpriority organics contained in sediment leachates from Western Processing (modified from Miller et al. 1985).

Constituent	Control	East Ditch Water	Pond 005	017	020
Phthalates	0.002	0.010	0.001	0.011	0.002
Ethylbenzene	0.002	<0.001	0.001	0.001	0.001
Nitrosamines	<0.001	<0.001	<0.001	0.010	<0.001
Phenol	<0.001	<0.001	<0.001	18.370	<0.001
Nonpriority Organics	0.3	15.9	0.8	11.9	0.2
Total Organics	0.3	15.9	0.8	29.9	0.2

Table 3.—EC$_{50}$ or LC$_{50}$ response in % sediment[1] (earthworm), sediment elutriate, and surface water to chemical contaminants in Western Processing Samples (modified from Miller et al. 1985).

Test Organism	East Ditch Control	Pond Water	005	017	020
Algae	45	0.8	0.4	24.9	NE[2]
Daphnia	90	18.5	3.3	NE	NE
Microtox 5 min	NE	82.7	41.2	55.4	NE
15 min	NE	21.3	<5.6	50.1	NE
30 min	NE	10.2	<5.6	43.4	NE
Lettuce RE	NE	NE	61.4	49/100[3]	NE
Earthworm[4]	NE	—	>50<100	>100	—
Mean EC$_{50}$[5]	87.0	32.4	34.1	73.7	>100

[1] Sediment soil samples.

[2] NE = no significant toxicity was observed.

[3] 49/100 = 49% inhibition in 100% sediment elutriate.

[4] LC$_{50}$ values = concentration at which 50% mortality occurs.

[5] Mean of algae, daphnia, microtox 30 min, lettuce RE, and earthworm tests.

ganic extracted (methylene chloride) sample. Results show that chelation of soluble metals with EDTA decreased toxicity 90-fold, but that the chelated elutriate remained highly toxic (Figure 7). Significant additional toxicity reduction was not realized when the sample was subjected to combined chelation and priority organic extraction. It appears from this analysis that metal toxicity dominated the Western Processing samples, but that nonpriority organic chemicals alone were sufficient to classify the soil leachate as highly toxic. The toxicological influence of priority organics in these samples appears to have been minimal. Therefore, predicted toxicity of these samples based on the concentration of priority pollutants would have severely underestimated sample toxicity.

SUMMARY

We have attempted to develop a biological toxicity screening protocol that has broad-based application potential. Based on results to date we believe that

1. A modified Porcella bioassessment protocol can be used to define and rank order the effects of selected heavy metals, herbicides, and insecticides.

2. Selected segments of the protocol can be used to assess the influence of complex wastes under field conditions, i.e., there is a relationship between laboratory bioassay responses to environmental samples and actual field conditions.

3. The protocol can be used to assess environmental toxicity potentials in situations where water quality criteria are lacking or nonexistent.

4. Direct bioassay of environmental samples produces toxicity results significantly different from those predictions based on measured chemical concentrations with extrapolation to water quality criteria.

5. Experience gained from the bioassay of hazardous waste site samples should have application to many aspects of the NPS pollution problem.

6. Algal assay appears to have great universal toxicant/stimulant assessment potential based on sensitivity to various toxicants.

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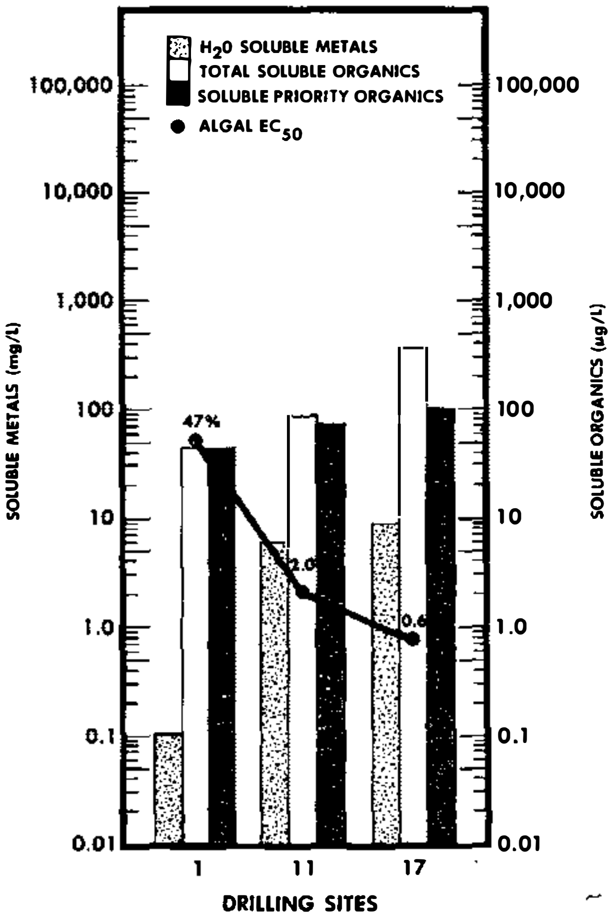

Figure 6.—Response of algal assay, EC_{50} (*Selenastrum capricornutum*) to chemical contaminants in 0-1 m depth soil elutriatas from well drilling site numbers 1, 11, and 17 at the Western Processing waste site.

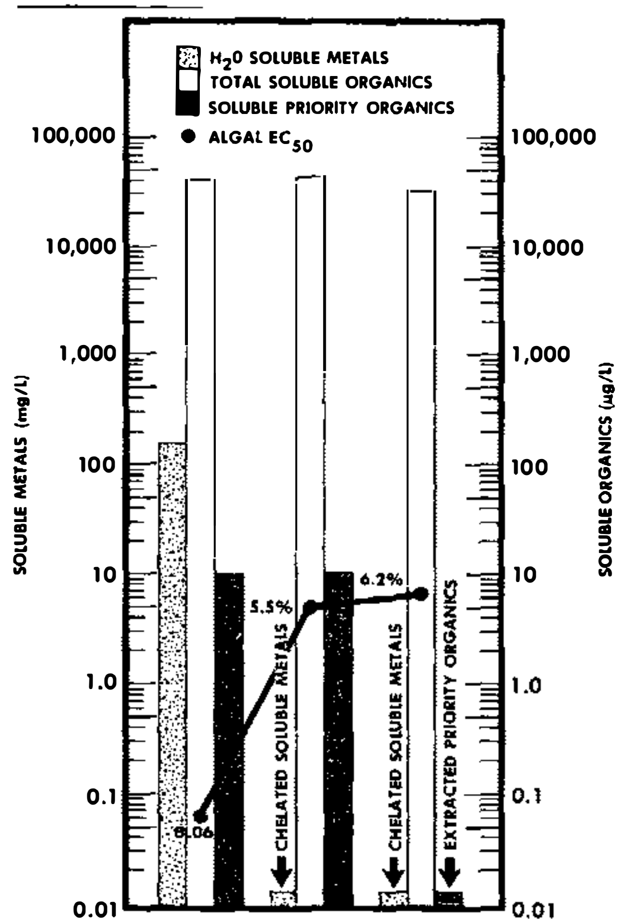

Figure 7.—Algal assay EC_{50} response to Western Processing soil elutriate from well drilling site 17 at the 3-4 m depth prior to and after chelation of heavy metals and extraction of priority organic pollutanta.

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Legal Aspects of Nonpoint Source Pollution

AN OVERVIEW OF THE NATIONAL NONPOINT SOURCE POLICY

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ABSTRACT

A task force composed of representatives of Federal, State, interstate, and local agencies and several private groups recently completed work on a new national nonpoint source policy. This policy will provide a framework for all nonpoint source programs. It sets out what activities are to be undertaken by each group. Among other things, the policy speaks to development of implementation strategies by the many agencies involved in nonpoint source management. In fact, the U.S. Environmental Protection Agency (EPA), the other Federal agencies involved in the task force, and several States have already developed implementation strategies. This paper presents key points from the policy and highlights of the various strategies, and it focuses on the most critical aspects for success. It also describes the evaluation framework EPA plans to use in assessing State program implementation strategies.

RESEARCH POINTED TO THE NEED FOR A NATIONAL NONPOINT SOURCE MANAGEMENT APPROACH

The impetus to embark on the process of developing a Federal, State, and local nonpoint source pollution policy began several years ago. In response to a Congressional mandate, the U.S. Environmental Protection Agency (EPA) conducted research to identify the magnitude and scope of this pollution problem. The research effort resulted in a Report to Congress, completed in the fall of 1983, which concludes that the pollutant loads from nonpoint sources present continuing problems in our efforts to achieve water quality goals and maintain designated uses in many parts of the Nation.

Other research efforts indicated similar findings:

- The 1982 State Section 305(b) reports indicated that virtually all of the States experienced water quality problems caused by nonpoint sources. One-half of the States identified this as a major barrier to achieving individual State water quality goals.
- The Association of State and Interstate Water Pollution Control Administrators (ASIWPCA) conducted its Nonpoint Source Pollution Survey in February 1984. Survey results showed that 78 percent of the States saw their nonpoint source problems as greater than or equal to those caused by point sources.
- The 1983 Environmental Management Reports revealed that 6 out of the 10 EPA Regions considered nonpoint source pollution to be the principal remaining cause of water quality problems for their geographic regions.

In addition to the technical findings about the severity of the nonpoint source pollution problem, the Report to Congress discussed the institutional and management difficulties associated with addressing the problem. In particular, program coordination was identified as a problem area. Because of the number of Federal, State, and local agencies involved—often with overlapping roles, responsibilities, and jurisdictions—the Report called for a coordinated management strategy.

A TASK FORCE IS ORGANIZED

Because one of its most direct agency missions is related to water quality, EPA assumed the leadership role and organized a task force. A group of 50 individuals representing Federal, State, and local agencies, as well as the private sector, worked for about 10 months to design a policy. The task force was successful in developing a policy that each agency endorsed.

The final policy establishes the framework and direction used by each participating agency to design its own individual strategy. The individual strategies specifically identify how—given each agency's perspective, mission, and capabilities—each agency can follow the policy and address the nonpoint source pollution problem. Supported by these strategies, the policy itself becomes a more profound statement.

THE NONPOINT SOURCE POLICY SETS A DIRECTION

The objective of the policy is "to support and accelerate the development and implementation of nonpoint source management programs that ensure water quality protection while recognizing the competing uses of resources." Eight actions are listed as fundamental elements for the overall policy to succeed.

1. To build upon the current compendium of knowledge and to promote further research efforts. The group recognized that much has been done in this area, and that existing work should be enhanced, not recreated.

2. To identify the appropriate roles of each agency, understanding that both the public and the private sector must be involved.

3, 4. The third and fourth actions go hand in hand. The policy calls for a coordinated effort, an increased level of resources, and a commitment to the problem from each agency.

5. To prepare specific agency strategies with the understanding that different geographical regions have different priority nonpoint source problems and are at different stages in developing programs.

6. To develop and assess Best Management Practices (BMP's) based upon site-specific factors. The group noted that natural background levels of pollution and the technical feasibility of the approach must be considered along with the social, political, and economic climate of the area.

7. To ensure the recognition that nonpoint sources are fundamentally different from point sources and should therefore be approached differently, and that nonpoint source programs must be based on site-specific actions and application of preventive practices.

8. To establish a working partnership among all participants: Federal, State, local, areawide, and interstate agencies, as well as the private sector, including nongovernmental agencies.

THE POLICY OUTLINES ROLES AND RESPONSIBILITIES

The policy asks for coordination and cooperation from all levels of government and outlines the major responsibilities for each level.

Federal agencies are asked to develop and implement their nonpoint source strategies. They are asked to integrate the provisions of the policy into their agency decisionmaking process and into their delivery systems for funding and technical assistance. EPA is asked to serve as the lead agency in coordinating interagency and State actions to manage nonpoint source programs.

States are assigned the lead in developing and implementing nonpoint source management strategies on State and private lands. Though several different State agencies may be needed to address nonpoint source problems, the policy asks that a lead State agency be designated to develop and implement State programs. The lead agency should have water quality as its primary concern.

Local, areawide, and interstate agencies are directed to use the mechanisms provided in the continuing water quality management planning process to develop their nonpoint source strategies. The policy recognizes that local agencies are often a first point of contact for the private sector. This position allows local agencies—with and through their areawide agencies—the opportunity to provide a vehicle for public participation.

The private sector is asked for its cooperation and effort. Government agencies will assist the landowners and help them coordinate nonpoint source management efforts with other components of the private sector. Government agencies will also help the private sector develop and apply resources to implement nonpoint source management practices.

SUCCESS RELIES HEAVILY ON THE INDIVIDUAL AGENCY STRATEGIES

Implementation

Skillful development of the specific agency strategies is vital to implementation. Each strategy is to include a discussion on (1) problem assessment, (2) program implementation, (3) incentives and compliance, (4) coordination, (5) resources, and (6) program evaluation and oversight.

The policy clearly recognizes that nonpoint source management actions must be site-specific. However, it does request a coordinated and a consistent approach across all levels of government.

Evaluation

EPA, as part of its responsibilities mandated under the Clean Water Act, reports to Congress on the effectiveness of water quality programs. Because each agency will periodically review its own program (the framework for oversight and evaluation is a part of each individual agency strategy), EPA will be able to use these evaluations in its overall assessment of whether national water quality goals are being adequately addressed. The direction of the national nonpoint source effort can be controlled and refined on the basis of well-planned evaluations.

In summary, the policy, like most policies, is a framework. It was carefully and diligently developed by the task force, and sets the direction for the next few years. It recognizes that much work has been done, but that nonpoint source problems require further attention if water quality goals are to be achieved. Most importantly, it challenges each agency to develop and carry out specific strategies to ensure implementation. Collectively, these strategies embody the principles of the policy and serve as the comprehensive plan to minimize nonpoint source pollution problems across the Nation.

APPENDIX A

NATIONAL NONPOINT SOURCE POLICY

PREAMBLE

The Clean Water Act establishes goals for the Nation's waters. Considerable progress has been made in achieving these goals. However, additional progress in restoring and maintaining the Nation's water quality and water uses will require greater implementation of nonpoint source (NPS) management programs in addition to ongoing point source control efforts. NPS management programs must build upon past planning and management efforts and strive for continued progress in achieving water quality goals and designated beneficial uses.

The objective of this National Nonpoint Source Policy is to support and accelerate the development and implementation of NPS management programs that ensure water quality protection while recognizing the competing uses of resources. The success of this policy is dependent on the willingness and ability of both the private and public sectors to manage their activities to support water quality goals wherever possible.

Meeting the objective of the Policy will require the following actions:

1. Use of the existing knowledge and program base and support of increased research efforts to define and assess NPS problems.
2. Identification of the appropriate roles of Federal, State, local, areawide, and interstate agencies and the private sector in developing and implementing NPS programs.
3. Provision of the structure, available resources, and commitment by which all levels of government and the private sector can coordinate their efforts to identify priority needs and develop and implement cost-effective NPS management programs.
4. Support for an increased level of effort and emphasis on NPS programs by all levels of government and the private sector, for the purpose of meeting water quality goals.
5. Preparation by each agency of a strategy for program development and implementation that incorporates both short- and long-term objectives; recognizes that different areas of the country are at different stages of developing their NPS management programs; and that different geographical areas have different priority NPS problems.
6. Development and assessment of Best Management Practices (BMP's) based upon site-specific conditions that reflect natural background and natural variability of nonpoint sources, and that include consideration of political, social, economic, and technical feasibility.
7. Ensuring the recognition that nonpoint sources are different from point sources and that NPS programs are based on site-specific actions and application of preventive practices. Further, recognition of the need for flexibility in water quality standards to address the impacts of time and space components of NPS as well as naturally occurring events.
8. Development of working partnerships among all Federal, State, local, areawide, and interstate agencies and the private sector, including nongovernmental organizations, to best address NPS problems. These organizations, working in partnership, will be responsible for identifying needs, developing NPS programs, gathering and assessing data, and maximizing available resources.

STATEMENT OF POLICY

Achievement of national clean water goals requires greater implementation of NPS management programs. Emphasis should be placed on implementing NPS programs in watersheds affecting priority waters. Sources of nonpoint pollution should be evaluated to assess potential water quality impacts and needed program actions. NPS management is required to protect high quality surface and ground waters, and to restore and/or improve water quality for designated uses. In many instances, prevention of degradation has proven to be far more cost-effective than remedial measures.

NPS management programs must be flexible to allow for site-specific solutions to problems, to accommodate changes in technical knowledge, to respond to changes in uses of land, and to optimize net on- and offsite benefits. A mix of both point and nonpoint source measures should be considered in developing cost-effective strategies to improve and maintain water quality.

With Federal leadership and coordination, all levels of government and the private sector need to cooperate to provide continued progress with available programs and delivery systems, to identify unmet needs, and to develop and implement NPS management programs where needed.

ROLES AND RESPONSIBILITIES

Following is a general summary of responsibilities of the different levels of government agencies and the private sector in managing NPS programs:

All agencies. All agencies, where appropriate, will determine what institutional barriers to NPS management and implementation exist and work to remove them. All agencies will work to coordinate their NPS related data collection and research activities. In addition, inter- and intra-agency mechanisms will be developed for coordinating NPS management and implementation.

Federal agencies. Federal agencies, in preparing their NPS strategies, will use available and future programs to provide State and local governments with financial and technical assistance and will conduct research and development. The provisions of this policy will be integrated into the decision processes of applicable Federal agencies and into their delivery systems for funding and technical assistance. Where Federal agencies have the responsibility for direct planning and management of NPS programs on public lands, they must coordinate NPS management actions with all levels of government.

As directed by the Clean Water Act, EPA will serve as the lead agency in coordinating interagency and State actions for managing nonpoint source programs. EPA will promote adoption of NPS management programs directed at achieving water quality goals; assist with program development; promote provision of incentives where needed; provide oversight of its water quality programs to ensure that they adequately address NPS problems; and include other agencies' evaluations of the water quality components of their programs in assessing overall NPS impacts on water quality. EPA will coordinate activities in research, education, demonstration projects, training, information transfer, technical assistance, and data collection and analysis with other agencies.

States. States will have the *lead* in developing and implementing NPS management strategies on State and private lands, in cooperation with appropriate levels of government and the private sector. Each strategy should define the State role and, in consultation with areawide and local agencies, the roles of areawide and local agencies in managing NPS programs, and designate a lead agency for managing NPS programs at the State level (several different State agencies may be needed to address different types of nonpoint sources). The lead State agency is responsible for developing and implementing strategies for managing NPS programs and should have water quality as its primary concern. States with effective NPS management programs should share their experiences with other States.

Local, areawide, and interstate agencies. Local, areawide, and interstate agencies, through the mechanisms provided in continuing WQM planning processes, will develop NPS strategies in coordination with their respective States and will implement the programs within their jurisdictions using direct or delegated authorities.

Local agencies, often the first point of contact for the private sector, are in a unique position to solve NPS problems. The active involvement of these local agencies, with and through their areawide agencies in the preparation of strategies, will help to ensure consistency among strategies and provide a vehicle for public participation.

Private sector. For activities other than those on Federal and State lands, successful implementation of the NPS Policy and agencies' strategies is dependent on the cooperation and effort of the private sector. It is the policy of the government agencies to assist landowners and coordinate efforts with involved organizations, associations, and industry. It is the further intention of these agencies to help develop the potential for application of managerial and other private resources in the implementation of NPS management practices as part of each agency's strategy. Private investment in nonpoint source research and development of BMP's is strongly encouraged and will be supported with agency resources where feasible and available.

IMPLEMENTATION

To implement this National Policy, Federal, State, local, areawide and interstate agencies will develop and implement NPS strategies. Key strategy activities for policy implementation include: problem assessment (e.g., problem identification, monitoring and data maintenance, research and development); program implementation (e.g., program planning, development, and implementation, targeting technical assistance and education, BMP emplacement); incentives and compliance (including enforcement); coordination; resources; program evaluation and oversight. The strategies will be refined as existing programs and authorities are reviewed for consistency with existing and future State NPS management objectives and as institutional barriers are identified.

Responsibility for NPS implementation will depend on the nature of the NPS problem, the area in question, and the statutory framework. Implementation activities will emphasize site-specific solutions but will maintain a consistent NPS management approach across all levels of government and the private sector. Where appropriate, all agencies should consider and include as part of their strategies minimum eligibility requirements to enhance implementation of NPS management practices. Cooperative agreements will be developed, as needed, to ensure continued progress toward meeting national water quality objectives. A schedule for strategy development and implementation should be drafted recognizing the nationwide variability in program implementation.

EVALUATION

The Clean Water Act requires EPA to oversee the implementation of water quality programs and to report to Congress on the effectiveness of these programs. Given that all agencies are individually responsible for the periodic evaluation of their programs, EPA will include these evaluations in its assessment of NPS management efforts in determining if national water quality goals are being adequately addressed.

GLOSSARY

Agencies: All governmental bodies and entities that—under their mandates—have a role in addressing and/or mitigating NPS pollution. Federal, State, local, areawide, and interstate agencies are included.

Benefits (onsite and offsite): The whole range of direct and indirect benefits including, but not limited to, water quality, soil conservation, recreational and other beneficial uses, habitat and wildlife protection, increased productivity, flood control, and economic benefits to landowners or the public at large.

Best Management Practices (BMP's): Methods, measures, or practices to prevent or reduce water pollution, including, but not limited to, structural and nonstructural controls and operation and maintenance procedures. Usually, BMP's are applied as a *system* of practices rather than a single practice. BMP's are selected on the basis of site-specific conditions that reflect natural background conditions and political, social, economic, and technical feasibility.

Net Benefits: Since trade-offs (competitive relationships, in the language of economics) may exist between water quality and other social benefits, the social objective must be in terms of optimizing *net* benefits.

NPS Management Programs: All programs conducted by the public and/or private sector toward the goal of preventing or abating nonpoint source pollution. A wide range of activities may be pursued to this end, including BMP identification, training, dissemination of educational materials, technical assistance, monitoring, research and development, and oversight/evaluation. Cost-sharing programs and other incentives can also play vital roles. Programs may be regulatory or nonregulatory (voluntary), or combinations of both.

Nonpoint Source (NPS) Pollution: Diffuse sources of water pollution that are not regulated as point sources and normally include agricultural and urban runoff, runoff from construction activities, etc. In practical terms, nonpoint sources do not discharge at a specific, single location (such as a single pipe). Nonpoint source pollutants are generally carried over or through the soil and ground cover via stormflow processes. Unlike point sources of pollution (such as industrial and municipal effluent discharge pipes), nonpoint sources are diffuse and can come from any land area. It must be kept in mind that this definition is necessarily general; legal and regulatory decisions have sometimes resulted in certain sources being assigned to either the point or nonpoint source categories because of considerations other than their manner of discharge (for example, irrigation return flows are designated as "nonpoint sources" by law, even though the discharge is through a discrete conveyance).

Partnership: As defined in this policy statement, "partnership" describes the arrangement between interested parties for solving the problem of NPS pollution. The key quality of this arrangement is cooperation. The NPS problem inherently requires that the private sector and all levels of government contribute to its solution. All entities act as decisionmakers within their respective roles and areas of responsibility, and the one that can most appropriately address a particular problem takes the lead. The specific arrangements that implement a partnership may vary from informal public agency/private entity cooperation in nonregulatory programs to memoranda of understanding, contractual agreements, and cooperative agreements as defined by OMB under Federal guidance (*Federal Register*, Vol. 43, No. 61, August 18, 1978).

Strategies: Written documents that specifically outline an Agency's plan of action to address nonpoint source problems that fall within its jurisdiction or legislative mandate. Strategy activities should be defined under six broad topics: problem assessment; program implementation; incentives and compliance; coordination; resources; program evaluation and oversight. A consideration of timeliness should be included.

INTERGOVERNMENTAL COORDINATION: FEAST OR FAMINE?

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ABSTRACT

Lake Washington, on Florida's east coast, is the sole water supply for over 100,000 people in south Brevard County. This lake is one of a chain of lakes on the St. Johns River. Water quality problems in Lake Washington, as well as the St. Johns River, have been described as natural problems aggravated by man. All of the man-induced water quality problems are the result of nonpoint sources. Historically, diking and draining of the St. Johns River marsh and continued agricultural drainage has been the principal nonpoint source of pollution. During the last 15 to 20 years, urban drainage has been introduced into the lake. An interagency task force was formed to protect and improve the water quality of Lake Washington. This task force included the major regulatory agencies, water resource managers, and water users of Lake Washington. The task force's effectiveness was governed by (1) problem definition, (2) agency statutory power, (3) agency program priority, and (4) interaction by policy level individuals.

Intergovernmental coordination has been a popular battle cry in recent years. Most public work projects and, in particular, water resources projects will affect more than one unit of government. The hierarchical nature of American government with cities, counties or parishes, sub-State, State, and Federal levels dictates that several levels of government will be affected. The division of labor by agency responsibility will require that numerous agencies become involved. In an attempt to put some order into this Medusa, intergovernmental coordination is often presented as a solution.

Numerous examples exist. The planning advisory committees required by the 201 and 208 programs are a recent past institutional requirement for coordination. In Florida, the Local Government Comprehensive Planning Act required an intergovernmental coordination element in all local plans.

This paper discusses the recent experience of intergovernmental coordination in a nonpoint source control program in Brevard County on Florida's east coast. This paper presents several observations on the efforts of the Lake Washington Water Quality Improvement Task Force and discusses some reasons for the success or failure of that Task Force.

BACKGROUND

In May and June of 1970, the Brevard County Board of County Commissioners constructed a canal approximately 540 m in length, known as the Sands Canal, connecting upland drainage with Lake Washington. This canal was constructed without the necessary State permits. Negotiations from 1972 to 1975 between the Florida Department of Environmental Regulation and Brevard County attempted to resolve this matter.

In 1976, the Department advised the County of its intent to deny the County an after-the-fact permit application. At this point, the County requested a formal administrative hearing. This hearing resulted in a recommendation of denial from the hearing officer, and the Department issued a final order on Oct. 15, 1977, denying the after-the-fact permit and directing the County to submit a plan of restoration for the canal.

Brevard County then appealed the permit denial to the governor and cabinet, sitting as the Board of Trustees of the Internal Improvement Trust Fund. In May 1978, the Trustees entered an order remanding the case to the respondent, directing the Department to formulate acceptable modifications. On Feb. 22, 1983, a consent order was agreed upon which settled this case.

The consent order required the following major actions. First, the County is to construct a permanent weir structure at the end of the Sands Canal. The purpose of the weir is to ensure the separation of waters between Lake Washington and the canal during periods when Lake Washington is below 405 cm msl. To provide navigational access across the weir, the weir may contain a movable gate. The gate's lowest elevation is 315 cm msl.

The County also is required to maintain a water quality monitoring program. Two sampling stations, one within the Sands Canal landward of the permanent structure previously described, and the second waterward of the canal entrance to reflect background conditions. Monitoring is required not less than once a month.

The third condition of the consent order concerns the operation of the adjustable weir gate. When the water quality monitoring of the lake shows no violations of Class 1 water quality standards in the canal and the lake stage is below 405 cm msl, the gate may be open. Any time lake stages exceed 405 cm msl the gates may be opened since the crest elevation of the weir is 405 cm msl.

The final requirement is the establishment of a Lake Washington Water Quality Improvement Task Force. This paper will discuss, in detail, the Task Force and its effectiveness.

LAKE WASHINGTON

Lake Washington is located on the St. Johns River in south Brevard County on Florida's east coast. The city of Melbourne is located just east of the lake (Fig. 1). The headwater of the lake begins in a large marsh in Indian River and Okeechobee County, 32 km to the south. The overall drainage basin is approximately 275,485 ha.

The lake is relatively shallow with a bottom elevation of 2.3 meters msl. The stage duration curves developed for the lake stages are less than 4.1 m msl 50 percent of the time. The bottom is typically of unconsolidated organic matter. At this time, few submergent species of vegetation exist in the lake. The shoreline is dominated by wetlands composed of saw grass (*Cladium jamaicense*), maidencane (*Panicum hemitomon*), spikerush (*Eleocharis* sp.), nutgrass (*Cyperus* sp.) and swamp willow (*Salix carolinia*). The eastern shore has one small area of urban land use, including a public boat ramp, marina, a home, and two water treatment plants.

The water quality of the lake is highly variable, depending on the time of year, lake stages, and local climatic conditions. In general, water quality and water quantity appear to be closely related, as water quality deteriorates with a decrease in flow. However, low dissolved oxygen and high color are associated with high flow conditions.

The water quality of Lake Washington is affected by several factors. The drainage basin of Lake Washington is dominated by large wetland systems, including marshes and hardwood swamps. These wetlands contribute to the color and organic loadings to the lake. In addition, during the last 50 to 60 years, much of the basin has been converted to agricultural lands. This has resulted in the loss of floodplain wetlands, the channelization of the marsh, agricultural runoff, and finally, significant alteration of the natural hydrograph. Other factors affecting the water quality of the lake, particularly during periods of low flow are: (1) inflow of ground water having higher chlorides and total dissolved solids concentrations, (2) canals that drain the uplands east of the lake, and (3) evaporation and evapotranspiration during the dry season.

Cultural pollution is from agricultural runoff and urban drainage. No sewage treatment plants discharge into the lake or its drainage basin.

Lake Washington is used mostly as a potable water supply. Since 1959, the city of Melbourne, which serves approximately 109,000 people, has used Lake Washington as its source of drinking water. The water quality has been described by the city as the most difficult to treat in the nation, primarily because of rapid changes in color and TOC. An algae bloom in the lake during 1984 resulted in taste and odor complaints for several days. Another concern is chlorides and total dissolved solids. As lake levels drop, these parameters increase in concentration. During a drought in 1980–81, the drinking water standard for chlorides was exceeded for 90 consecutive days and the TDS standard was exceeded twice for 140 and 141 consecutive days.

The lake is classified by the Florida Department of Environmental Regulation as a Class 1 surface potable water supply.

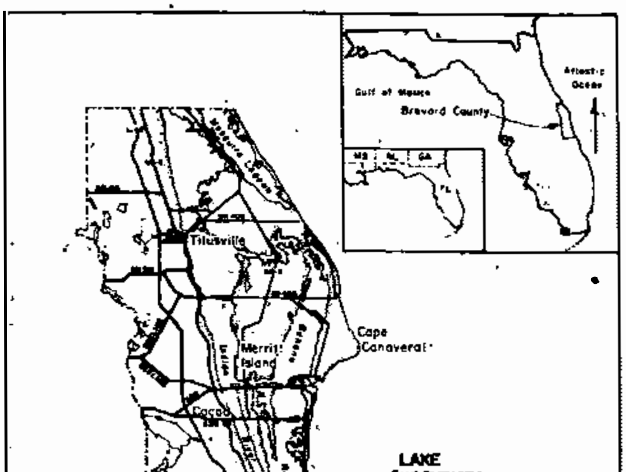

Figure 1.—Location map.

TASK FORCE

One of the requirements of the consent order was the establishment of a Lake Washington Water Quality Improvement Task Force. This Task Force, led by Brevard County, was to be composed of governmental agencies and interested parties who are involved in the preservation and protection of Lake Washington.

The Task Force had five specific purposes. The first was to evaluate existing and potential sources of pollution in Lake Washington. This included any canals or ditches leading into the lake. The second task was to identify existing and prospective uses of the Lake Washington water resources.

The Task Force was also to review land use planning and implementation. In reviewing policies and ordinances, potential sources of domestic or industrial wastes, stormwater sources, and the loss of filtrative vegetation were to be considered.

The fourth item was to develop educational materials on pollution abatement, stormwater management, and strategies to preserve and restore Lake Washington water quality. These are to be provided to existing and future property owners in the Lake Washington watershed. Finally, the Task Force was to identify sources of funding that may be used to mitigate water pollution in the lake. The work of this Task Force was to be completed in 24 months from the entry of the consent order.

In May 1983, the Brevard County Board of County Commissioners organized the Lake Washington Water Quality Improvement Task Force. It was decided that the Task Force would be a policymaking board. The membership consisted of:

1. The District 3 Brevard County commissioner.
2. The District 5 Brevard County commissioner.
3. The district manager of the St. Johns River District Office of the Florida Department of Environmental Regulation (FDER).
4. The Executive Director of the St. Johns River Water Management District (SJRWMD).
5. The representative of the Florida Game and Freshwater Fish Commission (GFWFC)
6. The city manager of the city of Melbourne.
7. A representative from the Lake Washington Homeowners' Association.

In the summer of 1983 the South Brevard Water Authority, the agency responsible for public water supply in the South Brevard area, was created and the Authority's executive director appointed to the Task Force.

In addition, a Technical Advisory Committee was established to perform the technical aspects of the study and to advise the Task Force. Each of the following agencies had one technical representative:

- Florida Department of Environmental Regulation
- St. Johns River Water Management District
- Florida Game and Freshwater Fish Commission
- Florida Institute of Technology Staff

The Brevard County Water Resources Department Staff acted as staff to the Task Force and the Technical Advisory Committee.

A plan of study was developed to facilitate the work of the Task Force. The overall program was divided into four subprograms: historical data, resource management, implementation, and post-implementation. Table 1 outlines this plan of study. A schedule provided that the work could be completed in 18 months, allowing for flexibility in meeting the 24-month deadline requirements of the consent order.

The Task Force met six times. A final report was adopted at the Task Force's last meeting, February 1985.

Table 1.—Plan of study.

*Task Force Meeting—Organizational.

History

1. Lake Washington boat tour.
2. Historical and existing information (water quality, water quantity, land and water uses).
3. Plans (Upper Basin, Brevard Co. Comprehensive Plan, Melbourne Comprehensive Plan).

*Task Force Meeting—adoption of a comprehensive report on the background of Lake Washington.

Resource Management

4. Resource evaluation: surface and ground water hydrology, water chemistry.
5. Resource evaluation: ecology, sociology (meeting with agricultural committee).
6. Resource management alternatives and funding.

*Task Force Meeting—prioritize management alternatives.

Implementation

7. Land acquisition program.
8. Water and land management regulations.
9. Property rights/compensation.

*Task Force Meeting—selection of implementation program.

Post-Implementation

10. Educational material.
11. Establish continuing planning/coordination program.
12. Final report.

*Task Force Meeting—review final report.

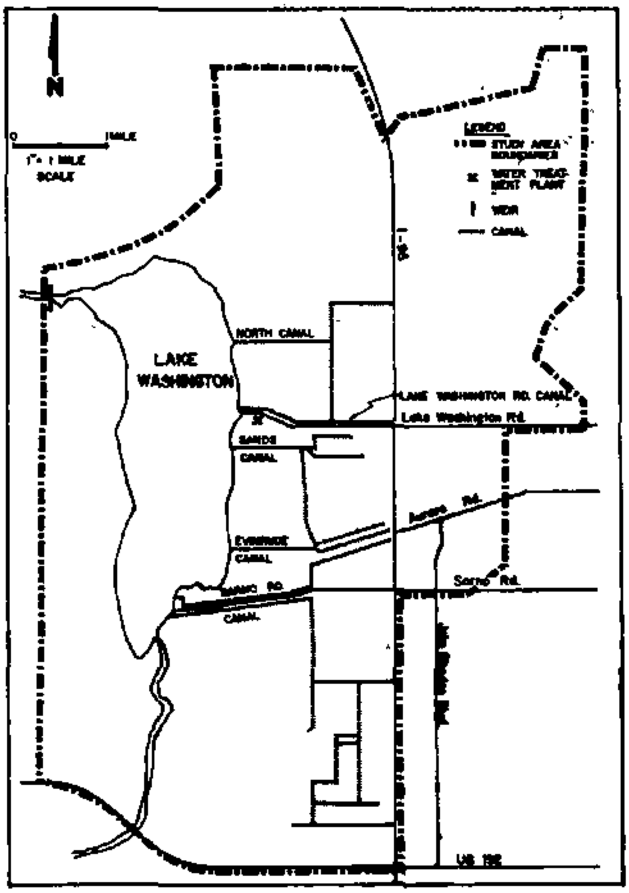

Figure 2.—Lake Washington study area.

EVALUATION

The effectiveness of an intergovernmental activity is hard to measure. If one agency provides strong leadership, a program may be implemented even without intergovernmental activity. Intergovernmental coordination may slow down or enhance implementation.

Accordingly, the success or failure of the Lake Washington Water Quality Improvement Task Force is also very difficult to evaluate. First, the recommendations of the Task Force have only recently been completed, in February 1985. Sufficient time has not passed to evaluate the success or failure of implementation. Secondly, many of the Task Force's recommendations resemble existing programs of the participant agencies. What effect the Task Force will have on them is not yet known.

However, various aspects of the Task Force can be discussed at this time. The four major factors affecting the effectiveness of the Task Force were (1) problem definition, (2) agency statutory power, (3) agency program priority, and (4) interaction by policy level individuals.

The first step in solving any problem is defining the problem. The consent order makes some vague reference to water quality standards. Studies have shown that the water quality of the St. Johns River and Lake Washington may be affected by numerous factors. However, direct cause and effect relationships have not been accurately defined. To minimize the area studied by the Task Force, the study area's boundaries were limited to the immediate area of Lake Washington (Fig. 2). This is just a small portion of the lake's total watershed.

As a result, the Task Force had a poorly defined problem. The cause and effect relationships needed to produce defensible solutions were not available. The study area boundaries needed to keep the study manageable also eliminated the most significant flow contribution to the lake—the watershed of the St. Johns River.

Each of the participants in the Task Force was limited by statutory authority. In a gross generalization, the FDER is responsible for water quality, the SJRWMD is responsible for water quantity and the GFWFC is responsible for wildlife. Each agency's responsibilities directly affect the others. However, because of their statutory limitations, it is difficult to estimate official agency interest outside of their jurisdictional boundaries.

Often, statutory authority is not considered. The consent order was developed between Brevard County and FDER. The SJRWMD was not a party to it even though they had to issue the permit for the required weir.

Because of statutory constraints as well as budget considerations, policies, and competing issues, each agency has its own program priority. Brevard County had a high priority in seeing the completion of the Task Force's work because of the consent order. The other participants did not have the same priority. The Task Force's work could be considered someone else's responsibility. In addition, because of incomplete programs which directly affect Lake Washington, agencies were reluctant to make specific recommendations or commitments. At that time, the SJRWMD was completing the Upper Basin Management Plan for the St. Johns River, and the Task Force final report was completed before SJRWMD publicly released their plan.

Finally, the individual level of participation affected the effectiveness of the Task Force. The GFWFC never appointed a representative. The FDER Task Force member never attended; however, his alternate did, occasionally. The SJRWMD member attended only the initial meeting.

The Task Force was established as a policy level group. Without the attendance of these individuals, resolution of policy conflict or commitment of resources could not be made.

CONCLUSIONS

The Lake Washington Water Quality Improvement Task Force was established to provide intergovernmental coordination in developing management policies for Lake Washington. The principal agencies concerned with the resources of the lake were involved; however, their effectiveness was limited by problem definition, statute, program priority and participation.

To enhance the effectiveness of intergovernmental coordination, the following is recommended:

1. **Problem definition.** It is important to keep the problem small enough to minimize necessary variables. However, in establishing the boundaries of the study, do not exclude variables that may have a significant impact.

If there is not enough information to define the problem, then wait. Do not attempt to develop a solution with a poorly defined problem. This will only result in an inadequate solution.

2. **Statutory power.** The powers given to an agency by the legislature must not limit or hinder intergovernmental coordination. One alternative is to divide agency responsibility by broad subject areas such as transportation, education, and natural resources, rather than by specific responsibilities such as water quantity, water quality, and wildlife.

A second alternative is to give each agency the specific authority to consider cumulative effects or multidisciplinary effects. While the agency's responsibility may remain specific, the ability to consider other effects will force intergovernmental coordination.

3. **Program priority.** Agency-established priorities will not enhance coordination. Program priority must come from one centralized authority. This can be done by an office of planning and budgeting within the governor's office, or a legislatively established budget review process. A statewide, regional specific plan of State priorities must be developed and periodically updated.

4. **Participation.** In general, intergovernmental coordination at the technical staff level appears to exist and often works well. It is at the policy level where coordination is often missing. One way to improve this is to hold regular symposia to discuss issues of mutual concern.

Intergovernmental coordination is not a cure-all or a curse. Because of the nature of American government, multiple agency involvement will occur. Coordination of these agencies' activities is essential to minimize wasteful duplication and unnecessary delays. However, coordination must be carefully managed to avoid prolonged discussion of the problem. Don't assume that since several agencies are meeting and discussing a problem they are coordinating their efforts. Strong leadership and individual commitment will help ensure intergovernmental coordination.

THE BASIC LEGAL ISSUES

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ABSTRACT

Nonpoint source water pollution is thought difficult to control because it derives from diffuse sources over a broad area. Many forms of nonpoint source pollution derive, however, from inappropriate use of land or water resources which are subject to regulation through Federal and State wetland protection laws, such as the Clean Water Act section 404 Program, local government zoning powers, and other local, State or Federal laws which control the siting of major infrastructure facilities which contribute directly or indirectly to nonpoint source pollution. With respect to urban or highway runoff, vigorous enforcement of Clean Air Act programs relating to mobile and stationary sources may result in significant reduction of impacts of metals, organics, and acid rain. Non-enforceable BMP's are virtually useless at controlling nonpoint source pollution. For some existing nonpoint source pollution, such as agricultural soil, nutrient and pesticide runoff, we must identify cost-effective economic investments which control such pollution through alternative use of waste resources and find the institutional mechanisms to facilitate those investments.

INTRODUCTION

The Federal Clean Water Act, 33 U.S.C. Section 1251 *et seq*, divides all causes of surface water degradation into two parts: point and nonpoint source pollution. In general, that Act prescribes regulatory programs to control discharges of pollutants and establishes planning programs to promote control of all other pollution, defined in Section 502(19) to be the manmade or man-induced alteration of the chemical, physical, biological or radiological integrity of water. Some courts have held and the U.S. Environmental Protection Agency has taken the position that the Clean Water Act's permit programs do not regulate discharges into ground water; therefore, under the Clean Water Act, pollution of ground water and in turn degradation of surface waters by contaminated ground water, are viewed as nonpoint sources of pollution. Subsequent Federal and related laws, however, including the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. Section 6901, and the Safe Drinking Water Act (SDWA), 42 U.S.C. Section 300f, provide for regulation of major discrete sources of ground water pollution, such as industrial impoundments, storage tanks, landfills, and underground injection wells. We can therefore characterize them as point sources of water pollution as well.

In general, we can view nonpoint source pollution as any pollution of ground or surface waters associated with diffuse land use activities that cumulatively result in water quality degradation. Agricultural, mining, and construction-related activities, urban or highway runoff, and residential or commercial septic system and lawn discharges are typical nonpoint pollution sources. Such pollution sources are recognized as major causes of degradation of many surface and ground water systems. However, since they are viewed as land use problems, the Congress and most States have not adopted regulatory programs to control them.

The theme of this paper is that Congressional hesitation notwithstanding, much nonpoint source pollution can in fact be controlled or prevented by existing State and Federal programs, coupled with local government land use powers; that local land use authority is not, by itself, typically effective at controlling nonpoint source pollution and that we need a Federal legal program that gives State and local governments and Federal agencies a compelling framework for using existing authorities to control nonpoint source pollution.

BASIC CONCEPTS

In designing a meaningful local, State or Federal nonpoint source pollution control strategy, we should keep in mind three basic principles.

First, nonpoint source pollution results from and is associated with a loss of natural vegetative cover. Natural forest or other plant communities do not generate pollution as defined in the Clean Water Act. Differently stated, retention or re-establishment of natural plant cover prevents or abates such pollution. The objective of a nonpoint source pollution control program must therefore be to retain or re-establish natural plant communities as much as possible.

Second, while most nonpoint source pollution is not directly controlled or regulated under State and Federal environmental laws, a good portion of it arises from preceding individual acts which are in fact *point sources* of pollution and regulatable as such through existing permit programs. Increasingly, therefore, nonpoint source pollution is a reflection of ineffective or inadequate implementation of point source pollution permitting authorities. If we recognize this fact and intend to do better in the future, it makes sense to distinguish future from existing nonpoint source pollution.

In many cases, effective use of point source pollution control programs to *prevent* future nonpoint source pollution may make economic and social sense. Emphasizing remedial action is always more problematic. In a world of limited resources, the pros and cons of preventive and remedial actions must always be assessed. We should also recognize that much nonpoint source pollution is a result of Federal and State-funded activities and may therefore be controlled through budgetary and planning processes.

Third, the siting of an agricultural, forestry, mining, transportation, commercial or residential activity within a surface or ground water watershed is central to its potential nonpoint source pollution impact on receiving surface or ground water quality. In terms of effect, the siting of such activities is as important as and often more important than the operational design.

It is appropriate to consider the critical portion of a surface or ground water recharge watershed as a basis for developing siting criteria for activities which may cause nonpoint source pollution. For a surface water basin, the most critical portion of the watershed may be its wetlands within the floodplain of the receiving river, lake, or estuary. For a ground water system, it is likewise possible to delineate a critical recharge zone in terms of soil conditions, recharge areas, and ground water residence times.

Imposing controls based on the location of an activity within a watershed and its nonpoint source pollution potential has a legal basis in many Federal and State environmental laws, including the Clean Water Act, the Clean Air Act, 42 U.S.C. Section 7601, RCRA, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), 7 U.S.C. Section 136, the Toxic Substance Control Act (TOSCA), 15 U.S.C. Section 2601, the Safe Drinking Water Act (SDWA) and the Surface Mining Control and Reclamation Act, 30 U.S.C. Section 1201. These Federal laws and their State counterparts in some measure authorize regulatory programs that incorporate geographic or siting criteria based on water quality, among other values, and can be used to prohibit siting of nonpoint source pollution-generating land uses in critical watersheds. Federal and State agencies, however, typically underutilize these legal authorities.

We can see how these general principles operate in a variety of contexts involving nonpoint source pollution activities.

Example I: Agriculture

Agricultural runoff with sediments, nutrients, or toxic chemicals is a prime example of nonpoint source pollution. The siting of agricultural activity can have a major impact on receiving water quality. Row crop operations in low lying floodplain areas, including freshwater wetlands, can have enormous impacts on receiving water quality because of their proximity to receiving waters and the loss of the natural wetland communities that could buffer upland runoff. Similarly, agricultural operations in critical ground water watershed areas can often result in high and damaging levels of nutrients and pesticides in recharged ground water.

With some 98 million acres of wetlands remaining (some 95 percent freshwater wetlands), the 48 coterminous States have lost more than 50 percent of their wetlands, more than 80 percent because of agricultural conversion, clearing, and drainage. In many riverine floodplains, including those in the Lower Mississippi Alluvial Valley, floodplain vegetation has been cleared to stream banks, with massive water quality degradation resulting. Agricultural conversion of floodplain wetland communities must therefore be viewed as a major nonpoint pollution source. Once the conversion has occurred, nonpoint source pollution inevitably increases dramatically.

While agricultural conversions of wetland systems traditionally have not been regulated at all (indeed, Federal water resource development programs have subsidized and promoted them), they are now regulatable under Section 404 of the Clean Water Act, 33 U.S.C. Section 1344, and some State wetland programs as well. In *Avoyelles Sportsmen's League* v. *Marsh,* 715 F. 2d 897 (5th Cir. 1983), upholding a district court opinion, 473 F. Supp. 525 (W.D. La. 1979), the Fifth Circuit held that agricultural conversions of Section 404 wetlands are not exempted as normal agricultural activities under Section 404(f)(1)(A); instead, mechanized clearing operations are "point sources" of pollution which "redeposit" cleared material. In addition, they are clearly regulated under Section 404(f)(2) which provides for any discharge of dredged or fill material into waters of the United States "incidental" to a change in use where the reach of those waters is impaired. The Seventh Circuit has recently rendered a similar opinion, *United States* v. *Huebner,* 752 F. 2d 1235 (7th Cir. 1985). Thus, future nonpoint source pollution resulting from agricultural conversion of wetlands can be regulated and avoided.

In terms of water quality and aquatic ecosystem protection, the fact is that row crop agriculture should not be sited in wetland areas. The Clean Water Act Section 404 program provides a legal basis for preventing such nonpoint source pollution. Some State wetland laws, for example, Florida's Warren S. Henderson Wetlands Protection Act, Fla. Stat. Section 403.901 *et seq.*[1], provide some limited protection from water quality degradation although other State wetland laws generally exempt agriculture. We need effective enforcement of the Section 404to limit agricultural conversion of wetlands.[2]

The role of wetlands in maintaining water quality and filtering water laden with sediments and nutrients would suggest that reforestation of wetland riparian areas, as well as converting high erodible lands to pasture or forest cover, should be prime remedial action strategies where existing agricultural activities are a major nonpoint pollution source. However, the Clean Water Act provides no legal basis to compel such a result.

The recent experiences with contamination of ground water by aldicarb in Suffolk County, Long Island, and by aldicarb and EDB in Florida show that pesticide-related degradation of ground water quality can be severe when the agricultural operations that use such pesticides are located in central recharge areas with soils not effective at retarding movement of such toxic pollutants. While EPA may have properly registered these pesticides, their use in such sensitive recharge areas was clearly inappropriate.

FIFRA provides a legal basis for restricting the use of registered pesticides geographically, although EPA has used this authority sparingly at best. Thus, FIFRA could be used to restrict use of specific pesticides in specific ground water recharge areas. Preparation of EPA's Ground-Water Protection Strategy (Aug. 1984) by EPA's Office of Ground-Water Protection may stimuate such use of FIFRA. Thus, although pesticide contamination of ground water is perceived as a nonpoint source of pollution, such contamination, whenever it occurs, is a consequence of a clearly regulatable act—the use of that pesticide in that area.

Example II: Minerals Extraction

Pollution of ground and surface waters associated with surface mining and other forms of mineral extraction has traditionally been viewed as nonpoint source. Certainly, Section 208(b)(2)(G) of the Clean Water Act, 33 U.S.C. Section 1288(b)(2)(G), viewed mining-related wastewater runoff in this light. Yet, many aspects of mineral extraction processes that can result in nonpoint source pollution are in fact subject to regulation.

Most aspects of surface mining, including development of mining and reclamation plans, are subject to Federal or, through delegation, State review and approval under the Surface Mining Control and Reclamation Act, 33 U.S.C. Section 1201. Section 101(c) of that Act, 30 U.S.C. Section 1201(c), recognizes that surface mining operations disturb surface waters, cause erosion, and pollute waters. Section 102(c) of this Act, 30 U.S.C. Section 1201(c), provides that mining is not to be conducted where reclamation is not feasible. If properly enforced, this Act should dramatically reduce contamination of surface and ground water arising from new mining operations that the Act regulates.

Further, to some degree, the Act provides for reclamation of abandoned stripmined sites which are a major cause of ground and surface water pollution in many parts of the country. The Act also provides legal authority to restrict surface mining operations that could cause irreversible pollution so that reclamation would be infeasible. In other words, the Act could be used to restrict or prohibit the siting of surface mining in critical surface or ground water watershed areas highly sensitive to contaminants.

As another example, saltwater intrusion in coastal Louisiana, which contains 40 percent of the country's coastal wetlands, can be viewed as a nonpoint source pollution problem. Such saltwater intrusion, which contributes to the accelerating erosion of the Louisiana coastal zone (now eroding at a rate of some 40 square miles or 32,000 acres of wetland annually—an inexcusable, manmade biological travesty), results from the construction of canals in this richly convoluted wetland maze of subtle salinity and vegegation gradients. These canals have been built for navigation, drainage, and water supply. Thousands of miles of canals have also been built to transport oil and gas exploration and development equipment and to provide for pipelines to transport extracted oil and gas. Consequences of the construction of this maze of canals include massive saltwater intrusion, interference with natural hydrological flows, extensive bank erosion, and accelerating rates of land loss. Yet, the construction of these canals has been subject to permit regulation for more than 10 years under the Corps of Engineers dredge and fill discharge permitting authority under Section 404 ofthe Clean Water Act, 33 U.S.C. Section 1344, and in the last 5 years under the Louisiana Coastal Zone Management Program.

Despite this State and Federal authority, permits continue to be routinely issued for construction of such canals with some conditions imposed to alter the alignment of canals and the design of dredged spoils. Neither the Coastal Zone Section of the State Department of Natural Resources nor the Corps of Engineers has used its legal authority to promote or force use of alternatives that in fact exist. Thus, while the Louisiana coastal zone suffers from increasing nonpoint source pollution in the form of saltwater intrusion and loss of sediments through erosion, construction of canals, the primary courses of such pollution, has been a regulated act for more than a decade.

The Suwannee River, an outstanding Florida water with its headwaters in the Okefenokee Swamp, a National Wildlife Refuge, and its mouth north of Cedar Key, Florida, is one of the few relatively pristine river systems remaining in Florida, indeed, in the entire Southeast. The Upper Suwannee River is characterized by unusual water quality—low both in nutrients and pH and high in color, a reflection of the swampy origins of its waters. The major cause of degradation of the Suwannee River is phosphate stripmining, mostly in Hamilton County, Florida. This pollution results from point source discharges into tributaries of the Upper Suwannee River, subject to NPDES permit requirements of Section 402 of the Clean Water Act, 33 U.S.C. Section 1342, and State water quality permit restrictions. It also results from loss of critical watershed wetlands that are stripmined or used as waste disposal sites. The mineland wastewater discharges, while regulated, furthermore cause degradation because they directly destroy tributary wetlands.

The fact is that most aspects of this phosphate stripmining, including chemical plant and mineland wastewater discharges, design and siting of waste disposal sites, and the siting of mining operations in wetlands, are subject to State and Federal regulation. The Corps of Engineers has asserted jurisdiction over the wetlands in Hamilton County under Section 404 of the Clean Water Act, 33 U.S.C. Section 1344, and has released a draft environmental impact statement intended to assess the impacts of proposed and alternative mining and waste disposal operations on the aquatic environment. Thus, existing Federal and State law together provide express regulatory control over the siting of mining operations in wetland systems within the Suwannee River's tributary watersheds. Vigorous restrictions on the siting of such operations as well as appropriate controls on point source wastewater discharges could protect the Suwannee River. Thus, continued degradation of the Suwannee River resulting from phosphate stripmining is a consequence of discrete regulatable acts.

Example III: Publicly Funded Infrastructure

Another source of what is typically considered nonpoint source pollution is the construction and siting of public infrastructure facilities, such as highways or dams, funded by Federal, State or county agencies.

Highways generate runoff with organic chemical contaminants and nutrients. In turn, with other public infrastructure investments such as sewers, they typically spur residential or commercial development that causes more nonpoint source pollution. The siting of highways in critical surface watershed areas, including wetlands, and in sensitive ground water recharge zones can greatly increase the magnitude of their impact on receiving waters.

Aside from direct funding controls, the siting of highways in wetland areas is regulatable under Section 404 of the Clean Water Act and under many State wetland laws. In addition, the siting of highways in a recharge zone of ground water designated as a sole source aquifer under Section 1424(e) of the Safe Drinking Water Act, 42 U.S.C. Section 300h-3(e), may be prohibited as a potential cause of ground water contamination by EPA. Needless to say, EPA has not used this veto authority aggressively. Further, because sole source aquifer designation now provides so little regulatory authority to control the siting of pollution sources in sensitive recharge areas, Section 1424(e) should be amended and strengthened. Senate Bill S.124 and House Bill H.R. 1650, the Safe Drinking Water Amendments of 1965 represent a step in this direction, although H.R. 1038 and S.24 would be a preferable amendment.

Much of the pollution associated with highway runoff stems from the exhaust and tire wear of automobiles, trucks, and buses. Although the organic chemicals and toxic metals in such runoff are deemed to be nonpoint sources of pollution, in fact these motor vehicle pollution sources are regulated under Subchapter II of the Clean Air Act, 42 U.S.C. Section 7521. Unfortunately, air pollution emission standards for trucks and buses are very lax, and emission standards for automobiles, as well as trucks and buses, are not stringent enough to prevent significant motor vehicle-related pollution runoff. Strengthened motor vehicle source emission standards would, of course, have innumerable benefits in terms of reducing concentrations of air pollutants, such as hydrocarbons, nitrogen oxides, carbon monoxide, and toxic air pollutants, as well as reducing concentrations of toxic contaminants in urban runoff. Highway runoff, which is presented as an example of nonpoint source pollution and which cannot be adequately treated by secondary treatment plants, arises in large part from a great number of regulated air pollution emission sources.

We have already mentioned one major cause of saltwater intrusion in coastal Louisiana—the construction of canals. Another cause of coastal riverine saltwater intrusion, such as is the case in the Gulf Coast of Texas, is constructing riverine dams for water supply and other purposes.

Aside from the issue of funding control, construction and, to a limited degree, the operation of such dams is subject to some regulatory control under the National Environmental Policy Act, 42 U.S.C. Section 4321 *et seq.*, the 1958 Fish and Wildlife Coordination Act, 16 U.S.C. Section 661, and, in some cases, Section 404 of the Clean Water Act. The construction of massive regional sewer systems in Long Island that collect and treat wastewaters in a ground water-dependent system and discharge them into ocean water has also resulted in saltwater intrusion into Great South Bay. Construction of such sewer systems is subject to the same statutory requirements as dams in addition to other legal requirements specified in Section 201 of the Clean Water Act, 33 U.S.C. Section 1281.

Example IV: Residential and Commercial Development

Residential and commercial development typically brings with it nonpoint sources of pollution—septic system discharges into ground water and lawn-related fertilizers and particles. The siting of such development is a major factor in determining the magnitude of its associated nonpoint source pollution on surface or ground water. As with all pollution sources, the siting of such development in wetlands, low lying floodplains, and other portions of critical surface or ground water watersheds can cause high levels of nitrate or organic chemical pollution. Its siting in less sensitive areas results in a far lesser impact.

Local governments in many parts of the country have recently been using their zoning authority to limit residential densities and prevent undue clearing of natural vegetation to protect ground and surface waters in critical watersheds. Long Island townships have used 2- and 5-acre zoning in part to limit residential pollution of ground water. Such zoning, when challenged, has been sustained. The New Jersey Pinelands Commission in its Pinelands Comprehensive Management Plan has severely restricted residential development in some 80 percent of the 1 million-acre Pine Barrens of southeastern New Jersey, in part to maintain the remarkably pristine quality of its surface and ground water, characterized by exceedingly low (below 0.2 parts per million) levels of nitrates. Indeed, that Commission has adopted the country's most ambitious multi-county transfer of development rights program in pursuing its objective to severely restrict development in the most sensitive areas of the Pinelands. A Virginia Court, *Aldre Properties* v. *Board of Supervisors,* Chancery Nos. 7846.3-A 19th Judic. Cir. V. Jan. 7, 1985, has recently upheld the rezoning of some 40,000 acres of a critical part of the watershed of the Occoquan reservoir in Fairfax County. Dade County, Florida, is prohibiting the siting of industrial facilities with any potential for discharge of broadly-defined hazardous wastes within the zones of influence of its new water supply well fields west of the most urbanized portions of the county.

Restrictions on residential and commercial potential nonpoint-source pollution in sensitive watersheds is not, however, limited to exercise of the zoning power. Local or State governments can and do ban the use of certain septic tank solvents and other toxic organic compounds in such watershed areas. In particularly sensitive areas, local or State governments could intensively apply such bans. In addition, under TOSCA, 15 U.S.C. Section 2601, EPA has the legal authority to prohibit use or disposal of specific chemicals. EPA could use this authority to limit or prohibit such use in sensitive ground or surface water watersheds.

Example V: Atmospheric Pollution—Acid Rain

Atmospheric pollution in the form of dry and wet deposition of oxides of sulfur and nitrogen—acid rain—is gradually being recognized as a major cause of acidification and resulting contamination by acid, sulfates, and mobilized toxic metals of surface waters in geologically sensitive areas. These sensitive areas are widespread—northern New England, the Adirondacks, portions of the Hudson Valley, the Catskills, the Appalachian Region, portions of Florida, the Upper Midwest, high elevation lakes and streams in the Rocky Mountain Region, and parts of the Northwest. Atmospheric deposition is therefore a major nonpoint source of water pollution.

While emissions of oxides of sulfur and nitrogen, the precursors of acid deposition from utilities, smelters, and other industrial sources, are not regulatable under the Clean Water Act, they are clearly regulatable under the Clean Air Act. The principal sources of sulfur oxides in the East and West are all "stationary sources" of air pollution. Further, acid deposition causes a range of adverse impacts on water quality, forests, crops, manmade materials, and visibility—all recognized as "welfare effects" as defined in Section 302(h) of the Clean Air Act, 42 U.S.C. Section 7602(h).

Unfortunately, the Administrator has not exercised his authority or performed his duty to establish a secondary annual national ambient air quality standard for sulfur deposition in the form of a sulfur deposition rate at a level designed to avoid sulfur's adverse welfare effects either based on an existing criteria pollutant, sulfur dioxide, under Section 109(b)(2), 42 U.S.C. Section 7409(b)(2), or by listing atmospheric sulfur in any chemical form as a new air pollutant under Section 108(a)(1) of the Clean Air Act 42, U.S.C. Section 7408(a)(1), and subsequently establishing air quality criteria and a secondary standard. Despite this failure to act, however, this nonpoint source of pollution of water quality is controllable under the Clean Air Act. Needless to say, in the face of continued EPA disregard of its legal duties, we can hope that the Congress will establish a program to rapidly reduce sulfur oxide emissions from major stationary sources.

CONCLUSION

To a large extent, nonpoint sources of water pollution result from preceding acts that constitute point sources of pollution subject to regulation under existing Federal environmental laws and their State counterparts. Existing law therefore can control and limit future nonpoint source pollution and, to a more limited degree, be used to remedy historic nonpoint source pollution. Vigorous enforcement of the Clean Water Act Section 404 wetland protection program would, by way of example, enhance control of nonpoint source pollution.

Siting of nonpoint source pollution-generating activities within a ground or surface watershed is also a major factor in determining the magnitude of impact of that pollution of receiving waters. To control nonpoint source pollution, EPA and State environmental protection agencies must take advantage of those provisions in the Safe Drinking Water Act, RCRA, TOSCA, FIFRA, the Clean Water Act, and other laws that authorize use of siting criteria. Since local governments play a major role in making land use decisions, they too should take advantage of these provisions.

It is certainly the case that State agencies and EPA have not taken maximum advantage of these statutory authorities. We need a general legal framework that facilitates using these authorities at all levels of government. Strengthening the sole source aquifer programs of the Safe Drinking Water Act would be a step in this direction. Adopting a comparable program for critical surface water supply watersheds at the State or Federal level would also be useful. Adopting Clean Water Act amendments designed to stimulate design and implementation of regional nonpoint source pollution control programs would also provide a broad legal framework for taking advantage of existing regulatory authorities.

END NOTES

[1]The Florida Wetlands Protection Act expands State jurisdiction over the State's waters, including wetlands, and establishes that State's first permit program expressly designed to regulate activities in wetlands. It takes away from the State's Department of Environmental Regulation authority to regulate agricultural activities; insofar as they are regulated in connection with construction of agricultural water management systems, the State's water management districts are assigned that responsibility.

[2]Administrative implementation of the *Avoyelles* decision has been slow. In October 1984, the Assistant Administrator of EPA for External Affairs issued interim guidance to all EPA regions instructing them that agricultural conversion operations in bottomland hardwood wetlands in general are subject to Section 404 regulation. The U.S. Army Corps of Engineers which directly administers the Section 404 program has issued a Regulatory Guidance Letter No. 85–4 dated March 29, 1985, which reflects that agency's begrudging accommodation to the mandates of the Fifth Circuit.

COMPELLING ON-THE-GROUND IMPLEMENTATION OF MEASURES TO CONTROL NONPOINT SOURCE POLLUTION

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ABSTRACT

Experience to date with implementation of measures to control nonpoint source pollution has been largely voluntary, dependent for success on education and subsidization of the costs of erosion control. The record is clear that these measures have not worked—nonpoint pollution is getting worse, not better. A dramatic change in attitudes abut how to control nonpoint pollution must be made if this serious source of water quality degradation is to be brought under control. Any program to compel implementation of best management practices must acknowledge the differences between types of sources of nonpoint pollution and the features that distinguish nonpoint pollution from point source pollution (e.g., the inherent problems associated with measuring the amount of pollution caused by that source). What is an appropriate incentive to achieve one source's compliance may not be appropriate for another. A mix of measures, ranging from traditional enforcement tools like citizen suits, cross compliance penalties, permits, and fines to financial incentives like taxes, subsidies, and rewards should be examined for their suitability to different sources of nonpoint pollution and to the particular conditions of a given watershed. The exact mix of measures should be determined at the State level in an EPA-approved nonpoint program. In applying these measures, off-farm contributors to the chain of nonpoint pollution should not be immune—for example, if excessive nitrogen is a water quality problem associated with nonpoint source pollution, then fertilizer manufacturers should be brought within the regulatory program. The final program must be equitable, effective, and easy to administer.

Although the catch-all title is "enforcement," implementation of nonpoint controls can be achieved only by a creative mixture of traditional enforcement or regulatory tools and economic incentives. The bottom line to any nonpoint program must be a discernible improvement in water quality and any proposed technique to achieve that end must be measured against that goal.

Nonpoint pollution and nonpoint polluters differ from point source pollution and point source polluters in several key aspects, but are the same in others. Understanding these distinctions and similarities is critical to designing any program to implement nonpoint source controls.

Unlike the industrial point source program, the beneficiaries of nonpoint source pollution control and the observable impacts of this form of pollution are generally far away from the pollution's point of origin. Runoff from a farm field or mine site often creates a water quality problem miles away from the pollution source, in some receiving stream, lake or estuary. This fact can create serious perception as well as enforcement problems. Farmers ask why they should be required to undertake the costs of implementing best management practices to produce benefits for the distant public-at-large; accordingly, they expect government assistance to offset the costs of implementing these controls. Whether or not that perception has any validity when compared to industrial pollution is irrelevant, because it must be dealt with in any nonpoint source implementation program.

The distance between the origin of pollution and its impact creates specific enforcement problems as well. Not all eroded soil ends up in a receiving stream. The distance factor makes it difficult to apportion liability for nonpoint pollution. Intervening causes of pollution have too much opportunity to occur between the points of origin of nonpoint pollution and its impact.

How can a specific farmer's share of the pollution and liability for it be distinguished from naturally occurring nonpoint pollution or, for that matter, from the runoff coming from the farm downstream or upstream of him? What if farmer A's eroded soil is being trapped by off-farm streambank vegetation, but farmer B, who's losing the same amount of soil, has no such assistance—should an enforcement policy distinguish between these farmers because only farmer B is causing a discernible water quality impact even though both farmers are losing soil?

How does one measure the percentage of pollution attributable to a particular activity and assess liability for it with any degree of precision, let alone equity—a basic premise of most pollution control programs—if one can't establish, let alone quantify, the relationship between the polluting activity and the pollution? What unit of measurement can be used to design an effective effluent reduction program for nonpoint source pollution under these circumstances? The Universal Soil Loss Equation, which measures on-farm erosion, is of no use when it comes to assigning liability for an off-farm adverse water quality impact. These questions are unique to nonpoint pollution.

The fact that a nonpoint source enforcement agency is faced with trying to regulate pollution that can't be measured at its source and can't be attributed in many situations to a single identifiable cause would seem to eliminate those enforcement techniques that depend on apportioning responsibility between sources: for example, effluent fees or monetary penalties.

A second distinguishing characteristic of nonpoint source polluters is that some of them receive a direct economic benefit from the application of control measures, while others do not. Few, if any, point source polluters receive any benefit from pollution abatement. Thus, the farmer, the forest products company, the miner, and the rancher should all benefit from the retention of soil on their land; however, the industrial or urban source of nonpoint pollution may not. This distinction between sources has relevance for assessing whether incentives, like subsidies or tax relief, are appropriate for a particular source. It makes no sense to subsidize a farmer or timber products company for adopting control technologies that are already in its best interests to employ. Using a subsidy in those situations amounts to giving those polluters an unwarranted double benefit.

A separate question that must be raised when evaluating incentives as a means of achieving implementation of control practices is whether the particular circumstances of the situation, such as the extremely depressed farm economy, warrant abandoning the basic premise of most pollution control statutes that polluters should not be reimbursed for the costs of cleaning up their pollution—"The polluter always pays" maxim. This is certainly a cardinal rule of the point source regulatory program. Yet, most discussions on achieving implementation of nonpoint pollution control measures assume the opposite, namely that the polluter should be reimbursed for his cleanup costs. I find these discussions deeply troubling and the relief proposed unwarranted in law or fact. Yet, mine is not a politically popular position to take and, therefore, one unlikely to prevail. However, if polluters are to be subsidized for the cost of implementing control technologies in the nonpoint as distinguished from the point source program, then that program must have as an indispensible component the achievement of some demonstrable reduction in nonpoint pollution. Otherwise, we will risk replicating the wasteful experience of the Rural Clean Water Program.

Another distinguishing characteristic of nonpoint pollution is that many factors affect nonpoint pollution, many of which are beyond the control of the source. Take, for example, agricultural nonpoint pollution. The occurrence, quantity, and quality of agricultural nonpoint pollution are influenced by weather, land contour, crop choice, plowing techniques, and pesticide and fertilizer use as well as by external factors, like the domestic and foreign demand for farm products, the cost of fuel and fertilizers, and government subsidy programs (Harrington et al. 1985).

Instead of looking at this list and concluding that nonpoint pollution is too complex to tackle in any regulatory or incentives program, the length and diversity of the list should provide multiple opportunities for abating nonpoint pollution. A nonpoint source implementation strategy should look broadly at the chain of contributors to the pollution and not just the last link in the chain, the final source. For example, in terms of achieving water policy goals, imposing controls on the production and cost of pesticides may be more cost effective than requiring the farmer to build terraces.

The last distinguishing feature of nonpoint pollution that deserves some mention here is the view that the farmer cannot be compelled to do anything, that is, that a regulatory program with permits, on-site inspections, and penalties simply will not work on the American farm. At the core of this perception is the myth that the American farm industry is composed of moderate-size family farms ($100,000 to $200,000 in annual product sales). The myth is given poignancy by the very real economic plight of the family farm.

In actuality, the American family farm is disappearing. Today, the family farm represents less than 11 percent of moderate-size farms; a decade ago, the number was 21 percent. The American farm industry is clearly in transition, moving from a diverse collection of various size farms to a distinctly bipolar structure composed largely of very small or parttime enterprises and very large, industrialized operations. The disappearance of the family farm, without question, has created very real stress on the farm economy as well as stress on many watersheds. Good conservation, which is a long-term investment, may not appear relevant during an economic depression when short-term goals hold greatest appeal.

Implementation of nonpoint source controls clearly did not cause the disappearance of the moderate-size family farm. Just as clearly, the conditions of this transition period should not be allowed to define the content or approach of any nonpoint source program that Congress creates. Yet the myth of the family farm persists and is at the center of the different approaches taken toward the polluter in the nonpoint and point source programs, even today. How else can one explain the reluctance to impose regulatory controls on farming activities and the too-ready reliance on voluntary, educational and subsidy programs? Yet, how different are the large, industrialized farms, which are clearly the wave of the American farm future, from industry or forest products companies?

A strictly voluntary approach has not worked and will not work for the farmer any more than it would work with the chemical industry. Nonpoint source pollution is increasing, not decreasing, perhaps reflecting the stress of the family farmer, who will opt for short-term gains and plow his highly erodible land rather than take it out of production. Why should the family farmer be any more willing to cut into profit margins than the steel industry, particularly in his economically distressed condition?

To allow the image of the family farm to dictate how we approach the nonpoint pollution problem would be a mistake. The attitude toward the farming community must change dramatically if this most serious source of water quality degradation is to be controlled. We must acknowledge that farming is no different from manufacturing chemicals, mining coal, or cutting trees when it comes to assigning responsibility for nonpoint pollution and bringing it under control.

I start with the premise that an effective nonpoint source control program must be regulatory in nature and generally indistinguishable from any other basic pollution control program. Such a program should provide for permits, objective standards, on-site inspection by State and Federal officials, and a full panoply of enforcement measures, including citizen suits. I think a useful model that might be pursued in designing such a program is that offered in the Surface Mining Reclamation and Control Act, a statute significantly dealing with erosion control and water quality. The regulatory core of that statute is its performance standards and design criteria, which dictate with some precision how mining will be conducted in various parts of the country. The law requires the industry to implement specific technological controls—like terraces and sedimentation ponds—to prevent environmental problems from occurring. Additional features of interest in that law are its bonding, small operators' assistance, and trust fund programs.

The design criteria approach of the Surface Mining Act, which is not very different from the technology-based approach of the Clean Water Act, has many of the same advantages for both the regulated industry and the regulating agency. Structures are easier to inspect than effluents, particularly nonpoint source effluents that can change under different background circumstances. Affected industries are given a measure of certainty that if they follow the design criteria they will meet the mandated performance standard and thus be in compliance with the law. These criteria and standards are objective and incontrovertible, limiting opportunities for subjective value judgments about possible violations. Certainty, equity and ease of administration are important features of any regulatory program and, therefore, should be goals of a nonpoint source pollution control program.

Regulation, however, is not the only consideration in developing this program. Affirmative action must be taken to eliminate the incentives currently encouraging practices that lead to nonpoint pollution. Crop subsidies, price supports, disaster assistance, and other financial help should not be available in those circumstances that can cause nonpoint pollution. The tax code also should be reviewed with an eye toward eliminating tax relief for pollution-causing activities. Instead, incentives should be built into the commodity and tax programs for nonpoint source control. The entire chain of contributors to nonpoint source pollution should be part of this review. The goal should be reduction at the source; in many instances this will not be the last link in the chain, but rather the first, for example, the producer of pesticides or fertilizers.

Any nonpoint source control program must be flexible and must offer a mix of measures, both disincentives and incentives, to achieve program goals. Different measures, both regulatory and economic, should be examined for their suitability to specific sources of nonpoint pollution and to the particular conditions of a given watershed. The exact mix of measures should be determined at the State level in an EPA-approved nonpoint program.

Any nonpoint program should have the capacity to distinguish between problems and to address those problems in some priority fashion. I would suggest that the first order of business should be bringing new activities into compliance, so that the inventory of problems does not keep growing. As those activities are brought within the regulatory fold, then the focus can shift to addressing the backlog of existing operations, which may be decreasing on its own for totally unrelated reasons.

Without question what I have proposed here is the most aggressive approach to solving the problem of nonpoint source pollution. It reflects my deep conviction that the problem is of sufficient severity to warrant the imposition of these types of measures and that the affected sources can absorb this responsibility like any other part of the economy, with neither less nor greater dislocation. Equally clear, traditional attitudes must change before this can be achieved. The legislation pending in Congress is a first step toward nonpoint source pollution control and does not bar States from following the approach proposed here. Should the States elect not to participate in the proposed program in a meaningful way, then Congress, at the next reauthorization of the Clean Water Act, should seriously consider taking the program to the next generation of control, as I have proposed in this paper.

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CONTROLLING NONPOINT SOURCES OF POLLUTION—THE FEDERAL LEGAL FRAMEWORK AND THE ALTERNATIVE OF NONFEDERAL ACTION

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ABSTRACT

This paper considers certain State and Federal legal aspects of nonpoint source pollution control including a general overview of Federal and representative State laws on the subject. A major emphasis is the benefits from reinforcing existing State legal and administrative institutions to serve as the foundation for a national nonpoint source pollution control effort. All too often, when a national regulatory effort is envisioned, individual State differences and preferences are ignored in the effort to articulate a *single* Federal policy. States can in fact develop and implement meaningful nonpoint source pollution control programs without traditional Federal controls. Moreover, even where such pollution involves more than one State and control efforts must be expanded accordingly, there is the potential to use such proven non-Federal dispute resolution tools as interstate compacts or interstate agreements. This paper also considers the adequacy of current Federal nonpoint source control efforts in the context of existing legislative authorities.

As each State strives to improve overall water quality, nonpoint source (NPS) pollution increasingly appears as a problem which has not been fully addressed in prior as well as current water quality enforcement efforts. (U.S. Geol. Survey, 1983; Off. Tech. Assessment, 1984). This conclusion becomes more apparent as existing Federal and State NPS statutes and regulations are enforced more strictly. Looking to the future, NPS pollution will have to be effectively controlled if the Nation's water quality is to continue to improve. While nonpoint source pollution is clearly a problem, the diffuse and intermittent nature of the discharges involved make definition as well as measurement difficult.

Many of the NPS pollution measurements are rather subjective in nature. For example, in America's Clean Water: The States' Evaluation of Progress 1972-1982 (Association of State & Interstate Water Pollution Control Administrators, 1984), States reported "severe" impairment of designated water uses as the result of nonpoint pollutants generated through the following activities (number of States reporting in parentheses): agricultural (16); urban (11); mining (15); land disposal (12), and construction (6). States reporting widespread geographic impairments caused by nonpoint pollutants from these same activities were as follows: agricultural (29); urban (8); mining (2); land disposal (5); and construction (6).

An important and still outstanding public policy question is whether the regulation of NPS pollution should be addressed through Federal or State control structure or some combination of the two. As a starting point in answering this question, this paper will examine the basic legal framework of Federal regulation of nonpoint source pollution of the Nation's water resources. Emphasis will be placed, of necessity, on the Federal Water Pollution Control Act, as amended by the Clean Water Act Amendments of 1977.

The basic thesis of this paper is that in the context of applicable Federal laws, States have the latitude and should take the initiative to develop and implement meaningful NPS pollution programs. There is no need to wait for Congress to develop and implement a comprehensive regulatory program. In fact, it can be argued that a traditional Federal regulatory program is not in the States' collective best interests. Why? To oversimplify, it is all too often the case that when a Federal regulatory program is designed, individual State differences and preferences are overlooked in the implementation of a National regulatory structure.

Where NPS pollution involves more than one State and control efforts must be expanded accordingly, there is the clear potential to use such proven non-Federal dispute resolution tools such as interstate compacts. It is the very nature of the NPS pollution (especially the diffuse and intermittent nature of the discharges) as well as potential legal problems associated with individual State action, that will often tend to support the interstate compact approach.

INTRODUCTION

It is often difficult to distinguish between point and nonpoint sources of water pollution. Many water pollution sources are not clearly "point" or "nonpoint", but have characteristics which suggest placement along a continuum between these two classifications. In addition, the classification of a pollutant as "point" or "nonpoint" may vary at different stages in the pollutant life cycle. For example, a nonpoint source may be reclassified as a point source if the pollutant materials in question flow into a more discernible, confined conveyance such as a ditch or channel. (See, for example, *Natural Resources Defense Council, Inc.* v. *Costle*, 568 F. 2d 1369 (1977).)

Unfortunately, Federal law does not provide a precise definition for NPS pollution. To understand the statutory scope of the concept, a mental definition must be drawn of the opposite of the following statutory definition for point source pollution:

> . . . any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft from which pollutants are or may be discharged. (33 USC §1362 (14))

APPLICABLE FEDERAL LAW RELATING TO POINT SOURCE POLLUTION

It is somewhat paradoxical that to understand nonpoint source pollution, one must first examine the statutory definition of point source pollution. Point source pollution is concerned primarily with pollutants discharged or otherwise dispersed from a discrete pipe or conveyance.

*The opinions expressed in this paper are strictly those of the author and should not necessarily be construed as those of the Department of Interior.

Among other examples of point source pollution are sewage effluent and incinerator residues. Applicable Federal law generally classifies any activity that emits pollution from an identifiable point source as point source pollution. Return flows from irrigated agriculture and unchannelled and uncollected surface water have been specifically exempted from the point source definition (33 USC §1362 (14)).

Since its original enactment in 1948 (pursuant to 62 Stat. 1155), the key Federal legislation for the control of all forms of water pollution has been the Federal Water Pollution Control Act (FWPCA). The Act was substantially amended in 1972 (pursuant to P.L. 92-500; 86 Stat. 816) and again in 1977 (pursuant to P.L. 95-217; 91 Stat. 1567). The 1977 amendments are known as the Clean Water Act of 1977.

Under the Federal Water Pollution Control Act, as amended (Clean Water Act), the actual administration of water quality standards for point sources has been left to the States, who are in turn free to impose stricter point source controls than these promulgated by the EPA. However, if the State standards are less strict than applicable Federal standards, the EPA may impose its own. Section 303 of the act requires States to identify water quality limited segments of streams or other watercourses. "Water quality limited" refers to that portion of a stream or watercourse that receives such a large amount of point source pollution that discharge standards alone are inadequate in and of themselves to preserve minimum water quality. Where such limitations on water quality apply, the act requires the establishment of total maximum daily waste loads for each threatened area. The total maximum waste load is then allocated among current users of the area.

Section 402 of the Clean Water Act established the National Pollution Discharge Elimination System (NPDES). An NPDES permit is required in order to discharge point source pollutants into navigable waters.

To obtain a Section 402 NPDES permit, certification must be obtained from the applicable State agency (or the EPA in the absense of responsible State authority) must certify that the proposed discharge complies with applicable Federal effluent standards. For the purposes of compliance, such standards include those specified by Section 301 of the act. Pollution standards prescribed under Section 301 have become more stringent in recent years. Under the current schedule, there is an ongoing shift from the mandatory use of "best practicable technology" (BPT) to "best available technology" (BAT). The 1977 amendments to the Clean Water Act established a group of "conventional pollutants" (e.g. suspended solids, coliforms, etc.) for which the "best control technology" must be used.

It should be remembered that the funding authorization for the Federal Water Pollution Control Act is expired but the regulatory authority continues. Funding reauthorization will again be addressed in the 99th Congress.

THE FEDERAL WATER POLLUTION CONTROL ACT, POINT AND NONPOINT SOURCE POLLUTION AND THE STATES

The Federal Water Pollution Control Act (33 USC §1251 (b)) expressly recognizes ". . . the primary responsibilities of the States to prevent, reduce and eliminate pollution." The act does not in any way affect State authority to allocate quantities of water within State boundaries. The FWPCA (33 USC §1251 (a)) obligates the EPA Administrator to:

> . . . encourage cooperative activities by the States for the prevention, reduction, and elimination of pollution, encourage the enactment of improved . . . uniform State laws relating to the prevention, reduction and elimination of pollution; and encourage compacts between States for the prevention and control of pollution.

There is every reason why this same authority which encourages cooperation between States in the administration of point source control programs could also be used as support for State NPS control programs.

Nonpoint Source Pollution and Applicable Federal Law. Nonpoint sources of water pollution include diffuse pollution sources that are not regulated as point sources. It normally includes agricultural and urban runoff, runoff from construction and from surface mining activities, among other sources. As the court noted in *United States v. Earth Sciences, Inc.*, 599 F. 2d 368, 373 (10th Cir., 1979):

> . . . [t]he legislative history [of the FWPCA] indicates..Congress was classifying nonpoint source pollution as disparate runoff caused primarily by rainfall around activities that employ or cause pollutants.

The U.S. Senate Report on what eventually became the Clean Water Act (33 USC §1314) was cited by the court in Earth Sciences as indicative of the significance of NPS pollution in the overall Federal water pollution control effort. This Report stated, among other things:

> Sediment, often associated with agricultural activities is by volume our major pollutant, not only by the degrading effect of the sediment, but because it transports other pollutants. Fertilizer and pesticide runoff are also major agricultural nonpoint sources. Poor forestry practices, including indiscriminate clear-cutting, may also generate substantial soil erosion problems.
>
> One of the common problems associated with pollution control is the dramatic increase in storm runoff when the earth's surface is made impermeable. Thus, highways, buildings, and parking lots all contribute substantially to the accelerated runoff of rainwater into natural water systems. The greater volume and greater velocity produce high rates of erosion and siltation. In addition, highway runoff often includes oil, rubber particles, lead asbestos and other elements or additives deposited on highways as a result of vehicular traffic.

There is some evidence in the legislative history of the 1972 and 1977 amendments to the Federal Water Pollution Control Act to suggest that Congress might have regulated nonpoint sources of pollution as well if they could have found a way to do so. Instead, Congress was forced to content itself with such statutory tools for addressing the NPS problem as the following:

Section 201, which declares that one of the key objectives of the United States Code subchapter (Section 201 et seq. of the FWPCA) relating to grants to municipalities for the construction of waste treatment works is control "to the extent practicable" of nonpoint sources.

Section 208, provides for areawide waste treatment management planning. The preparation of areawide plans started in the mid-1970's with the publication of guidelines by the EPA Administrator (pursuant to 40 Federal Register 55, 321, eventually codified as 40 CFR Part 35). The guidlines enable the Governor of each participating State to identify areas within the State as the result of urban-industrial pollution concentrations or other factors have substantial water quality problems.

Under Section 208, after the Governor of each State identifies the areas of the State having substantial water quality problems, he or she is then mandated to: (a) Designate the boundaries of each such area; and (b) select a single planning organization which includes local representation, capable of developing and implementing a continuing areawide waste treatment management planning process.

Each State is required to act as the chief planning agency for all portions of its territory not otherwise designated. An alternate procedure for the designation of water-quality impaired areas is available in the absence of gubernatorial action.

Plans developed under Section 208 process are required to contain alternatives for waste treatment and be applicable to all wastes (both point and nonpoint) generated in the area involved. Under Section 208, areawide plans must also identify municipal and industrial waste treatment works necessary to meet the anticipated waste treatment needs of the designated area over a 20-year period. During the 1970's, a period of strong Federal support for the Section 208 construction program, the award of Federal waste treatment funds was based in large part on the identification of anticipated waste treatment needs.

Finally, Section 208 plans must include a process to identify and control nonpoint sources of pollution to the extent feasible. (Section 208 (b) (I) (F) through (H)). Unfortunately, feasibility is not defined in the statute or the applicable regulation (40 CFR §35.1505 (d)). According to 40 CFR §35.1521-4(c), Section 208 plans must control nonpoint sources of pollution through the use of best management practices (BMP's). In the nonpoint context, BMP's are defined as

> ... those methods, measures, or practices to prevent or reduce water pollution and include but are not limited to structural and nonstructural controls, and operation and maintenance procedures. BMP's can be applied before, during, and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters. Economic, institutional, and technical factors shall be considered in developing BMP's. BMP's shall be developed in a continuing process of identifying control needs and evaluating and modifying the BMP's as necessary to achieve water quality goals (see §35.1521-3 (h)). To the extent practicable, BMP's should be set forth in a document which can be distributed widely in the planning area. (40 CFR §35.1521-4 (c))

From the beginning, designated planning agencies found it easier to address point rather than nonpoint sources. Why? At the risk of considerable oversimplification, the key reason is that point sources are easily definable and control technologies are relatively well-developed. By contrast, the chief techniques for controlling NPS pollution often involve some form of land use planning or other public control of private land use, a topic over which there is much political controversy. The limited acceptability of key NPS control strategies coupled with delays on the part of EPA in preparing necessary guidelines, resulted in the targeting of such Section 208 waste treatment construction monies as were available on point source control efforts. This assymetric targeting has resulted in the construction of a network of waste treatment facilities which are less than adequately equipped, in the view of several observers, to handle the more diffuse NPS problem.

While the 1977 amendments to Section 208 took certain steps toward regulating nonpoint sources, the nonregulatory flavor of the section was retained. On the control side, subsection (j) established an agricultural NPS control program. Under this subsection, the Secretary of Agriculture, in conjunction with the EPA Administrator, is empowered to develop and administer a program under which rural land owners and operators are eligible for Federal financial assistance for NPS control. In return, the rural land owner or operator must provide a contractual commitment of at least 5 years to use best management practices (BMPs) to control specified agriculturally-based nonpoint sources of water pollution. By virtue of the fact that contracts are made directly between the Department of Agriculture and the rural land owner or operator (rather than through the State or local government or areawide planning agency), Section 208 (j) authorizes what amounts to direct Federal support for NPS control. It should be emphasized, however, that participation under subsection (j) is voluntary.

The 1977 amendments to Section 208 also made clear that prior to the determination by the Governor of any State that an NPS control program was necessary under Section 208 (b)(4) to meet Statewide water quality standards and implementation plans required by Section 303, the approval of the EPA Administrator is necessary. It was previously unclear whether such approval was required.

Section 208 was also amended in 1977 to require that any NPS control program developed under Subsection (b)(4) as part of a Statewide program under Section 303, adequately consider the impact of nonpoint sources on the Nation's wetlands. This is done through the requirement (pursuant to §208 (b)(4)(B)) that any NPS program designed at least in part to control the discharge of dredge or fill materials into navigable waters include provisions to ensure: (1) coordination with approved State Section 404 programs; (2) that discharge activities are conducted pursuant to BMP's; and (3) consultation with relevant parties such as the State agency with primary jurisdiction over fish and wildlife resources.

Section 304, relating to information and guidelines, contains a mandate to the EPA Administrator to develop (a) guidelines for identifying and evaluating the nature and extent of nonpoint sources of pollution; and (b) processes, procedures, and methods to control pollution resulting from such sources as:

- agriculture and silvicultural activities, including runoff from fields and crop and forest lands
- mining activities, including runoff and siltation from new, currently operating and abandoned surface or underground mines
- all construction activity, including runoff from facilities resulting from such construction
- the disposal of pollutants in wells or in subsurface excavations
- salt water intrusion resulting from the reduction in fresh water flow for any cause
- changes in the movement, flow or circulation of ground waters.

However, Section 304 does not provide for the actual regulation of NPS pollution as such.

Section 304 was amended in 1977 to authorize the EPA Administrator to mandate BMP's to address toxic and hazardous pollutants (the section specifically mentions point sources but implicitly includes nonpoint sources as well) which are associated with or ancillary to an industrial manufacturing or waste treatment process. Over the longer term, the importance of these amendments to Section 304 will largely be a function of how the courts construe the terms "associated with or ancillary to".

Implementation of Applicable Federal Law by EPA. Enforcement of the NPS provisions of the Federal Water Pollution Control Act has not been a high priority of the agency since the passage of the 1977 amendments. Regardless of whether the effect has been positive or negative it is clear that the issuance of NPS guidelines has, in some cases, been delayed and certain NPS regulatory initiatives have not moved beyond the proposal stage. Over the last year there has been renewed activity. On December 12, 1984, an EPA-directed task force issued a National Nonpoint Source Policy. The overall objective of the task force is to support and accelerate the development and implementation of NPS management programs that ensure water quality protection. The statement of general policy issued by the task force provides a key sense as to where EPA now wishes to direct its NPS control efforts:

Achievement of national clean water goals requires implementation of NPS management programs. Emphasis should be placed on implementing NPS programs in watersheds affecting priority waters. Sources of nonpoint pollution should be evaluated to assess potential water quality impacts and needed program actions. NPS management is required to protect high quality surface and ground waters and to restore and/or improve water quality surface uses. In many instances, prevention of degradation has proven to be far more cost-effective than remedial measures.

NPS management programs must be flexible to allow for site-specific solutions to problems, to accommodate changes in technical knowledge, to respond to changes in uses of land, and to optimize net on- and off-site benefits. A mix of both point and nonpoint source measures should be considered in developing cost-effective strategies to improve and maintain water quality.

With federal leadership and coordination, all levels of government and the private sector need to cooperate to provide continued progress with available programs and delivery systems, to identify unmet needs, and to develop and implement NPS managment programs where needed.

Nonpoint Source Control at the State level. The preceding review of Federal law relating to point and nonpoint sources of water pollution was not meant to suggest that individual States have not been active. While it is beyond the scope of this paper to detail the range and variation of State NPS initiatives, two examples of State actions illustrate State involvement. Given the key role that agricultural activities play in the generation of NPS pollution, both of these examples come from the agricultural sector. In the 1970's, the State of Iowa enacted a soil conservation law (pursuant to Iowa Stat. Ann. Chapter 467 A) under which rural land owners and operators can, under certain circumstances, be forced to adopt soil conservation measures to reduce or eliminate NPS pollutants with the assistance of appropriate public agencies. Similarly, New York has enacted legislation that requires the development of soil conservation plans (Soil Conservation Districts Law §4 et seq., McKinn. Consol. Laws).

STATE MANAGEMENT OF THE NPS PROBLEM—A POLICY PERSPECTIVE

From a more general, policy-oriented perspective, it seems likely that any attempt on the part of Congress to move toward Federal management of nonpoint sources of water pollution would be inherently ineffective because it would fail to recognize the very significant regional variations in the NPS problem. It is difficult to conceive of a system of Federal regulation that could adequately, effectively and equitably recognize different NPS problems in, for example, New York and Arizona.

The water policy of the current Administration clearly follows from the established tradition of congressional deference to State management of State water resources. The Administration takes the view that the States have primary authority for the management of their own water resources except where Congress has indicated otherwise on a case-by-case basis.

If the States are, as I suggest, going to continue to be the primary managers of their own water resources as well as address pollution problems that are not susceptible to cost-effective National regulation, then what mechanisms can be put forward in the name of effective State management. As the next section of this paper indicates, I believe that interstate compacts, a mechanism with proven success in resolving interstate surface water disputes, can be effective in controlling nonpoint sources of water pollution that affect more than one State.

Constraints to Individual State Action. Despite its traditional deference to State water laws and failure to definitively supersede State regulation of nonpoint sources, Congress has not granted States the authority to regulate. The Commerce Clause of the Federal Constitution would otherwise prohibit any individual State action to regulate NPS pollution on the basis of the police power reserved under the Tenth Amendment must be weighed against the potential burden on commerce. A long series of U.S. Supreme Court decisions (e.g., *West* v. *Kansas Natural Gas Co.*, 221 U.S. 229 (1911); *Pennsylvania* v. *West Virginia*, 262 U.S. 553 (1923); *Pike* v. *Bruce Church, Inc.*, 397 U.S. 137 (1970); *Douglas* v. *Seacoast Products, Inc.*, 431 U.S. 265 (1977); *City of Philadelphia* v. *New Jersey*, 437 U.S. 617 (1978); *Hughes* v. *Oklahoma*, 441 U.S. 322 (1979); and *New England Power Co.* v. *New Hampshire*, 102 S. Ct. 1096 (1982)) have invalidated State attempts to burden interstate commerce in the name of simple economic protectionism. Where this rationale has been utilized for State legislation seeking to regulate any form of interstate commerce, a per se rule of invalidity has traditionally been employed (*Bowman* v. *Chicago & Northwestern Railroad Co.*, 125 U.S. 465 (1888); *H.P. Hood & Sons* v. *Dumond*, 336 U.S. 525 (1949); *Bread* v. *City of Alexandria, La.*, 341 U.S. 622 (1951); *Huron Portland Cement Co.* v. *City of Detroit, Michigan*, 362 U.S. 440 (1960); and *Sporhase* v. *Nebraska, ex rel., Douglas, 102 S. Ct. 3456 (1982)).* Where State legislation has been sufficiently related to the public health, safety and welfare more flexible burden-on-commerce balancing test has been used *Southern Pacific* v. *Arizona*, 325 U.S. 761 (1945) and its progeny (especially *Pike* v. *Bruce Church, Inc.*, 397 U.S. 137 (1970)). The burden-of-commerce test contained in *Pike* v. *Bruce Church, Inc.*, 397 U.S. at 142, is worth repeating:

> [W]here the [State] regulates evenhandedly to effectuate a legitimate public interest, and its effects on interstate commerce are only incidental, it will be upheld unless the burden imposed on such commerce is clearly excessive in relation to the putative local benefits.

On the strength of the Commerce Clause, the Supremacy Clause and Court decisions (*International Shoe Co.* v. *Washington*, 326 U.S. 310 (1945), *Prudential Insurance Co.* v. *Benjamin*, 323 U.S. 408 (1946), and *Western and Southern Life Ins. Co.* v. *State Board of Equalization of California*, 101 S. Ct. 2070 (1981)), Congress may grant to the States authority to regulate commercial activities in the name of NPS control in a manner that would not otherwise be permissible. Since Congress has not chosen to do so, basic constitutional restraints on individual State action may encourage States to reexamine the compact alternative to NPS control.

INTERSTATE COMPACTS—AN OPPORTUNITY FOR COLLECTIVE STATE ACTION

It is always possible, of course, that Congress will determine that a comprehensive (and inherently expensive) Federal program to regulate and control nonpoint sources of water pollution is necessary. In such event, State laws (including compacts) could be superseded. I suggest, however, that in the present Federal budget climate, any such action is unlikely at best. Moreover, a National program to regulate nonpoint sources of water pollution may unavoidably overlook individual State differences and preferences in the effort to articulate a comprehensive Federal policy. What then are the options for States if one accepts the proposition that nonpoint sources of water pollution constitute, in certain areas, a potentially serious threat to public health? I suggest that there are basically two options. The first is individual State action as represented by the efforts of Iowa and New York (among other

States) to address NPS problems of particular concern. Such individual State action may not unduly burden interstate commerce. Second, and perhaps a more functional non-Federal approach given the often regional manifestations of NPS problems, is that of interstate compacts.

Interstate Compacts and NPS Management. Interstate compacts are cooperative agreements enacted by the legislatures of signatory States and thereafter consented to by Congress the requirement of congressional consent follows from the U.S. Constitution (Article I, §10) which (a) precludes States from entering into any treaty, alliance or confederation and (b) stipulates the consent of Congress to be a prerequisite for any State to enter into any agreement or compact with another State. The basic theory surrounding the requirement of Congressional consent is the purported need to protect the interests of the Federal Government and of States not parties to the compact. The late Justice Frankfurter has written of interstate compacts as the primary mechanisms available to the States to circumvent the institutional barriers to regional development. (Frankfurter and Landis, "The Compact Clause of the Constitution", 34 Yale Law Journal 685 (1925)).

Not every compact requires congressional consent. Following *Virginia* v. *Tennessee,* 148 U.S. 503, 518-519 (1893), it appears that consent is required only for those agreements that increase the political power of signatory States in contrast to nonsignatory States and thus potentially conflicts with the Supremacy Clause. Because any interstate compact dealing with nonpoint sources of water pollution can be viewed as being potentialy in conflict with the Supremacy Clause, congressional consent is assumed for the purposes of this paper to be necssary.

Application of the compact approach to interstate water pollution problems is not a totally untried concept. While an interstate compact has yet to be developed to address purely nonpoint sources, at least four water pollution compacts have already been enacted:

1. *New England Interstate Water Pollution Control Compact.* Signatories: Connecticut; Maine; Massachusetts; New Hampshire; New York; Rhode Island and Vermont. Approved by Congress pursuant to 61 Stat. 682 (P.L. 80-292 (1947)). Purpose: To establish the New England Interstate Water Pollution Control Commission to control and reduce pollution on interstate waters in the New England States, including New York.

2. *New Hampshire–Vermont Interstate Sewage and Waste Disposal Facilities Compact.* Signatories: New Hampshire and Vermont. Approved by Congress pursuant to 90 Stat. 1221 (P.L. 94-403 (1976)). Purpose: To provide authority to local governments and sewage districts in New Hampshire and Vermont to establish joint sewage disposal and other waste product treatment facilities as part of comprehensive pollution abatement efforts.

3. *Ohio River Valley Water Sanitation Compact.* Signatories: Illinois; Indiana; Kentucky; New York; Ohio; Pennsylvania; Virginia and West Virginia. Approved by Congress pursuant to P.L. 76-739 (54 Stat. 742 (1940)). Purpose: provided authority for a coordinated State response to water and waste treatment problems in the Ohio River Valley.

4. *Tri-State Sanitation Compact.* Signatories: Connecticut, New Jersey, and New York. Approved by Congress pursuant to Pub. Res. No. 62 (49 Stat. 932 (1935)). Purpose: To establish an Interstate Sanitation Commission with the overall mandate to improve water quality in the boundary areas shared by Connecticut, New Jersey, and New York.

Interstate efforts to address NPS problems of mutual concern may in time be preempted by a comprehensive Federal law. Such was in fact the case in the mid-to late-1960's when several interstate air pollution compacts were enacted (e.g., Illinois-Indiana Air Pollution Compact; Mid-Atlantic States Air Pollution Compact; Ohio-Kentucky Air Pollution Compact; Ohio-West Virginia Air Pollution Compact; and Kansas-Missouri Air Pollution Compact). While several of these compacts were pending before Congress, the Air Quality Act of 1967 was enacted (P.L. 90-148; 81 Stat. 485). Similar preemption of interstate NPS compacts is, of course, possible but it is considerably less likely for two reasons. First, a general scheme for the control of water pollution is already a part of Federal law. Second, Congress has expressly encouraged, pursuant to 33 USC §1251(a), compacts between States for the prevention and control of water pollution.

State Nonpoint Source Programs

FUNDING NONPOINT CONTROL PROJECTS IN MISSOURI

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On June 15, 1983, the Missouri General Assembly approved House Joint Resolution No. 21. This measure, called Constitutional Amendment No. 2, was passed by public vote in the November 1984 general election. This amendment increased the State sales tax by 0.1 percent. Taxation begins July 1, 1985, and will be in effect for five years. The sales tax will generate approximately $30.5 million annually, to be divided equally between State parks and historic sites, and soil conservation.

Missouri's Constitutional Amendment No. 2 is a partial answer to solving the problem with funding nonpoint controls related to soil conservation.

The Soil and Water Districts Commission proposed to use 77 percent of its $15 million annual share for direct financial assistance to landowners; 19.7 percent for technical planning and clerical expenses at the county level; and 3.3 percent for program administration and State office personnel. This paper describes how the soil protection revenues will be used.

MISSOURI SOIL AND WATER CONSERVATION COST-SHARE PROGRAM

The Missouri cost share program equals 50.8 percent of amendment revenues for soils.

Farmers realize the long-term benefits of soil and water conservation. In the short term, however, the costs outweigh the profits. Through the cost-share program, the public directly assists the farmer and his conservation efforts. The long-term benefit for the public is plentiful food at reasonable prices.

It has been estimated that $250,000,000 of cost-sharing funds are needed by the end of the century to protect Missouri's topsoil. The U.S. Department of Agriculture's Agricultural Stabilization and Conservation Service (ASCS), through its agricultural conservation program, supplies approximately $8 million annually to its cost-share program. In addition, State funding of at least $8 million per year is needed for an effective operation. The amendment will fund the state's cost-share program at approximately this level for 5 years.

Through the cost-share program, the farmer pays approximately half of the installation costs and the state pays the rest. Conservation programs eligible under the cost-share program include terracing, conservation tillage, strip cropping, and other proven soil and water conservation techniques. The intent of this portion of amendment revenues is to make more funds available to the farmer as an incentive to install soil and water conservation practices.

SMALL WATERSHED PROTECTION AND FLOOD PREVENTION PROGRAM

This program equals 13.3 percent of amendment revenues for soils.

Water that does not evaporate or soak into the soil usually drains off the land into ditches, streams, marshes, or lakes. The area drained by a stream makes up a watershed. Watersheds sometimes can be complex, such as when land is drained by small streams that flow into a larger stream. Because several different properties may be involved, a cooperative watershed program among neighbors is very important for soil and water conservation. This also explains why more than one conservation measure within a watershed is necessary for best results. More than 100 such watersheds have been designated for planning in Missouri.

The watershed protection and flood prevention program does more than conserve soil and water. It also keeps sediment from entering streams and lakes; this sediment can reduce the volume of the lake or interfere with fishing. New revenues will be used to accelerate the watershed program by funding several completed watershed plans. Money will be available for cost-sharing assistance to landowners for soil and water conservation projects within selected watersheds. These projects include terraces and strip cropping to help water soak into the soil instead of running off, and small dams to hold back runoff water that otherwise would cause flooding.

MISSOURI SOIL AND WATER CONSERVATION LOAN INTEREST-SHARE PROGRAM

This program equals 13.3 percent of amendment revenues for soils.

Many farmers feel they cannot install conservation practices because of cash-flow problems, and they cannot borrow money because of high interest rates. The interest–share program provides financial incentives to landowners who are conserving soil without the benefit of other available programs.

Amendment No. 2 establishes a permanent fund to serve as a financial base for reduced-interest loans. It provides further incentive to landowners to install soil and water conservation measures.

WATER QUALITY ASPECTS OF AMENDMENT NO. 2

While 77 percent of the anticipated $15 million will be for direct assistance to landowners, only 13.3 percent (about $2 million per year) will be available for water quality related land treatments through the small watershed protection and flood prevention program. This situation makes targeting extremely important if the State wishes to achieve measurable water quality improvements.

Therefore, applications will be requested from watershed districts and evaluated on the basis of percent landowner participation, likelihood of success, potential for water quality improvement or protection and other factors. One key drawback may involve lack of interest in areas that have good potential for environmental improvement. While Missouri DNR's Water Pollution Control Program has identified numerous areas where protection or improvement is desired, the watershed districts are governed by a board of supervisors who operate independently. Similarly, problem areas may exist because landowners want to operate independently of government assistance programs.

Initial watershed protection areas will be identified in the spring of 1985 and land treatment will begin shortly thereafter. Project monitoring will be conducted prior to, during, and following land treatment. Because of the difficulties associated with quantifying runoff-transported pollutants, monitoring efforts will focus on habitat quality index changes and alterations in fish community structure. This study should contribute to the not-well-understood relations between stream biota and land use activities.

STATE OF MARYLAND NONPOINT SOURCE CONTROL IMPLEMENTATION PROGRAM

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ABSTRACT

The State of Maryland has had a number of nonpoint source control implementation programs dating back to the late 60's and early 70's. Beginning in 1982, the research findings of the Chesapeake Bay Program added momentum. In January 1984, the General Assembly added a great many new programs and modi ed some existing programs. Not all these programs are outgrowths of the Chesapeake Bay emphasis. Many of them preceded that event. Each program has a different political and institutional situat on from which it has been derived. These 12 different programs will indicate the variety of political situations in which support can be built for new programs. This paper covers each program, how it came into being, how it is inst tutionally implemented, what the responsibilities at the Federal or State or local level are, how it is financed, and what the State of Maryland has done to date in implementing the program.

SEDIMENT CONTROL

The first program I would like to cover is sediment control. Roy Benner of the State's Water Resources Administration has written a very lengthy article, "Urban Sediment and Stormwater Control: the Maryland Experience," published in the February 1985 Journal of Soil and Water Conservation and from which much of this information comes. The Maryland Attorney General's Office declared sediment a pollutant on July 31, 1961. That ruling stated that silt discharged into the waters of the State resulting from stormwater runoff over land areas exposed from land clearing or development operations was legally subject to regulatory control by the State agency. It was largely the result of this decision, and subsequent analysis of the extent to which sediment contributed to the State's water pollution problems, that led Maryland to enact the first statewide erosion and sediment control legislation on Earth Day, April 22, 1970. (Nat. Resour. Article, Title 8, Subtitie 11, Annotated Code of Maryland.)

The major features of the 1970 sediment control legislation are:

1. No clearing, grading, or transporting of soil can take place until the developer submits an erosion and sediment control plan to the local soil conservation district for approval. The developer must specify that he will carry out the plan. Only then is he granted a local grading or building permit.

2. Maryland's 23 counties and 151 municipalities are required to adopt grading and sediment control ordinances acceptable to the Water Resources Adminstration. These ordinances include the necessary procedures and provisions needed to implement and enforce the local sediment control programs.

3. Exemptions from the law include agricultural land management practices and, in some counties, construction of single family homes on lots larger than 2 acres.

4. The Water Resources Administration has leadership for assisting local governments in conservation districts in carrying out their responsibilities under the law. Moreover, the Administration must review and approve all land clearing or construction projects conducted on any State or Federal property.

5. Penalties for not carrying out the provisions of the law are deemed a criminal misdemeanor. Conviction subjects one to a $5,000 fine, 1-year in prison, or both, for each violation.

This understanding of the basis of the program is essential to understand the changes made to it since 1970. The State implemented the program with plan review and enforcement at the local level, but provided no local funding. Primary emphasis was placed on the training and effective use of existing agencies and staff.

After 10 years of experience with the program, three deficiencies appeared to be at the root of most of the inadequacies: lack of an administrative commitment to the program, inadequate field inspection, and an inadequate enforcement process.

Many local jurisdictions failed to commit themselves to developing an effective erosion and sediment control program for several reasons. Most of them do not have the financial resources or personnel to administer the program effectively. This is particularly true of small municipal governments which are often run by an administrator or a small clerical staff. Other local governments may have had the financial resources to develop an effective program but for various reasons did not devote sufficient effort to their erosion and sediment control program. When local administrators failed to commit themselves to developing an effective program, the inspection and enforcement efforts generally proved ineffective as well.

Evaluations of local program effectiveness throughout the State have consistently indicated that erosion and sedimentation caused by mankind's acitivities are not being effectively controlled, and that the best practical combination of procedures and people may not always be at the local level. For this reason, in 1978, the General Assembly amended the sediment control law to require that applicants for erosion and sediment control plans certify that any project engineer, superintendent, or foreman in charge of on-site clearing must have attended a State training program. This had been done previously on a voluntary basis only.

The law was also amended in 1984 to add a civil penalty as an alternative to a criminal sanction. The civil penalty is a fine that is double the cost of installing or maintaining the controls as shown in the approved plan.

The most significant change made in 1984, however, was to provide that, as of April 1, 1985, the State will assume all inspection and enforcement of local erosion and sediment control programs. A local jurisdiction may request and be granted delegation of enforcement authority by the State. In keeping with this shift in authority, about 20 new inspectors were added to the State staff of 14 inspectors. In March 1985, the Department of Natural Resources granted sediment control inspection and enforcement authority to eight counties and Baltimore City. The authority was denied to eight other counties and the Washington Suburban Sanitary Commission, which operates outside of Washington, D.C.

Although it is obviously too soon to predict the effectiveness of the amended sediment control program, we are hopeful that it will achieve its original goals and we will have it very much back on track. It is an example of a delegation to a local government which did not work and, therefore, was taken back with more control and oversight at the State level.

STORMWATER CONTROL

Maryland has two stormwater programs. One is a regulatory program requiring that a stormwater management ordinance be adopted at the local level subject to State criteria (Nat. Resour. Article, Title 8, Subtitle 11A, Annotated Code of Maryland). The second stormwater program is an incentive grants program for demonstration projects to show the effectiveness of urban stormwater practices.

In 1980, it became obvious to the State that 11 of our 23 counties had stormwater management ordinances that contained many different provisions. We were concerned about this not only from the developer's perspective of having to comply with different requirements, but also from the perspective of determining the most desirable provisions to be put into regulations. Of particular concern to us was the issue of whether or not to maintain as nearly as possible natural runoff characteristics. This could be accomplished by augmenting infiltration, by controlling the release of development-related stormflow increases, or both.

In 1981, regulating stormwater and its downstream impacts was the subject of extensive oversight hearings by a joint committee of our General Assembly. That committee's efforts led to the passage, in 1982, of the State stormwater management law. The State's stormwater management regulations represent a diversified approach to controlling the hydrologic consequences of urban development rather than simply focusing on controlling peak flow. Consideration is given to volume reduction, low flow augmentation, water quality control, and ecological protection.

Having learned from our sediment control experience, the State enacted in 1984 a new grant program of $1.7 million to make startup money available to local jurisdictions to implement their local stormwater management programs. Local stormwater programs were to be in effect by July 1, 1984. With the threat of a building permit ban, most counties and about two-thirds of the municipalities had adopted ordinances and received State approval by that date.

As of January 1985, grant agreements for local stormwater program development have been executed and funds awarded in 13 counties and four municipalities. The total amount of funds awarded out of the $1.7 million was $870,000. The State's regulatory requirements for local stormwater management programs are contained in the Code of Maryland Regulations 08.05.05.

The second State program having to do with stormwater management provides State bond funds as an incentive for demonstration projects using best management practices in existing urban areas. These grants are provided as 75% State/25% local grants to local governments to ascertain the cost and effectiveness of methods of solving stormwater runoff problems created by existing development. New development is covered by the regulatory program previously described.

In 1984, the State authorized $1 million for grants to local governments for demonstration projects. In addition, the State authorized $750,000 of General Construction Loan funds for retrofitting stormwater best management practices at State facilities. In the first quarter of FY '85, preliminary proposals were received from 12 local governments for demonstration stormwater control projects in existing developed areas. Standards and criteria were completed for the demonstration grant program and regulations were promulgated, effective April 8, 1985. Eight potential State projects have also been identified.

It is important to note that this program, in part, addresses a loophole in the overall abatement of stormwater pollution. Although the new regulatory program will deal with new development, thousands of acres of the State that require best management practices are not subject to a regulatory program. We are hopeful that the National Urban Runoff Project reports prepared for the Washington Metropolitan area and for the Baltimore Metropolitan area will be of value to us in deciding the types of demonstration projects to fund. We are also hopeful that this financial commitment of $1 million at the State level will encourage local governments in the State to implement similar projects.

Finally, we have received $875,000 from the Federal government for nonpoint source abatement projects in the Chesapeake Bay drainage area in Maryland. Several of these projects involve retrofitting stormwater facilities on highways and in existing developed areas. This combination of a variety of funding sources with regulatory and incentive programs allows us to more fully address control of stormwater pollution from existing developed areas.

AGRICULTURAL RUNOFF CONTROL

One of our agricultural nonpoint source control programs is agricultural cost-sharing. The history of how this program came into being is interesting. In 1979, as an option provided under section 208 of the Clean Water Act, the State formulated, adopted, and submitted to the U.S. Environmental Protection Agency a Water Quality Management Program for the Control of Sediment and Animal Waste from agricultural lands. This was adopted and approved by EPA as an applicable statewide nonpoint control program pursuant to section 208 (b)(4)(A).

We persuaded the agricultural community to support this program, although not all of the cause and effect relationships of agricultural runoff affecting water quality and living resources were well defined. Several decisions were instrumental in gaining agriculture's support. First, we asked the agricultural community to write the 208 agricultural control plan. We provided the EPA and State program format, and they provided the technical and institutional details pertaining to determining priority problem areas, best management practices, and implementation. Second, we made a commitment to work with them to secure funding for cost-sharing.

We began to succeed with our funding commitment when, in what we believe to be a unique move, we secured approval from our 1982 General Assembly to reallocate $5 million of State sewerage facilities construction grant bond funds to agricultural cost-sharing. In 1984, we secured another $2 million of State bond funds for agricultural cost-sharing. Also, in 1984, we secured approval of an additional $1.4 million in State general funds to hire 42 new people to work in soil conservation districts to implement agricultural cost-sharing. With these approvals, we felt we had kept our 1979 promise to the agricultural community to get funds to implement the agricultural 208 plan.

The purpose of our agricultural cost-sharing program is to implement best management practices within priority watershed areas that contribute the greatest amounts of pollution. Our goal is to have conservation plans in place for the farms in these priority watershed areas within 5 years.

For FY '86, we received from the General Assembly an additional appropriation of $5 million in bond funds for cost-sharing. So, to date, we have secured approval of a total of $12 million in State funds for agricultural cost-sharing. Of this amount, we have obligated all of the initial $5 million for 2,000 projects, of which 628 are now completed. We have estimated the total cost of installing best management practices on all agricultural lands in the State by the end of the century to be $90 million.

We are also proposing to use some of the Federal Chesapeake Bay implementation funds for FY '65 to install agricultural BMP's in priority watersheds. So it is really a combination of State bond funds and Federal funds that we are using for agricultural cost-sharing.

In 1984, the Maryland Department of Agriculture, in cooperation with our Office of Environmental Programs, developed and approved a report entitled Statewide Priority Watersheds for the Potential Release of Agricultural Nonpoint Phosphorus and Nitrogen. The report ranked all watershed segments that drain to the Chesapeake Bay in order of their relative potential to release phosphorus and nitrogen as a result of agricultural activities. Factors included in the ranking of the watersheds were: (1) the intensity of agricultural land use; (2) intensity of agricultural cropping; (3) the amount of cropland under conventional tillage; (4) the fraction of cropland on steep and erodable or, for nitrogen, highly permeable soil; (5) the potential intensity of animal waste application to cropland; and (6) an estimate of the influence of topography upon phosphorus movement. In setting priorities, we met with our Department of Natural Resources to learn where stressed aquatic areas corresponded with critical agricultural areas.

The 42 new State-funded positions have been assigned as technical teams to work in the soil conservation districts serving the priority watersheds. These technical teams in the districts are being supported by the University of Maryland for educational and demonstration activities.

In summary, at the present time, thousands of farmers in Maryland are applying for available cost-sharing funds. We are seeing a harmonious coming together of the Federal agricultural community, our State Soil Conservation Committee, soil conservation districts, and water quality agency staff, to get best management practices on farms.

An additional agricultural nonpoint source program provides for enforcement in problem areas. Enforcement actions are taken against landowners when water pollution standards are clearly being violated and landowners refuse to install best management practices. In these instances, we work through the appropriate soil conservation district to try to get BMP's on the land as a voluntary action. If the district runs into resistance, then the case is refered to the water quality agency. We exercise our water quality authority to bring the landowner into compliance. This approach has been supported by our agricultural community. They are making the utmost effort to achieve voluntary compliance. We estimate taking approximately 30 enforcement actions in FY'86 and 80 in each succeeding year with new staff.

AGRICULTURAL DRAINAGE CONTROL

Prior to 1984, the EPA Chesapeake Bay Study had documented agricultural runoff as one of the major sources of nutrient and sediment inputs to the Bay. It was also observed that several large agricultural drainage projects were being planned, financed, and constructed by the U.S. Soil Conservation Service and local public drainage associations with little or no opportunity for State regulation. We felt this process was not adequately protecting the State's natural resources and water quality. Inspection during project construction, as well as for periodic channel maintenance, has traditionally been the responsibility of the U.S. Soil Conservation Service.

For all of these reasons, we prepared legislation which was enacted in 1984 to require that, prior to constructing or reconstructing an agricultural drainage project, a local public drainage association must develop a construction operation and maintenance plan for approval by our Department of Agriculture, with concurrent review by our Departments of Health and Mental Hygiene, and Natural Resources. The statute also requires the three Departments to jointly establish criteria for plan approval, including standards for design, construction, operation and maintenance of agricultural drainage projects. To protect against sedimentation, flooding, nutrient runoff, and habitat loss, inspection and enforcement of plan compliance is carried out by the State. The legislation also provides a civil sanction for violations. Regulations to implement the statute are undergoing final review now. We are hoping to add additional staff to implement this program in future years.

SHORELINE EROSION CONTROL

The next program provdes for the abatement of shoreline erosion around the Chesapeake Bay and its tributaries. The shoreline erosion control program in the State before 1984 addressed only critical eroding areas and promoted structural controls such as bulkheads and riprap. Less critically eroding areas can be stabilized through less expensive vegetative means, using, wherever possible, clean spoil from maintenance dredging of channels to reduce annual dredging costs. Maryland has 376 miles of critically eroding areas (more than 2 feet per year of bank loss) and 965 miles where erosion is less critical. In 1984, we expanded the program to triple the current level of abatement in critical areas. We established a two-pronged nonstructural approach. One prong gave financial assistance to private landowners in the form of 50/50 matching grants. The second provided for State planning in conjunction with dredging projects. In addition, the Shore Erosion Control Loan of 1984 authorized $3 million for loans to property owners to continue structural shore erosion control.

To implement the program, operating funds of $300,000 were approved with a staff of five. The program is now operating with projects being actively designed and constructed. To facilitate implementation of the program, a number of workshops were held in the first year with the State Soil Conservation Committee, Federal soil conservation officials, and various county and regional agencies. Some of the FY'84 Chesapeake Bay implementation funds are also being used for nonstructural vegetative measures to reduce shoreline erosion.

CRITICAL AREAS COMMISSION

The next nonpoint source program involved the creation of the Chesapeake Bay Critical Area Commission pursuant to legislation enacted by the 1984 General Assembly. The purpose of creating the Commission was to establish a State policy of protection, restoration, and enhancement of the critical shoreline area surrounding the Bay and its tributaries, to the head of tide. Through a State/local partnership, the Commission works to develop and adopt protection plans for the critical shoreline area. The ultimate goal is to foster more sensitive development activities to minimize damage to water quality, natural habitat, and scenic values.

The shoreline areas of the Bay system are particularly fragile environments very susceptible to being adversely impacted by human activity. Pollutants associated with development in these areas may reach waters of the Bay and its tributaries in greater amounts than those associated with development in more inland areas. Before the existence of the Commission, some local governments in the State had established protection programs. However, as of 1984, there was no uniform protection program along the shoreline area. The Commission is now fully operational. Regional public hearings have solicited public comments on criteria for managing activities within the critical area. The Commission operates with approximately $500,000 per year of State general funds. We have high hopes that this nonpoint source program will be extremely effective over the long run in seeing that land in the critical area around the Chesapeake Bay will be used and managed to minimize water pollution. It has succeeded in raising the consciousness of many of our State's citizens to the important role their land plays in the overall ecological cycle.

RETENTION OF EXISTING FORESTLAND

The purpose of the retention of the existing forestland program is to maintain existing forest buffer areas around the Bay and its tributaries to intercept surface runoff and to infiltrate it to the forest soil profile before reaching the water. The program consists of several stages: (1) defining and mapping the critical land areas currently forested adjacent to the Bay and its tributaries; (2) providing technical assistance to landowners including the preparation of forest management plans; and (3) cooperating with local soil conservation districts in developing forested buffers as best management practices for agricultural land.

Approximately one-third of the land in Maryland's portion of the Chesapeake Bay basin is currently forested. In most cases, this land is subject to conversion to other less protective land uses. Program implementation involves foresters working with landowners in targeted areas around the Bay and its tributaries.

No new legislation was required to implement this program. Approximately $100,000 of State operating funds is being used for four forester positions. In the first half of FY '85, the new foresters developed five forest management plans covering 365 acres. They are also using student volunteers to compile the names and addresses of people owning forestland within the critical areas.

CONSERVATION EASEMENTS

The State program of acquiring conservation easements encourages private landowners to preserve and protect undeveloped or low density areas along the shoreline of the Chesapeake Bay and tributaries by executing easements pursuant to the existing Maryland Environmental Trust Easement Program. Easements offer landowners the opportunity to make an individual contribution to protecting the Bay. Because they are permanent, the total number of easements increases the amount of long-term protection.

The Maryland Environmental Trust program was started in 1974 to substantially increase the acreage placed under easements through cooperative efforts of the Chesapeake Bay Foundation. It was modified in 1984 to assist easement owners in identifying and putting into use conservation practices appropriate for their properties. A staff of three and operating funds of $60,000 per year were appropriated for this program. Easements so far in 1985 amount to about 2,000 acres, covering 3 miles of shoreline.

DREDGE AND FILL PROJECTS

Another nonpoint source initiative approved in 1984 was an expansion of the State water quality certification program pursuant to sections 401 and 404 of the Clean Water Act. The Office of Environmental Programs is expected to review approximately 2,000 construction projects each year for which water quality certificates are required by section 401. The Corps of Engineers may not issue a section 404 dredge or fill permit unless a State water quality certificate is issued. Certification is a process through which the State may ensure that certain conditions are attached to 404 permits. The increased staff will be able to review 250 to 300 permits per year and conduct 350 to 425 site visits per year related to these permits. This is an example of using an existing Federal program and the interest in the Chesapeake Bay to acquire the political support and resources to perform the job more effectively.

NONTIDAL WETLANDS

A cooperative program is designed to protect non-tidal wetlands with responsibilities shared by the State and county governments. Maryland's non-tidal wetlands are transitional environments existing as isolated entities or between open waters and dry land. These wetlands possess many of the same values as tidal wetlands. They have complex and extensive root systems that stabilize stream banks, reduce the velocity of sediment laden water, and trap sediments and pollutants contained in these waters. They also provide wildlife habitat and food, particularly to waterfowl and fur-bearing animals. However, current State law directly protects only tidal wetlands. Since 1973, Maryland has lost 14,150 acres of non-tidal wetlands. By comparison, only 250 acres of vegetated tidal wetlands were filled with dredge material from 1971 to 1983.

The initiative relating to non-tidal wetlands did not involve new legislation. Rather, it created funding of approximately $150,000 to: (1) encourage and assist local governments with the design and implementation of locally administered non-tidal wetlands management programs; (2) initiate a non-tidal wetlands resource assessment and monitoring system that will provide for a quantitative analysis of wetlands types; and (3) establish criteria for soil and water conservation plans to help maintain the integrity of non-tidal wetlands systems.

The new State staff has prepared a handbook regarding non-tidal wetlands protection and is preparing maps in cooperation with the U.S. Fish and Wildlife Service. The staff is expanding training programs and utilization of educational materials for the protection of non-tidal wetlands. Staff members organized and recently conducted a Chesapeake Wetlands Conference.

MINING (NONCOAL)

Another nonpoint source program regulates surface mining in the State. In 1975, the Maryland Surface Mining Act (Nat. Resour. Article, Section 7-6A-01) was passed. This law requires mitigation of the effects of land disturbance, elimination of hazards to public safety, and prevention of the waste of mineral resources. The law and regulations allow only licensed operators to obtain surface mining permits. To obtain a permit for a specific site, a detailed mining and reclamation plan is required, indicating the steps to be taken to minimize adverse environmental effects and to restore the landscape. The law also requires that a performance bond be deposited by the permittee. This bond is released only after satisfactory fulfillment of all permit conditions and completion of reclamation. In general, industry compliance with this program has been good.

A related program, funded by the Surface Mined Land Reclamation Fund (Nat. Resour. Article, Section 7-6A-04), provides for reclamation of existing abandoned mines and pits. The fund receives money from surface mine permit fees, forfeited bonds, and fines. In June 1981, we completed an inventory of abandoned mines. Priority sites are now being reclaimed using the current accumulated fund of approximately $800,000.

Failing Septic Systems

Maryland also controls on-site waste disposal systems. State regulations specify that domestic sewage or sewage effluent may not be disposed of in any manner that will cause pollution of the ground surface, ground water, bathing area, lake, pond, watercourse, or tidewater, or create a nuisance (Comar 10.17.02). A permit must be obtained from local health departments to on-site disposal systems. In addition, a second regulation provides that subdivision development may not be allowed where infiltration of individual sewage system wastes might result in ground water contamination (Comar 10.17.03). Violation of either regulation brings a $100 fine each day on which a violation occurs.

Presently, the State is considering adopting new regulations that would greatly facilitate the use of innovative on-site disposal systems. A demonstration project, using 201 construction grant funds, is testing a clustered mound system on Maryland's Eastern Shore. This innovative system is designed to serve more than one dwelling unit in a part of the State in which conventional septic systems frequently fail.

COAL MINING

The State created a Land Reclamation Committee (Nat. Resour. Article, Annotated Code of Maryland) some years ago to regulate strip mining for coal in the western portion of the State.

THE WISCONSIN NONPOINT SOURCE PROGRAM

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Nonpoint sources are land areas where activities, including land management, result in the transport of pollutants or contaminants, generally by runoff water, to lakes, streams, or ground water. Pollutants from point sources usually are discharged directly to waterbodies in fairly constant concentrations and amounts, whereas pollutants from nonpoint sources may follow transport paths which partially deposit them before they reach receiving waters. The concentrations and volumes vary greatly by season and year; therefore, nonpoint sources are usually more difficult to identify, and produce chronic degradation of water quality. Nonpoint source pollution problems also vary greatly between geographic regions of the United States and between individual States.

Water quality problems associated with organic and nutrient loads as well as sediment exist in areas of the United States where livestock-based agriculture is prevalent. In the Upper Midwest, nonpoint source pollutants from both croplands and livestock operations have degraded many surface water resources.

Since major portions of Wisconsin are in this critical area, officials recognized years ago that fishable and swimmable water quality will not be reached in many lakes and streams unless an aggressive program for controlling urban and rural nonpoint sources is pursued. The degradation of smallmouth bass and trout fisheries, accelerated eutrophication of inland lakes, and impaired water quality of the nearshore waters of Lake Michigan are examples of the water quality problems that require the control of both point and nonpoint sources. Water resources such as these are vital to Wisconsin's economy because of their important recreational use.

The Wisconsin legislature recognized this need and responded in 1978 by creating and funding the Wisconsin Nonpoint Source Water Pollution Abatement Program. The program was tailored to the nonpoint source needs in urban and rural areas of Wisconsin by incorporating aspects of various existing programs as well as devising new approaches.

Overall responsibility for the Wisconsin nonpoint source control program is assigned to the Wisconsin Department of Natural Resources, which administers both resource management and environmental protection (including water quality) programs. Cities, villages, and counties are assigned the responsibility for local implementation in project areas. In rural areas, this framework is designed to maximize local agency contact with individual landowners and is based as much as possible on existing agencies and institutions. In urban areas, this framework is designed to maximize city and village involvement.

PROGRAM PURPOSE AND OBJECTIVES

The basic purpose of the program is to systematically control nonpoint source pollution so surface water and ground water quality goals can be met within a reasonable timeframe. The program is designed to deal with the varying nature of nonpoint sources throughout the State. This includes sediments from croplands, construction sites, streambanks and grazed woodlots, and nutrient loads from barnyard runoff, cropland erosion, manure spread on croplands, and runoff from city lawns and streets.

The three major program objectives are: (1) to identify the most effective approach for achieving specific water quality objectives, and to provide adequate financial and technical assistance to landowners and operators to assist in installing of approved nonpoint source control practices; (2) to coordinate nonpoint source pollution control with other elements of the State's water quality program; and (3) to focus limited technical and financial resources in critical geographic areas.

The third objective warrants specific attention. Unlike many erosion control programs, the Wisconsin program (1) concentrates on entire hydrologic units rather than on random or political boundaries; (2) deals with all urban and rural categories of nonpoint sources rather than selected categories; and (3) relies on systematic processes to identify, rank, and select critical watersheds and portions of watersheds to receive comprehensive attention.

Single source management programs will achieve many onsite land management objectives and may achieve some pollution control. However, these programs often are of limited value in solving pollution problems arising in larger hydrologic units because of their scattered installation. The Wisconsin program concentrates available funds for technical and educational support into selected hydrologic units where maximum comprehensive improvements in water quality can be achieved.

This hydrologic unit approach, called the Priority Watershed Approach, allows all categories of urban and rural nonpoint sources within specific critical areas of a watershed to be identified and controlled through the installation of management practices. Specific areas within a watershed that contribute pollutants to lakes and streams are collectively called Priority Management Areas.

In addition to identifying problems and sources, the priority watershed approach has proven an effective framework for project implementation. Through Priority Watershed Projects, this approach concentrates available educational, financial and technical resources in those critical watersheds where maximum water quality benefits will result from investing money and personnel. To date, there are 26 Priority Watershed Projects in varying stages from project development to final implementation. Each project requires 1 year for identifying critical problem areas, 3 years for landowner signup, and 5 more years for installing control practices.

PRIORITY WATERSHED PROJECT OBJECTIVES AND CRITICAL SOURCE IDENTIFICATION

Selection of a Priority Watershed Project is followed by an 8- to 9-year planning and implementation process. An implementation plan is prepared based on a detailed inventory and assessment of critical source areas in the watershed and the project's water quality objectives. Generally, about 1 year is required to complete the assessment and prepare the plan. The Priority Watershed Plan consolidates water quality and land use information so the specific causes and critical areas contributing to the water quality problem can be identified and the most practical means of controlling the pollution can be developed. The plan guides the Priority Watershed Project and details procedures and responsibilities to help local staff work more effectively. It can also be important educationally by showing the cause and effect relationship between land management and water quality.

Central to each Priority Watershed Project are the water quality objectives identified for its lakes and streams. The determination of critical pollutants, significant sources, the level of desired nonpoint source pollutant load reduction, and the measurement of accomplishments are all based on these specific water quality objectives. In addition, the severity of water quality problems and the attainability of water quality objectives are primary factors in selecting projects.

Pollutant impacts on water resources must be understood to determine water quality objectives. The objectives must be based on potential use. However, with objectives related to nonpoint sources, the type of impairment rather than the numerical criteria commonly used for instream standards is more important. Impairments such as degraded fish habitat caused by sedimentation of the bottom substrate, which commonly occurs in many of Wisconsin's trout streams, do not relate well to numerical standards. Identifying water quality problems and objectives in Wisconsin depends, to a large degree, on biological and physical techniques that relate to the type of impairment and use. Reliance on chemical parameters alone could easily result in many impaired uses being overlooked. Biological indicators often integrate fluctuations in chemical parameters and retain an overall measure of water quality impacts for a long period of time. Identifying water quality objectives in this manner requires the efforts of aquatic biologists and fish managers.

In Wisconsin, some of the water quality objectives identified for Priority Watershed Projects are: (1) protection of the nearshore waters of Lake Michigan, (2) rehabilitation of a warmwater fishery, (3) rehabilitation of a coldwater fishery such as the upgrading of a trout stream through habitat improvement, (4) protection of a desired warmwater fishery, (5) protection of a desired coldwater fishery, (6) rehabilitation of an inland lake, and (7) protection of an inland lake.

With the variety of dairy and cash crop farming and urban land uses in Wisconsin, water quality problems are seldom caused by a single type of nonpoint source. Thus, a categorical approach, one that deals just with one category of sources, such as eroding croplands, will not be effective in controlling nonpoint source pollution. Conversely, involving all landowners is inefficient and not cost effective because not all land management activities contribute significantly to the water quality problems.

A comprehensive assessment of all nonpoint sources is conducted prior to implementing a Priority Watershed Project. Barnyards, fields where manure is spread, eroding streambanks, eroding croplands, construction sites, and existing urban areas are all inventoried. These inventories enable more efficient use of time and money during implementation. For example, 25 to 50 barnyards can be inventoried in the time required to design and install barnyard runoff controls on one or two barnyards. Thus, substantial time and money are saved by not designing and installing practices for barnyards that might have been considered significant using less detailed or more subjective inventories.

DEVELOPMENT OF IMPLEMENTATION STRATEGIES

An equally important and potentially overlooked program aspect is design of the project and the detailed strategies for implementation. Currently, implementation strategies include detailed landowner contact lists based on the results of watershed inventories. These lists are accompanied by a preliminary assessment of the severity and extent of nonpoint sources for each operation on the lists. Project implementation strategies also identify and schedule educational activities, outline fiscal management procedures, discuss preliminary project budgets, and estimate staff needs.

STATE BUDGET SUPPORT

Wisconsin provides financial support in three major categories: (1) cost-share funds for landowners and municipalities to install management practices; (2) aids for local governments to fund additional technical assistance, education and information, and financial and project management; and (3) administrative and planning funds for State administration and preparation of Priority Watershed Plans.

Individual management practices are cost shared at 50 to 70 percent of the installation cost. Higher cost-share rates are used for practices where the capital costs for installation are high and the offsite water quality benefits exceed the landowner's onsite benefits. Since 1978, the State has appropriated over $23 million to implement the nonpoint source program. Over 80 percent of these funds have been used to help landowners install control practices.

MANAGEMENT PRACTICE PACKAGE APPROACH

Since effective management practices must operate as systems, the Wisconsin cost-share agreements must contain all management practices necessary to control nonpoint sources on each participating farm or municipality. The landowner or land manager may not limit participation to the practices most directly useful. This approach is similar to the Experimental Rural Clean Water Program, but is quite different from that of the traditional Agricultural Conservation Program. Many installed practices and nonstructural controls would not be applied without the systems package requirement.

ACCOMPLISHMENT TRACKING

Wisconsin's program also includes progress or accomplishment tracking. Accomplishment indicators have been used to some degree in all projects and are being used to a greater degree in new projects. The accomplishment indicators used: (1) relate directly to the water quality objectives and the pollutants causing the problems, (2) relate to the type and significance of the sources to be controlled, so that pollutant load reductions can be calculated, (3) provide feedback to the implementing governmental unit so progress can be determined on a frequent basis, and (4) provide sufficient detail on the location and level of control to guide and interpret monitoring results.

SUMMARY

Although participation by landowners and operators is voluntary in this State funded program, substantial pollutant load reductions have been achieved in Priority Watershed Projects. However, no voluntary program will achieve the desired levels of control in all situations. In those cases, regulatory mechanisms must be considered.

The elements of the Wisconsin program are designed to effectively and efficiently achieve water quality objectives impaired by nonpoint source pollutants. These program elements, along with the experiences gained during the past 6 years, have resulted in a program structure that is well defined and adaptable to changing needs. Different areas have different needs and existing institutional structures. However, the principles used as the foundation for the Wisconsin nonpoint source control program can be applied to developing effective programs to control a variety of nonpoint source problems in any State.

Institutional/Financial Aspects of Nonpoint Source Controls

BRIDGING THE GAP BETWEEN WATER QUALITY AND NONPOINT SOURCE ACTIVITIES: A CONTINUUM OF INSTITUTIONAL ARRANGEMENTS

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ABSTRACT

Successful nonpoint so rce control implementation requires devising institutional/legal arrangements to draw formally the various interests and agencies responsible for Best Management Practices (BMP's) into the water quality management process; yet, at the same time, formalize the role of the State Water Quality Management (WQM) agencies. EPA and the New England States have established an array of mechanisms by which State WQM agencies formally involve the State forester, timber industry, construction industry, and agricultural interests in activities ranging from technical assistance on BMP certification and plan review to limited inspection. Corresponding mechanisms for backup enforcement by the State WQM agency, Attorney General, and EPA vary. This presentation outlines and evaluates the experience with these mechanisms over the past 5 years, suggesting improvements, refinements, or new mechanisms for the future. The evaluation covers a continuum of measures from the voluntary to backup enforcement, and from private to public responsibilities.

INTRODUCTION

Nonpoint sources (NPS) by definition are diffuse, widespread, and subtle. Their control touches the daily lives of countless individuals, groups, and enterprises. Best management practices (BMP's) to control nonpoint pollution must become integrated in diverse activities through a mix of informal and formal, or voluntary and contractual relationships—sometimes labeled nonregulatory and regulatory.

Nonpoint source programs include both formal and informal steps: formal standards setting, informal education and technical assistance, followed by formal inspection and enforcement. First, Federal/State water quality management agencies must formally adopt water quality standards and criteria under the water pollution control laws prohibiting discharge of pollutants into the waters of the Nation.

Then, informal, voluntary education, technical assistance, inspection, and self-policing programs may help people adapt their activities to prevent or reduce NPS pollution. Informal education and technical assistance efforts must reach the farmer in the field, the logger in the woods and the builder on the back lot. Often, the most effective way of reaching them is through associates who share their interests, professional knowledge, or community values.

The final step, formal inspection and regulation, must be waiting in the wings as backup. Here, the State Water Resources investigator and the compliance officer become involved. If violations persist, the attorney general may prosecute. Finally, the responsible Federal or State agency must evaluate the effectiveness of the informal arrangements in carrying out the formal mandates of the laws, standards and prescribed BMP's.

A Continuum of Formal and Informal Arrangements for Water Quality BMP's

For successful nonpoint source control, the institutional arrangements must draw those affected by the controls into the formal water quality management process. The formal environmental agency objectives, standards, and BMP's must be incorporated into diverse economic activities. Usually, water quality objectives and BMP's can be best integrated into these activities through informal arrangements involving fellow workers or professionals, friends, or neighbors in whom the operator places personal confidence and trust. At the same time, the formal mandate for the public interest must be met. Social scientists have developed a body of theory on the role of informal and formal groups in the adoption of new practices (Homans, 1950; Spicer, 1952; Wilkening, 1950).

This presentation outlines and evaluates experience with informal, voluntary arrangements for providing education and technical assistance and, in some cases, inspection and compliance to carry out the mandate of the formal Federal/State standards. It suggests improvements, refinements, and conditions for success of various approaches.

Though programs are labeled regulatory and nonregulatory, in practice nonpoint source programs entail a series of formal and informal steps using a range of approaches: formal for setting standards; informal for education, technical assistance, and initial implementation; and formal for backup enforcement if informal efforts fail.

Informal arrangements are most appropriate for activities that are dispersed, intimately associated with family operations, voluntary in contrast to contractual, and rural in contrast to urban. Generally, activities rank in order from the informal/voluntary to the formal/contractual in the following order: agriculture, forestry, on-site waste disposal, individual home construction, oil and hazardous materials handling, and large-scale construction.

The major types of institutional arrangements bringing formal programs closer to the people are:

1. **Voluntary associations.** Enlist voluntary associations of the industry or activity that the formal agency is trying to reach, e.g., trade associations and lake or watershed associations.
2. **Professional affiliation.** Enlist fellow professionals. They can be presumed to be more knowledgeable and understanding of one's activities and problems, even if they have formal regulatory responsibilities.
3. **State programs with local option.** Involve localities, regional agencies or district. Local governments are perceived to be more responsive to local needs and activities than State or Federal agencies:

Case Evaluations

The cases to be evaluated cover a continuum of measures from the informal/voluntary to the formal/contractual, demonstrating both private and public responsibilities. The cases range, in order of increasing formality, from the Vermont Timber Harvesters and Truckers Association self-policing program, New Hampshire regulations on earth-disturbing construction and forestry activities, and Massachusetts Minimum Forest Cutting Practices Regulations, to Maine and Vermont Statewide Environmental Laws with Local Option.

Vermont Timber Truckers and Producers Association

To help implement BMP's for forest practices recommended in the Vermont Water Quality Management Plan, 5 years ago the Vermont Timber Truckers and Producers Association set up a Committee to provide education and technical assistance and to investigate complaints. The Association, made up of over 200 loggers, truckers, mill owners and operators, landowners, and professional foresters, reflects the logger and his values, reaching out to him through his own peers. (Vt. Timber Truck. Prod. Assn., 1984).

Initially, the Vermont Timber Truckers and Producers Association, the Vermont Agency for Environmental Conservation, Cooperative Extension Service, and Soil Conservation Service jointly prepared a pocket handbook, Guide for Controlling Soil Erosion and Water Pollution on Logging Jobs in Vermont, and conducted workshops with loggers throughout the State (Vt. Agency Environ. Conserv., 1979). The booklet and workshops were funded by a grant from the U.S. Environmental Protection Agency.

To follow up, the Vermont Agency of Environmental Conservation refers complaints about logging jobs polluting streams and lakes to the Vermont Timber Truckers and Producers Association. A local Association committee member visits the site with the logger to investigate the complaint. If there is a problem, the committee member encourages the logger to apply the appropriate BMP's. If the logger does not voluntarily comply, the case is referred to a State Water Resource investigator for formal investigation, technical assistance and possible legal action. A violator risks having his job shut down and may be subject to fines of up to $25,000 a day under the laws governing turbidity and discharge of pollutants.

The process for registering complaints, followup, and reporting results is formally spelled out for the public record. The steps are clearly outlined on a Department of Water Resources form: location, nature and source of complaint; investigation and followup action by an Association committee member; results of reinspection; and action taken in case of noncompliance. Figure 1 is a copy of the Complaint Record Memo.

Two years ago, the Association, Agency of Environmental Conservation and other parties held a workshop to review the progress of the program, to emphasize the continuing mission, and to motivate those involved.

The program's success can be measured by the voluntary adoption of BMP's as a routine part of logging operations and by the decline in complaints. Settling basins are now installed in the course of clear-cutting. A major paper company requires filter strips and water bars as part of the job, holding back $1.00 a cord in payment to the logger until BMP's have proved successful. The volume of complaints has fallen nearly 75 percent since the beginning of the program 5 years ago. Only one problem has been referred to the Attorney General. This decline in complaints occurred during a period of increased logging, increased clear-cutting, and heightened concern over water quality. The State's Water Resources investigators find that involvement of fellow loggers in education and enforcement encouraged adoption of BMP's. They are satisfied that adequate BMP's have been chosen and implemented.

New Hampshire Statewide Erosion and Sediment Control Program

The New Hampshire Water Supply and Pollution Control Commission amended its dredge and fill regulations under the Water Pollution Control Statutes (RSA 149:8-a) on April 18, 1981, to require permits for timber harvesting and construction activities that significantly alter the terrain or affect water quality (N.H. Water Supply Pollut. Control Comm., 1982). Anyone undertaking earth-disturbing activities must obtain a permit from the Commission for commercial logging or for residential or commercial construction affecting over 100,000 square feet in or adjacent to surface waters.

Under the forestry permit, an operator acknowledges familiarity with and agrees to apply BMP's such as those outlined in New Hampshire's pocket handbook, Timber Harvesting Practices for Controlling Erosion (N.H. Water Supply Pollut. Control Comm., 1979): State forest rangers advise operators on these practices. If voluntary efforts fail and complaints are registered, the Water Supply and Pollution Control Commission investigates and issues cease and desist orders. The Commission devotes the equivalent of one full-time person to inspection and enforcement. As many as one or two cease and desist orders are issued per week.

Before the program began operating (1980–83), complaints averaged five a week, but now have fallen to two a week. Of these, approximately 60 percent are resolved at or near initial contact.

Department of Water Resources

COMPLAINT RECORD MEMO FOR LOGGING JOBS

To Be Completed by Water Resources Investigator.

Report No.............. Date Rec.., 19....... Time.................................. A.M. P.M.

Complaint by .... Address ....

Phone..

Received by .... Title ....

Screened by .... Date......................., 19....... Time........................ A.M. P.M.

Nature of Complaint:

☐ Siltation of ☐ Stream ☐ Pond ☐ Other

☐ Tree Tops in Stream

☐ Skidding through Active Stream

☐ Other

Explain: ....

....

....

To be Completed by Vermont Timber Truckers and Producers Association Committee Member

Person Investigated—

Name.. Phone ....

Address..

Date Contacted ...., 19....... Committee Member ....

Exact Location of Log Job ....

....

Cause of Complaint ....

....

....

Recommended Action to Eliminate Problem:

☐ Install water bags or dips ☐ Relocate landing

☐ Mulch or seed landings or skid paths ☐ Remove treetops or brush from stream

☐ Bridge stream ☐ ....

Reinspected by .... Date ....

Water Quality Problem Eliminated ☐ Yes No ☐

Signature of Committee Member ....

NON COMPLIANCE ONLY

Turned over to Water Resources Investigator Name..

Date................................., 19.........

Action Taken ....

....

Figure 1.—Complaint form used in Vermont was developed by a committee from the Vermont Timber Truckers and Producers Association. This self-policing program represents high cooperation among private industry, State, and Federal personnel.

Unlike Vermont, New Hampshire has not formalized or publicized procedures for referring violations from the State forester to the Water Supply and Pollution Commission for investigation and enforcement. Fewer than 20 percent of the complaints were made after encouragement by the foresters; approximately 80 percent came directly from the public. Some foresters have been more involved that others, as would be expected. In addition, the Cooperative Extension Foresters have limited their role to educational activities, avoiding involvement with the regulatory activities of the Commission. Without formal procedures, the State and Extension foresters may not feel comfortable taking action or reporting violations to the Commission. Split authority makes "buck passing" a concern.

Under a construction permit, an applicant submits a plan for erosion/sediment control measures, runoff treatment, and flood management. Drawing on the Durham, New Hampshire, National Urban Runoff Project (U.S. Environ. Prot. Agency, 1984), the Commission has worked with builders and designers to develop design criteria for swales and vegetative surfaces to absorb runoff. Commission staff site visits may lead to redesign or subsequently to enforcement. All applications are ultimately approved, with conditions. The Commission staff feels that applicants prefer to negotiate on reasonable conditions rather than incur costs in delays in approval. Only a couple of permit violations have been reported. A very small percentage (5 to 10 percent) of construction activities are undertaken without a permit, according to staff.

Workload and staff limitations preclude much attention to followup visits and compliance monitoring. An average of two applications per day are received with as many as five per day during the peak construction season. Aside from a special coastal officer, the Commission can devote the equivalent of only one staff-year to the program throughout the State, including the rapidly developing south central Interstate 93 corridor. Efforts are limited to reviewing applications, with limited site evaluation. Site visits average three to five per week. Few followup visits for compliance monitoring take place. Coastal Zone Management grants provide an additional officer to serve the seven coastal towns. This officer is able to work more closely with the towns and applicants. The officer can visit each site and conduct followup inspections. On the basis of the success demonstrated in the coastal towns, two officers would be added to followup compliance throughout the State if funds were available.

No cases have been referred to the attorney general during the past few years because of the State's enforcement priorities.

Massachusetts Minimum Forest Cutting Practices Regulations

Massachusetts has recently undergone a metamorphosis from a rarely enforced formal law on the books toward regulations perceived as more practical, more informal, and in most parties' mutual interest. On January 1, 1984, the Massachusetts Division of Forests and Parks adopted new Minimum Forest Cutting Practices Regulations (Ma. State Forest. Comm., 1984) requiring operators to file a cutting plan. The plan includes BMP's to protect water quality, such as filter strips and road and skid trail standards. The State foresters and wardens review and approve the plans and follow up on compliance. Local conservation commissions can notify the State foresters of concerns and violations.

This type of regulatory program only recently gained acceptance as a realistic way to implement a long-dormant law, on the books since 1943, requiring forest plans and cutting permits. Several mutual interests converged to support the change. The timber industry sought minimum standards applicable to all operators to assure equitable competition in the face of alleged fly-by-night operators who would bid high, disregard cutting standards, and leave landowners dissatisfied with harvesting timber. Several towns had recently adopted their own individual regulations, setting a trend toward crazy quilt regulation. For the first time, new State Wetlands Protection Regulations specified minimum cutting practices, but exempted an operator from the more lengthy and complex wetlands regulatory process if he had a State-approved forest cutting plan (Ma. Dep. of Environ. Qual. Eng., 1983). Loggers felt more comfortable in dealing with State foresters than with local conservation commissioners.

Despite past opposition to this regulatory scheme, the various parties now express satisfaction. Though site visits are mandatory only for wetlands or steep slopes, the foresters or wardens have actually been visiting most sites, educating loggers on BMP's. Landowners and loggers are just learning of the new regulations so considerable cutting is taking place without plans. The importance of publicity that actually reaches landowners and loggers cannot be overstated.

State Programs with Local Option

Maine and Vermont have statewide minimum standards for new development. Maine gives localities the option to administer their own programs, while Vermont delegates administration to nine districts, retaining a greater degree of State control.

Maine's statewide environmental laws, notably the Shoreland Zoning Act and the Site Location Act, provide statewide minimum standards and a framework within which localities can play as formal or informal a role as they choose (Maine State Plann. Off., 1984). Effectiveness depends on the degree of local initiative, the dedication of resources, and, above all, the will to exercise persuasion, approval/denial, and enforcement. Communities have the opportunity to adapt laws to local conditions, but, by the same token, they can remain passive participants in a local network of intergroup and personal relationships that condone lax practices and violations.

The role of local code enforcement officials is being formalized so that the responsible individual acquires a sense of professionalism and an official role beyond the network of local, often familial, relationships.

For over 10 years, State trained and certified evaluators have determined the suitability of sites for septic systems. Certification has formalized their role and set public expectations that they will follow the law. In 1984, the Maine Legislature considered requiring local code enforcement officers to become certified through training. Although the requirement did not pass in its entirety, certification is now a prerequisite to presenting cases in court. This eliminates the extra expense of hiring special legal counsel, giving towns a financial incentive to train their code enforcement officers.

Vermont's statewide land use and development law, Act 250 sets up the most systematic formal statewide framework for regulating land use activities (Vt. Environ. Board, 1982). A State Environmental Board sets policy and hears appeals. Nine District Environmental Boards review and pass on permit applications, including all forestry, construction, and earth-disturbing activities above 2,500 feet elevation. Although the District Boards are appointed by the Governor, they try to involve localities and bring education, technical assistance, and regulation closer to the people. Districts vary in their handling of environmental issues—a problem associated with some informal approaches.

Evaluation: Conditions for Strengths & Weaknesses

Reviewing strengths and weaknesses of these approaches can help tailor voluntary approaches for different situations.

Voluntary Associations

Voluntary associations offer the following advantages:

1. Because of close relationships and trust, often, peers can best arouse concern about water quality and suggest controls.
2. Fellow workers may be able to tailor effective yet acceptable controls.

Disadvantages are as follows:

1. Fellow workers may find it difficult to criticize or take exception to their peers' operations or practices.
2. Fellow workers may be unduly influenced by the interests of the operator or by personal relationships. Peer pressure cuts two ways.
3. A recalcitrant operator may not respect or accept his peers' advice. He may seek the authority of an official agency.
4. The public may not know how to refer or follow up on complaints.

Professional Affiliation

Professional affiliation offers the following advantages:

1. Fellow professionals respect one another.
2. Operators look to professionals in their field of activity for information and advice.
3. Professionals can often prescribe the most effective and acceptable BMP's tailored to the situation.

Disadvantages are as follows:

1. Fellow professionals may be more concerned about the economic interests of the operator than about water quality.
2. Professionals may be set in conventional ways of doing their business, closing out consideration of some BMP's.
3. Professionals in one sector may be reluctant to refer failures to those in another, especially to regulators.
4. The public may not understand that the formal agency has a responsibility when the professional does not secure compliance.

Statewide Programs with Local Option

Statewide programs with local option have the following advantages:

1. State standards assure a minimum program throughout the State.
2. Mandatory provisions provide an incentive for localities to enact laws and develop programs.
3. Localities can tailor the programs to local situations, including special concerns and needs.
4. Localities can adopt higher standards than the statewide minimum.
5. Localities can informally and formally keep in closer touch with activities, problems, and violations than can distant, limited State agency staff.

Disadvantages are as follows:

1. Statewide minimum standards can reduce local standards to the lowest common denominator.
2. Local officials can remain bound to local interests rather than broader public environmental interests.
3. Localities may lack the resources or expertise.
4. States and localities may pass the buck, each feeling the other should act or take the heat.

CONCLUSION: CONDITIONS FOR TAILORING EFFECTIVE FORMAL AND INFORMAL INSTITUTIONAL ARRANGEMENTS

With all informal/voluntary institutional arrangements, the greatest problem is involvement in and loyalty to the system, rather than to environmental quality. The formal environmental agency must clearly define ultimate responsibility under its mandate. The public must have a clear understanding of the reciprocal responsibilities of the formal public agency and the informal arrangements. If the informal arrangement fails, the public must know its rights and procedures for referral and followup action by the public agency.

Informal/voluntary arrangements appear to work most effectively when:

1. The voluntary association or group depends on environmental quality for its continued livelihood or cares intensely about the environment in its value system;

2. The voluntary association has a stake in maintaining minimum standards that eliminate unfair competition and insure equity. Fly-by-night operators using short cuts lower potential competitors' costs.

3. Professional loyalties and standards transcend individual or local interests. For example, loggers, timberland owners and consulting foresters and engineers perceive a professional bond with State foresters. They accept their advice, usually voluntarily. Even though the public forester is a regulator, he is also a fellow professional.

4. Professionals in the operator's field have specialized knowledge of BMP's tailored to his activity. The operator perceives that they have this expertise.

5. Local officials have status so that fellow citizens expect them to transcend the local web of personal relationships and loyalties. The community has come to expect the site evaluator, for example, to follow the law.

6. The State or Federal environmental agency formally states the law, standards, criteria and procedures within which the voluntary association or professional is to operate. Roles and responsibilities are clearly defined.

7. Staff of the public agency and of the informal association, profession, or locality cooperate in a relationship of mutual trust and concern for the environment.

6. The landowner and operator are fully aware of their responsibilities to submit plan applications and carry out BMP's. Education programs are tailored to reach all landowners and operators.

9. The role of associations, professionals, or local officials in environmental programs is clear not only to the public agency and to the responsible group, but also to their respective constituencies and the public. Support is essential to their public interest role. It lets the public know what is expected of the group. It makes them accountable. Further, it lets the public know what specific remedies are available should voluntary action fail.

10. Referral procedures are agreed upon, specified and widely publicized. In several cases, the public was not aware that the environmental agency would take action if the professional voluntary association failed to act.

11. Backup enforcement by the environmental agency is certain and prompt. Demonstrated investigation and enforcement action encourages voluntary BMP's. If enforcement standards are unclear and enforcement inconsistent, the voluntary program loses credibility. Violations persist, requiring more agency staff time.

12. The formal agencies and parties to a voluntary program meet periodically to evaluate progress, refine the program, and reaffirm their responsibilities. Continuing publicity is essential.

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THE UTAH AGRICULTURE RESOURCE DEVELOPMENT LOAN PROGRAM

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ABSTRACT

In 1983, the Utah Legislature provided $2.4 million for soil and water conservation practices to the Utah Agricultural Research Development Loan (ARDL) program. Loans are made at a 3 percent interest rate with a one-time 4 percent administrative fee and a maximum 12-year loan length. The Utah Soil Conservation Commission administers the program and local Soil Conservation Districts are responsible for plan approval. After 2 years of operation, over $11 million has been loaned to farmers for conservation work. The ARDL program is divided into three categories: (1) the regular ARDL program for soil and water conservation practices; (2) the watershed program for conservation and water quality practices in special targeted areas; and (3) the emergency conservation program. This program has been successful in implementing conservation practices and improving water quality in Utah. The program is a revolving fund loan and provides operators with an incentive to install practices that benefit the public at a low cost to the taxpayers. Utah is currently the only State in the Nation operating a program of this kind.

In 1976, the Utah legislature provided $250,000 and began the Rangeland Development Fund. Over the next several years this fund continued to provide low interest loans to applicants for making range improvements.

This fund was expanded in 1983 to $2.48 million to include cropland conservation measures. This program is under the direction of the Utah Soil Conservation Commission and staff support is provided by the Utah Department of Agriculture. The Soil Conservation Service in Utah agreed to provide technical assistance to begin conservation measures under the direction of the local soil conservation districts.

The program was expanded because of Federal budget cuts and a growing need for conservation in the State. The Utah Soil Conservation Commission lobbied the legislature for a 20-year plan that would result in an $80 million revolving loan program. Approximately half of the initial request was met by the legislature and they have demonstrated a continuing commitment by providing an additional $1.9 million in fiscal year 1985 and $2 million for FY 86. In addition to these appropriations, the legislature chose the loan program as a vehicle to assist farmers damaged by flooding, allocating an additional $3.6 million for emergency measures.

The loans are available to all farmers and ranchers in the State for use on private and State lands. Loans are made at a 3 percent interest rate and carry a one-time 4 percent administrative fee. The maximum life of a loan is 12 years and conservation practices must be maintained at operator's expense for the full life of the loan.

Early in the program it was recognized that local soil conservation districts represent a valuable and underutilized resource. These district supervisors are most aware of the resource needs for their respective areas. Rather than add to State staff for program administration, the Commission turned to these local districts.

The districts pooled their resources through the Utah Association of Conservation Districts and created a framework to assist in the administration of the program. The State is divided into six zones, each comprised of six or seven districts. Loan funds are allocated to the zones by the Commission based on resource needs as demonstrated by loan applications received and annual plans and reports. The zones then allocate funds to the local districts. The districts are responsible for receiving and processing applications, as well as approving plans and monitoring projects. A local supervisor monitors each project (Fig. 1).

To assist the zones and districts, the Utah Association employed three regional coordinators. These coordinators provide staff support for the loan program and other district educational and resource activities. The State did not increase its staff. The 4 percent administrative fee is distributed as follows: 1 percent to the State for program administration; 1 percent to the district in which the loan originates; and 2 percent to the Utah Association for the regional coordinators.

The program's early success was due to two critical factors. First, the program was decentralized and resource needs determined at the local level. This gives the program grass roots support and uses the potential of local districts as resource managers. The second critical factor was the support of the Soil Conservation Service (SCS). The State SCS and local officers totally supported the program and agreed to provide technical assistance. SCS participated in the development of program guidelines and is an ongoing partner.

Conservation practices eligible for funding under the program are essentially the same as those eligible under the Agriculture Stabilization and Conservation Service, Agriculture Conservation Program (ACP). These practices were adopted by the Commission with only slight modifications. It was felt that the broadest set of practices should be made available for selection as local districts determine which activities are necessary and appropriate for their areas.

In addition to the regular program, the Commission recognized that special needs may exist across the State. To meet these needs, the Commission established the priority watershed program and energy conservation program and made special funding set-asides. Later, the emergency program was added to meet the needs of farmers and ranchers damaged by flooding.

The ARDL watershed subprogram was set up to meet special conservation needs in priority areas. Projects un-

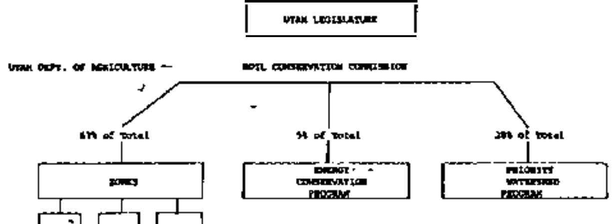

Figure 1.—ARDL fund allocation process.

der this program are designed to control water pollution, erosion, or flooding. The strategy behind these projects is to improve the entire watershed and to develop a coordinated approach to watershed improvements. The guidelines require the Commission to designate priority watersheds and focus attention on these areas.

The Upper Weber and Upper Provo River drainages provide most of the drinking water needs for residents of the Wasatch Front (Utah's most populated area). These rivers are also the main channels for heavy spring runoff experienced along the Front. As the headwaters and source of Utah's most important water resources, the high watersheds have been recognized by the Utah Soil Conservation Commission, Utah Department of Health, and Soil Conservation Service as being the most critical areas for improvement in the State.

The Commission has established watershed funds for use exclusively in these designated areas. To meet the technical demands resulting from these projects, funds have also been set aside from the watershed grant fund. The purpose of these funds is to provide program coordination and assistance for project implementation within the priority areas.

This designation and special funding is intended to provide many benefits within the priority area. Targeting will offer the opportunity for extensive and coordinated use of conservation measures. The priority areas have major conservation, water quality, and flood control needs that cannot be adequately addressed through the regular program.

Early in 1984 the Utah Soil Conservation Commission appointed a subcommittee known as the Priority Watershed Committee to look at these problems and to help develop solutions. The Committee consists of representatives from Wasatch, Summit, Morgan, and Kamas Valley soil conservation districts.

The main goal of the Committee is to begin projects that will meet the needs of the watershed and to facilitate other projects. The Committee has met with several other agencies and discussed developing joint projects. Wasatch, Morgan, and Summit Counties have been involved in streambank improvements and other watershed treatments. In addition, the Weber Basin Water Conservancy District has begun projects in this area. The Priority Watershed Committee is coordinating the efforts of many agencies involved in watershed protection, providing funding as well as guidance for priority projects. The Committee has also assisted in providing technical assistance for many watershed improvement projects.

The priority watershed program has gained the support of the Soil Conservation Service, Utah Division of Wildlife Resources, local counties, and State and local water quality agencies. The following projects have been approved for funding:

Streambank improvements	$ 75,500
Animal waste control	$ 58,000
Range improvements	$103,500
Irrigation water management for water quality	$218,900
	$455,900

These projects have resulted in multiple benefits to the watershed area. Water quality has been improved through the control of animal wastes and sediments; streambank erosion has been controlled by placement of riprap; and streamside vegetation and runoff waters have been reduced through increased infiltration of water into improved rangelands.

Perhaps most important, the Committee has provided a mechanism for coordinated action to avoid duplication and ensure that projects do not have a detrimental effect on the environment or downstream users. This Committee is beginning to become a force in the watershed area for dealing with critical needs in a coordinated manner. Through its contacts, the Committee will provide technical assistance for projects, assist in obtaining permits, and set priorities for program implementation.

The Commission set aside 5 percent of the total program funding for energy conservation projects. This program is administered by a special subcommittee with representatives from Utah State University Extension Service, Utah Energy Office, and Utah Power and Light. Projects approved to date include conservation tillage, hydroelectric generation, and irrigation water management programs.

In 1983, Utah experienced the devastation of a 100-year flood. Although much of the reported damage occurred within developed communities, farmers and ranchers across the State suffered large losses. Most land in Utah adjacent to streams is currently in agricultural use. Utah Lake and the Great Salt Lake are swallowing large portions of pasture and cropland. Again in 1984, flood damaged many acres of quality agricultural lands. Thousands of acres of crop and pastureland have literally been washed away and many more acres have been covered with water, gravel and sediment. Diversion structures, canals, irrigation systems, fences, and farm roads were destroyed during these periods of high runoff.

The Utah Department of Agriculture documented over $71 million in physical damages, crop, and livestock loss during 1983. During 1984 the Department recorded nearly $13 million in agricultural damage.

The Utah legislature provided $3.6 million in 1983 and 1984 in low interest loans to farmers and ranchers for flood damage and prevention. These loans were used to restore irrigation structures, diversions, level land, clear debris, restore land fertility, rebuild fences and roads, stabilize streambanks, and install measures to reduce the risk of future flooding.

These emergency loans were channeled through the Utah Department of Agriculture to the Utah Soil Conservation Commission. Local soil conservation districts assessed and reported damage to the Department and made requests for emergency money based on these assessments.

The sum of $1,972,500 was loaned to repair irrigation diversion systems, canals, laterals, fences, debris removal, clearing, and releveling. Of that amount, $700,200 was dedicated to streambank protection and stabilization and for measures to prevent or reduce the risk of damage from future flooding.

SUMMARY AND CONCLUSIONS

The Utah ARDL program is still evolving. The State and the Commission have only 2 years of experience with the expanded program. Yet, early signs are positive. To date, over $11 million has been put into conservation projects across the State. These projects have protected soil and water resources, improved water quality, and reduced the risk of damage caused by flooding.

Perhaps the greatest achievement of this program is the revival of the local soil conservation districts. These districts, in their role as natural resource managers and water quality management agencies, have great potential for protecting and improving water quality.

The local districts have the support of area landowners, are locally elected, and understand the problems of their areas. Through the loan program the districts have a meaningful function. They have been given a reason to evaluate the resources in their areas and to set priorities for implementation. Several districts have become involved with county planning agencies and are working cooperatively on resource issues. The districts are gaining an understanding of how they might affect the resource base and many are undertaking broad programs to benefit the land, water, and the people living there.

The Soil Conservation Commission is supporting the development of the districts, seeing them as the alternative to Federal funding. Staff support has been provided to the local areas and the loan program emphasizes local control. Other State grant programs are being applied to district programs and additional resources are being sought from the legislature to support this program.

The response of landowners to the program has also been positive. Because the program is a loan, some of the reluctance to accept grants has been removed. Farmers feel more responsible for the project, heightening their sense of achievement. While there has been an overwhelming response to the program and applications exceed available funds, some practices are still undersubscribed. Some of the soil conservation and water quality practices with a low economic return, such as terraces or animal waste control systems, do not receive much attention. These practices often require the additional incentive of an ACP cost share used in conjunction with a loan. The State set-asides are used to balance out the funds used for any particular type of project.

The State has also tried to minimize the paperwork required for processing loans. State regulations are less cumbersome than those for the Federal ACP; however, some landowners are still reluctant to fill out the required forms and many balk at the financial statements.

Overall, the program has succeeded in getting conservation on the ground. There are administrative problems in processing loans, and set-asides have not proven extremely successful in attracting desired projects. Currently, the Commission is exploring alternatives such as varying the interest rate for different practices to encourage some desired applications. Many other changes are due as the program matures, but the groundwork has been laid for a successful, long-term program that will enhance the natural resource base of the State of Utah.

ARDL APPLICATION PROCESS

I. First District Board Meeting

A. Applicant completes application form.

B. Soil Conservation District (SCD) Board reviews application. Checks for completeness, preliminary indication of credit made, and application screened to determine if request complies with ARDL program.

C. Application will be approved or disapproved for planning. The applicant will be notified in writing by the SCD Board as to decision and given a financial statement form to fill out and send to the Soil Conservation Commission (SCC).

D. Technical assistance is assigned by the SCD Board to develop conservation plan for the approved applications.

E. SCD Board assigns a supervisor to track application progress and planning.

II. Interim

A. Individual applicant sends financial statement and supporting data as required on the financial data request form to the Soil Conservation Commission (SCC) within 15 days.

B. SCD Board sends copy of completed application form to the Zone Coordinator (ZC) and ZC in turn forwards application to the SCC.

C. Technical assistance agency develops plan with the individual.

D. SCC investigates applicant's credit and repayment ability. Upon finding negative information, the SCC will notify the SCS Field Office and SCD Supervisor and the applicant.

III. Second District Board Meeting

A. Completed conservation plan is presented by the applicant to the full SCD Board for final approval and funding (provided funds are available). SCD Board will notify applicant in writing if final plan receives approval for funding, pending final determination by the SCC. Work cannot begin on projects until loan contracts are signed.

B. SCD Board sends copy of final plan to the ZC and ZC forwards plan to the SCC.

IV. Post Project Approval

A. Security agreement and repayment schedule is developed between the State and the individual. (Applicant will be responsible for a portion of loan initiation fees beyond the 4 percent administrative fee.)

B .The SCC will notify the SCD Board, SCS Field Office and ZC when final contracts are completed and project is ready to begin.

V. Practice Installation and Certification

A. Technical Assistance (TA) agency will design and monitor practice installation.

B. SCD Board representative monitors implementation of project and follows up on loan activities as necessary.

C. TA agency will certify to the State that the practice is or is not installed according to standards and specifications.

DEVELOPING NONPOINT SOURCE CONTROL STRATEGIES FOR BIG STONE LAKE: TWO APPROACHES

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ABSTRACT

Big Stone Lake, a hypereutrophic lake located on the Minnesota–South Dakota border, suffers from algae blooms, excessive weed growth, and sedimentation. The South Dakota Department of Water and Natural Resources, with support from the Minnesota Pollution Control Agency, completed a Diagnostic-Feasibility Study that identified nonpoint source pollution from agricultural land use practices in the lake's 2,938 km² watershed as the major source of pollution to the lake. Institutional barriers often present a greater task for nonpoint source projects than the technical factors involved in addressing nonpoint source problems. The Big Stone Lake Project provides an interesting case study because its initiation involved and required the cooperation of two regional EPA offices, two States, five counties, and a multitude of State and local agencies. The large size of Big Stone Lake's watershed has also required innovative approaches to identifying and prioritizing nonpoint source pollution strategies. A computer model will be used to target nonpoint source control projects within subwatersheds.

INTRODUCTION

"In recent years there have been complaints of increasing growths of rooted aquatic plants (weeds) and nonrooted, generally small, scum-forming plants (blue-green algae) in the lower or southern end of Big Stone Lake, especially in the vicinity of Ortonville, Minnesota. . . ." This excerpt is from a report requested by the governors of South Dakota and Minnesota after a meeting of their representatives at Milbank, South Dakota, in 1967 (S. Dak.–Minn. Comm. 1967). As can be seen from this nearly 20-year-old report, concern for eutrophication of Big Stone Lake by South Dakota and Minnesota is not new. What is new is the coordinated effort by both States to solve many of the problems contributing to the lake's degradation.

The information presented here is meant to provide an understanding of the management philosophies of the two States involved in the project and to show how institutional differences have been meshed to develop this joint restoration effort.

Basin Description

Big Stone Lake is located on the border of South Dakota and Minnesota (Fig. 1). Big Stone is a large, hypereutrophic, warm water lake with a surface area of 5,002 ha (12,360 acres), a shoreline length of 96.4 km (59.9 m), and an average depth of 2.4 m (8 ft). Big Stone Lake was formed about 8,000 years ago by an alluvial fan deposited by the Whetstone River in the glacial valley of the River Warren (Bray, 1977). In 1939, the lake became a reservoir when a concrete dam replaced the natural outlet following the diversion of the Whetstone River into the lake for flood control. This diversion increased the watershed of Big Stone Lake from 178,588 ha to 295,367 ha (729,841 acres) and significantly increased problems of nutrient enrichment and sedimentation. Of the 295,367 ha, two-thirds lie in South Dakota and one-third in Minnesota (Fig. 2).

Water quality of Big Stone Lake is best described as hypereutrophic. Growth of blue-green algae dominated by *Aphanizomenon* is the primary factor limiting recreational use of the lake from early July to October. Algal density is usually the principal factor limiting water transparency, which typically ranges from over 4 m during the spring zooplankton pulse to less than .5 m in August. Water transparency is occasionally limited by resuspension of sediment in the shallow areas adjacent to major tributary inlets. These and many other shallow areas are covered by extensive aquatic macrophyte growth during the summer (S. Dak. Dep. Water Nat. Resour. 1983). Water quality degradation over the past 20 years has led to a significant decline in sport fishing and water-based recreational use of the lake, which has been an important regional resort and vacation area for the past 100 years.

The major sources of pollution to Big Stone Lake arise from agricultural land use in the watershed. Erosion from cropland and runoff from animal feeding operations are major sources of nutrient and sediment loadings to Big Stone Lake. Rapid runoff characteristics and streambank erosion in some subwatersheds also contribute to lake pollution loadings. Water quality monitoring on tributary streams has shown unacceptable loads of both nutrients and sediment. While nonpoint source pollution from intensive agricultural land use is the major source of pollutants to Big Stone Lake, other sources such as the municipal sewage facilities at Browns Valley, Minnesota, and Sisseton, South Dakota, contribute to water quality degradation (S. Dak. Dep. Water Nat. Resour. 1983).

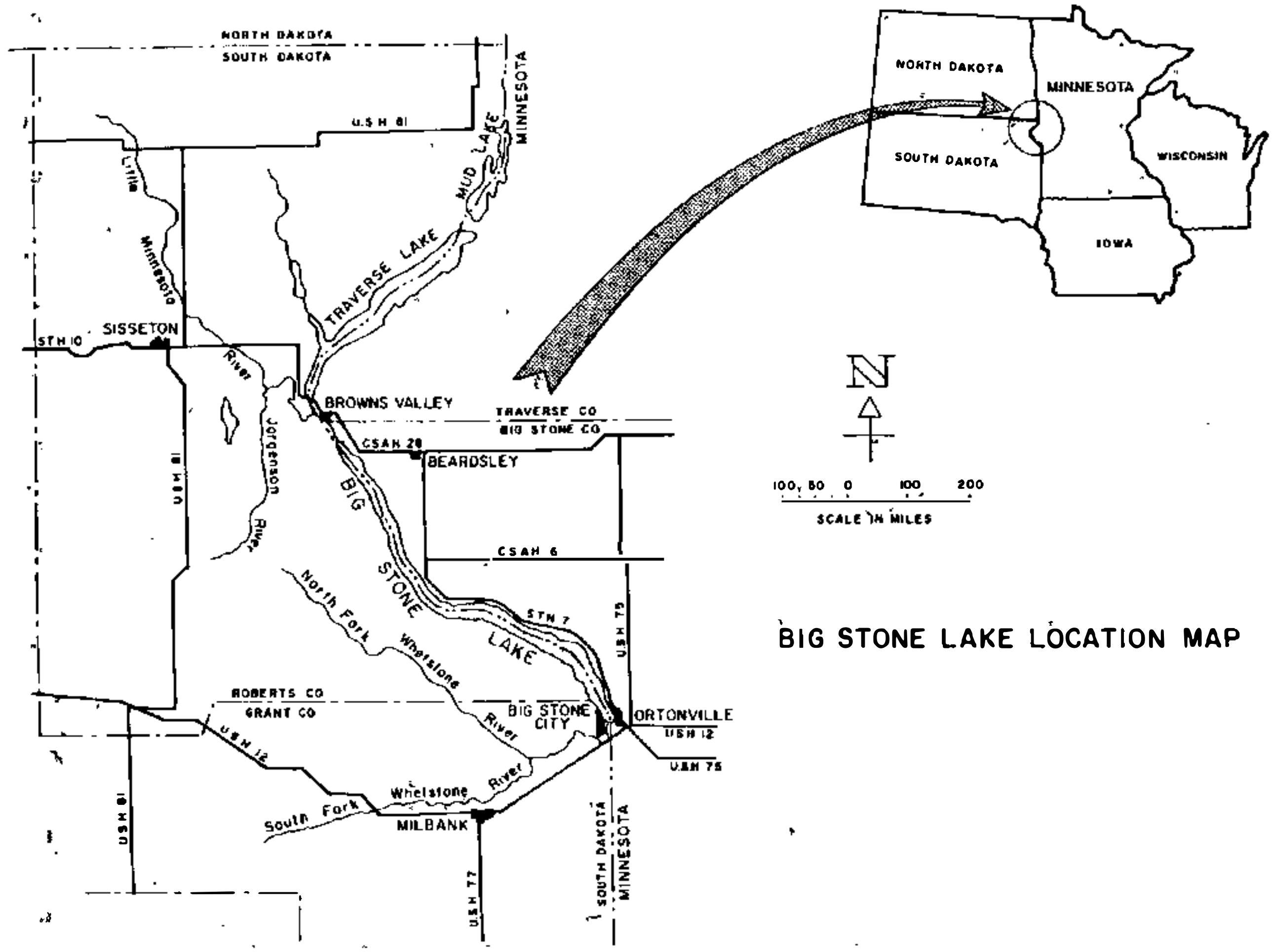

Figure 1.—Big Stone Lake location map.

STATE NONPOINT STRATEGIES AND PROGRAMS

Although the public has been interested in restoring Big Stone Lake for at least 20 years, efforts have been limited by differences in program priorities and organizational philosophies on either side of the lake.

The South Dakota Strategy and Program

In 1976, designated by the Governor as the statewide management agency responsible for the "formulation of implementable water quality management plans," the South Dakota Department of Water and Natural Resources (SDDWNR) began developing a methodology for preparing a comprehensive 208 management plan. Serious consideration was given to a variety of methods. Finally, the SDDWNR decided not to prepare an all-encompassing State plan, but rather to target areas for intensive efforts; and, as individual plans were prepared, more areas would be added, eventually encompassing all problem areas of the State. As a rural State with agriculture as the primary industry, agricultural nonpoint source problems were expected to be prominent.

Having selected this management approach, SDDWNR, then the Department of Environmental Protection, solicited potential candidates for water quality study areas from planning districts, soil conservation districts, lake associations, and various other public and private

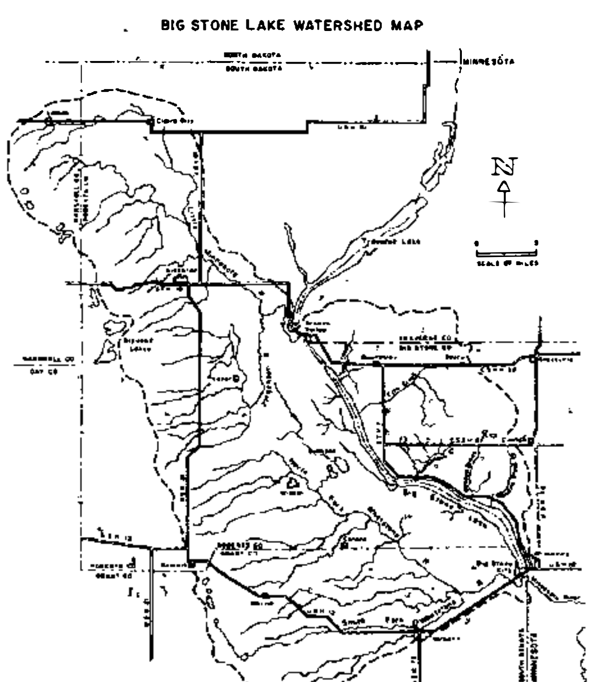

Figure 2.—Big Stone Lake watershed map.

groups. Each group was asked to submit recommendations to the appropriate planning districts, which then submitted their top three choices to SDDWNR. Selections were based mainly on available data, public support, and perceived problems. All of the original selections were rural watersheds with lake or stream problems resulting from nonpoint sources of pollution.

The SDDWNR collected the preliminary data necessary to prepare individual plans. Soil conservation districts were contracted to assist with water sample collection, compilation of land use data, and dissemination of public information. The SDDWNR evaluated the data and prepared reports and plan recommendations. South Dakota used the 208 program to fund promotion of best management practices (BMP's) on selected critical areas.

Soil conservation district employees were responsible for BMP promotion. Although not State employees, soil conservation district staff activities in areas of water quality and nonpoint source pollution were directed by SDDWNR staff. As is evident, the 208 planning process for South Dakota was not only managed, but many elements were actually conducted by the SDDWNR from project initiation through the preparation of final evaluations and reports. Assistance was provided by other agencies.

This somewhat independent management philosophy has since carried over into all lake projects In the State. The application of this philosophy to the Big Stone Lake Restoration Project occurred naturally, considering past project management. Although the Big Stone Lake project did not evolve through the 208 process, it had the same attributes as other State projects: local support, serious water quality problems, and extensive baseline data. The difference with this watershed is that, instead of going through the 208 planning process as a targeted water quality study area, Big Stone Lake and its associated watershed went from preliminary baseline data into a Phase I Study.

In preparing the Phase I grant application, SDDWNR used existing staff, secured matching funds, stationed a fulltime employee in the watershed, and purchased the required monitoring equipment. The fulltime coordinator collected, compiled, and evaluated all the data required for a Phase I report, and prepared major sections of the report, the remainder of which were prepared by SDDWNR headquarters staff. Almost all of the agencies previously mentioned, as well as the local agricultural agencies and the South Dakota Department of Game, Fish and Parks collected data.

Once the Phase I report and Phase II application were completed and submitted to U.S. EPA, preparations were made for implementing the Phase II grant award. As with the Phase I, the project coordinator assumed responsibility for finalizing the matching fund commitments, modeling feedlots for implementation, and selecting a model with which to identify necessary BMP's. After the grant was awarded, SDDWNR continued to actively participate in the project through the coordinator, with direct assistance from headquarters staff.

The Minnesota Strategy and Approach

The Minnesota Pollution Control Agency (MPCA) is the Minnesota water quality management agency. Minnesota's nonpoint water pollution effort began in 1976 with the development of the Minnesota Water Quality Management Plan (208 Plan) led by the MPCA. Its purpose was to identify significant water quality problems caused by nonpoint sources of pollution and to set forth effective programs to address those problems. Unlike South Dakota, the Minnesota 208 plan was not a blueprint for action in individual watersheds; rather, it summarized existing management policies and programs as well as recommended future policies and actions. The plan recognized that a continuing nonpoint program would involve three functions: (1) continued study of nonpoint source issues, (2) preimplementation activities that would lead to putting recommended programs into operation, and (3) actual implementation of management programs.

In 1983, the MPCA initiated a study to identify major barriers to implementation of integrated water quality and land management in Minnesota. The four barriers identified were: (1) a poor understanding by the public of the existence and economic significance of water quality problems resulting from land management, (2) poor understanding of available solutions to nonpoint pollution, (3) government fragmentation of water quality and land management, and (4) the limited funds available to solve the problems (Richfield, 1983).

Minnesota then delineated three strategies to address these problems. First, MPCA completed an information strategy to develop public awareness of the economic and recreational impact of nonpoint pollution. Second, Minnesota initiated meetings with other State and Federal agencies to encourage inclusion of water quality management in their existing programs, to encourage their assumption of new water quality activities, and to provide technical support. Third, MPCA helped organize and apply for U.S. EPA Clean Lakes funds for two watershed projects where nonpoint problems adversely affect water uses, to demonstrate successful approaches to nonpoint source management. These projects are intended to demonstrate technical solutions to nonpoint control, the viability of an integrated land and water management approach, the importance of cooperation in overriding fragmented resource management, and actual implementation costs, thus providing an accurate assessment of the control effectiveness of project funds. Big Stone Lake is one of Minnesota's nonpoint demonstration projects.

Minnesota's involvement in the Big Stone Lake project is based on a program approach developed through the U.S. EPA Clean Lakes Program. MPCA provides funding and technical support, while contracting with a local unit of government to lead the effort locally. This approach allows local project control and decisionmaking to best meet the local needs and conditions while providing technical oversight.

In the case of Big Stone Lake, the Upper Minnesota River Watershed District is the grantee. The watershed district, a local unit of government whose purpose is developing and coordinating water management programs, is a five-member board of managers with taxing authority keyed to hydrologic boundaries. The unique form of local government is a natural local leader for this project although initially State sponsorship was sought. The watershed district was experienced, having sponsored a U.S. Army Corps of Engineers project to modify the Big Stone Lake outlet, by which more of the Whetstone River will bypass Big Stone Lake, reducing nutrient and sediment loading from the Whetstone River.

In addition to the technical review, the Big Stone Project has benefited from other ongoing nonpoint program activities. The MPCA instituted a feedlot permit program in the early 1970's, designed to eliminate and prevent pollution hazards from livestock and poultry operations. The Minnesota Feedlot Computer Model, developed by the USDA Agricultural Research Service in cooperation with the MPCA, determines the pollution hazard, and prioritizes cost-share funds for cleanup of feedlot problems. This program, in cooperation with local soil and water conservation district activities, has solved most of the feedlot problems contributing to the Big Stone Lake from the

Minnesota watershed. Three serious existing problems are now receiving attention from the MPCA enforcement staff.

Identifying the sources of nonpoint source pollutants and tracing their path through a watershed is a complex and time-consuming process. To more efficiently identify and trace nonpoint pollution, the MPCA funded and joined with several conservation agencies to develop two computer water quality models (AGNPS I and II). The Agency used one of the subwatersheds from Big Stone Lake to verify and test these models. The Upper Minnesota River Watershed District will use this information and these models to prioritize problems and assist in designing the implementation program at Big Stone.

The MPCA actively solicited project support from State and Federal agencies already engaged in nonpoint control, and is coordinating the considerable support received. Important to that effort was a meeting organized by MPCA staff, attended by local representatives of the Watershed District, SDDWNR, the Minnesota Soil and Water Conservation Board, University of Minnesota Agricultural Extension Service, Minnesota Water Resources Board, the Soil Conservation Service, and the Agricultural Stabilization and Conservation Service. The meeting resulted in additional support and interest for this project.

The Minnesota Soil and Water Conservation Board (SWCB) will target several subwatersheds to receive an intensive communications program over a 2-year period. The program will communicate to farm operators the economic and social implications of soil erosion, nutrient loss, and degraded water quality. The SWCB is also expected to directly provide additional implementation funds through two State programs for erosion control and water management.

THE COORDINATED TWO-STATE APPROACH

Big Stone Lake and its contributing watershed lie in two U.S. Environmental Protection Agency regions, two States, five counties, one watershed district, and a multitude of other local governments and governmental agencies. This project represents an extreme case of fragmented political boundaries and consequent limits to water quality protection. The same organizational complexity which once threatened this project is now recognized as a project asset, flexible in overcoming obstacles to water quality improvement.

Initially, both States were concerned about the other's management philosophy, although both States recognized that any improvement in water quality would require involvement by both South Dakota and Minnesota. Although both States expressed an interest in the restoration of Big Stone Lake, they had to overcome several barriers and differences in approach at the regional, State, and local level. These differences centered on several areas:

1. Project evaluation criteria
2. Pollution control standards
3. Approaches to pollution problems
4. Project management approaches
5. Clean Lake project prioritization criteria
6. The strengths and weaknesses of the two agencies.

A smaller project, involving a more easily defined and straightforward solution, would have eliminated several of these barriers and differences. The enormity and nature of the lake's problems also complicated joint efforts, making it difficult to complete the Phase I report within the budgetary constraints.

The MPCA and Region V EPA had more experience with engineering approaches to lake problems and attempted to apply these criteria to a nonpoint source control project focusing on best management practices. SDDWNR, on the other hand, emphasized direct implementation during the planning process and felt that the emphasis on planning could delay the project's implementation. Staff changes at both agencies and regions during the Phase I project and during the interim period between the completion of the Phase I and implementation of the Phase II project also complicated the development of a cooperative working relationship.

The solution involved developing greater flexibility on the part of Region V EPA and the MPCA to allow consideration of a nonpoint source control project developed on a limited budget. This also required SDDWNR and Region VIII to agree to accept some of the stricter standards and procedures implemented by Region V. Both EPA regions had to agree to allow some activities, considered as "planning" in more traditional Clean Lakes projects, to receive funding under the Phase II effort. Further, staff from both State agencies had to sell the need for a different approach to the rest of their agencies and to other State programs.

While both SDDWNR and the MPCA could have eventually resolved these differences and overcome the barriers to a cooperative effort, the time required would have jeopardized the project's momentum and reduced chances for FY 1984 Clean Lakes funding.

Both EPA regions played a crucial role in speeding up the negotiation process, cutting through red tape, finding solutions to the problems that emerged, and helping the State agency staffs sell the project to the rest of their agencies. Because many of the differences emanated from different approaches by the two EPA regions, decisionmaking at the regional level was necessary for a compromise solution. In other instances, where the differences arose from differing State approaches, EPA intervention helped avoid lengthy rulemaking processes and overcome bureaucratic barriers that could have slowed the negotiation process. In areas where the two regions and States continued to differ, the EPA regions helped the States work out solutions that converted these differences to variations in emphasis, rather than barriers to cooperation.

The resulting merger of the two different approaches has led to a stronger project. The resulting cross-fertilization has allowed each State to learn from the other's approach, management style, and legislation. The fact that some differences remain has allowed greater flexibility on the local project level. For example, for some measures that both States felt important, one EPA region had a greater likelihood of approving and funding than the other. In other cases, one or the other of the two States might be better equipped to implement a certain required measure. By allowing differences to remain, the local project benefits from the strengths of each State agency and both regions.

This project has provided the following lessons:

1. Geographic and political fragmentation should not bar project initiation. Addressing these problems is as important to improving water quality as are the technical issues.

2. Many of the differences between States and other governmental units, while barriers at first, can work to the advantage of a project because the different groups bring different sets of experiences, skills, and tools to the project.

3. In this project, misunderstood communications between States and between the States and local units of government impeded the project. When open, effective communications were established, cooperation overcame philosophical and political causes for disagreement.

4. For the two States to agree, they needed to develop

procedures to work out how and where these differences would be resolved.

5. Projects involving more than one State and region require a high degree of flexibility on the part of the parties involved.

6. NPS projects require more planning and coordination than more traditional Clean Lakes projects; the parties involved either have to accept a less rigidly defined project or allow for a greater planning effort.

7. Active involvement by EPA can facilitate and expedite negotiations between States in their attempts to address interstate pollution problems.

8. Nonpoint source projects need strong local cooperation. Although the MPCA typically does not get involved in a project until this is developed, the SDDWNR actively helped develop the local cooperation during the Phase I study by involving them in the process. This played a key role in the project's success.

CONCLUSION

Institutional barriers often present a greater task for nonpoint source control projects than do the technical factors involved. The Big Stone Lake Project provides a case study because its initiation involved and required cooperation of two regional U.S. EPA offices, two States, five counties, and a multitude of local units of governments and government agencies. This same organizational complexity that once threatened this project is now recognized as a project asset allowing the programs the flexibility necessary to overcome obstacles to water quality improvement.

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NONPOINT SOURCE POLLUTION OF RESERVOIRS: WHAT THE TENNESSEE VALLEY AUTHORITY IS DOING ABOUT IT

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ABSTRACT

The Tennessee Valley Authority has constructed a multipurpose reservoir system that is recognized throughout the world as a model for water resources management on a watershed basis. As early as the 1930's TVA recognized the importance of controlling soil erosion to prevent the premature filling of reservoirs and began working with Valley farmers in implementing soil conservation practices. In the 1980's indications of declining water quality in TVA reservoirs prompted a renewed emphasis on reducing nonpoint source pollution and relies heavily on Valley States and other Federal agencies to assist in implementing corrective measures in cooperation with private landowners. TVA uses a variety of techniques to reduce nonpoint sources. These are discussed.

Nonpoint source pollution is adversely affecting water quality in the Tennessee Valley. In a recent survey of water quality in the region over half of the 10 most critical water quality problems resulted from nonpoint sources (Clark et al. 1980); three additional problems have been identified since that survey (Tenn. Valley Author. 1984a). The types of water quality impacts that can be attributed to nonpoint sources in the Tennessee River watershed include siltation and filling of reservoirs, bacteria contamination, accelerated eutrophication of reservoirs, low dissolved oxygen, and elevated levels of metals.

Although many of the nonpoint-source-related water quality problems in the Tennessee Valley have a very interesting history, the primary objectives of this paper are to examine the Tennessee Valley Authority's (TVA) role in protecting its reservoirs from nonpoint source pollution and describe TVA's efforts to resolve existing problems and improve the overall nonpoint source management throughout the region. This discussion is based only on activities in TVA's water resources programs.

TVA was created by Congress in 1933 as a corporate agency of the Federal government. Not part of any Federal cabinet department, it is an independent agency that operates with a certain degree of the autonomy and flexibility of a private corporation. TVA planned, built, and now manages a unified water control system of 40 dams and reservoirs that regulate the entire length of this Nation's fifth largest river plus key stretches of its principal tributaries. TVA water resources activities are supported by annual appropriations from Congress (Tenn. Valley Author. 1985).

TVA follows a stewardship philosophy in management, resulting in the maximum beneficial uses today and in the future. Also, TVA promotes the economic growth and development of the region while ensuring the enhancement of the Valley's natural resources. Water pollution resulting from nonpoint sources can affect not only water use in the TVA region and TVA's ability to manage the reservoir system, but can also hinder or preclude regional development.

Although it is not a regulatory agency for controlling pollution, TVA does not depend on the Valley State regulatory agencies to carry the entire burden of improving water quality in Valley reservoirs. Several nonregulatory TVA activities help the Valley States keep TVA reservoirs clean and suitable for beneficial uses.

STEWARDSHIP

TVA is a steward for the water resources of the Tennessee Valley and four specific water resources activities that help the agency fulfill that role: (1) controlling nonpoint source pollution emanating from properties under TVA's custody or control, (2) reservoir water quality management planning, (3) septic tank suitability analysis for reservoir shorelines, and (4) reservoir release improvements.

Controlling Nonpoint Source Pollution from TVA Properties

TVA has fee-owned lands and flowage easement rights along its reservoirs. Fee-owned lands located above the normal maximum pool are managed under short-term renewable license or long-term land use agreements for multipurpose uses that include agriculture, recreation, wildlife, and silviculture.

Since 1981 TVA has been recognized by the State of Tennessee and the U.S. Environmental Protection Agency (EPA) as the management agency for controlling nonpoint source pollution emanating from properties under TVA custody or control. This recognition is pursuant to Section 208(c) of the Clean Water Act of 1977 and its implementing regulations, 40 CFR 35.1521-3. A memorandum of understanding between TVA and the State of Alabama for similar recognition in that State is being finalized and agreements are being pursued with the five other Valley States.

As a recognized management agency TVA has developed provisions to be included in deeds, easements, leases, and licenses requiring the use of best management practices (BMP's) for controlling erosion and sedimentation resulting from land disturbing activities. Special procedures now used in issuing agricultural licenses ensure that TVA lands are suitable for row crops and that State-approved BMP's are followed to protect water quality and the long-term agricultural capability of the land. In addition, TVA has developed BMP's for timber harvesting activities on TVA lands.

Reservoir Water Quality Management Plans

TVA reservoirs, like large settling basins, are particularly vulnerable to nonpoint source pollution. The beneficial effects of reservoirs on water quality are well documented as are the consequences of uncontrolled nonpoint source pollution (Churchill, 1957; Clark et al. 1980). Improving and protecting water quality in the TVA reservoir system is the major reason behind TVA's involvement in nonpoint source pollution control. The cornerstone of TVA's efforts is the Reservoir Water Quality Management Plan.

Through its reservoir water quality management planning process TVA has an active role in defining water quality problem areas, identifying corrective actions, and implementing appropriate management actions. These plans help States carry out their regulatory programs and guide TVA itself in operating and managing the reservoir system.

The reservoir management planning process includes the following five phases:

1. Identifying water quality problems and management issues.
2. Developing a data base appropriate to the problems and needs identified.
3. Identifying cause and effect relationships and using those relationships to predict changes in water quality that would result from applying alternative pollution control strategies and further development.
4. Developing a management plan that synthesizes the information into recommendations for correcting existing use impairments and preventing future water quality problems.
5. Implementing the management plan recommendations.

By the end of 1985 TVA will have completed management plans for five reservoirs and be well into the implementation phase (Tenn. Valley Author., 1984b). Three other reservoirs will have management plans in one of the other four phases.

Septic Tank Soil Suitability Analysis

Soil conditions along the reservoir shorelines of many TVA reservoirs are unsuitable for conventional septic tank soil absorption systems. Because of this, many conventional systems are failing and may be contributing bacteria and nutrients to TVA reservoirs. In 1985 TVA is attempting to document the extent of water quality degradation resulting from failing septic tank systems along reservoir properties. To combat this nonpoint source TVA is providing guidance to local and State health departments and land developers on the capability of shoreline properties to handle onsite sewage disposal systems. This guidance is a conceptual plan that identifies shoreline properties suitable for conventional or alternative onsite systems and also properties not suitable for any type of onsite system. In the latter case these properties must be sewered or remain undeveloped. This analysis is performed using soil survey information digitized on TVA's Geographic Information System. The soil suitability analyses are performed by an experienced soil scientist and environmental engineer familiar with the soil requirements for conventional and alternative onsite systems. Conceptual plans have been completed for two TVA reservoirs (Sagona, 1985); another is scheduled to be completed in 1985.

Reservoir Release Improvements

Nonpoint sources contribute to the natural dissolved oxygen depletion processes occurring in TVA's deep, thermally stratified reservoirs. The primary result of this dissolved oxygen depletion is almost 300 miles of stream below TVA dams that are low in dissolved oxygen. One way of dealing with this condition is to increase the dissolved oxygen at the point of release, the dam. In 1981 TVA began a 3-year experimental program designed to study and test alternative methods of enhancing dissolved oxygen levels in reservoir releases. This program has been very successful (Tenn. Valley Author. 1984c). The implementation phase will probably continue for at least another 3 years.

To complement the reservoir release improvement program, in 1985 TVA initiated a basin rehabilitation project for the South Fork Holston River. One of the purposes of this project is to reduce point and nonpoint source contributions in the watershed above two TVA reservoirs experiencing dissolved oxygen depletion. The results of this project will help TVA determine the degree of improvement that could be expected from improved reservoir quality.

RESOURCE ENHANCEMENT

An adequate supply of water capable of supporting a variety of beneficial uses is essential to economic growth and future development that may be in the public interest. The resolution of nonpoint source-related water quality problems will aid TVA's efforts to promote natural resource-based economic development.

Three activities that support TVA's resource enhancement role include: (1) identification of nonpoint source problem areas, (2) serving in a facilitator role to resolve nonpoint source pollution problems, and (3) conducting demonstrations of solutions to nonpoint source problems.

Identification of Nonpoint Sources

Three years after its creation in 1936 TVA conducted a survey of water pollution in the Tennessee River (Scott, 1941). Since that time water quality monitoring and assessments have continued to be a key component of TVA's water resources programs. Although the emphasis of the monitoring program has shifted from time to time, the primary objective remains: to identify problem areas and evaluate the effectiveness of corrective actions. Traditional TVA ambient monitoring programs have been only partially effective in identifying nonpoint source-related problems; therefore, TVA has recently turned to intensive surveys of suspected problem areas with rainfall event sampling for targeted water quality parameters (Milligan et al. 1984; Carriker and Mullins, 1963).

The diffuse nature of nonpoint source pollution coupled with its seasonal and hydrologic variation make source identification technically difficult and expensive. TVA uses aerial photography and stereoscopic interpretation techniques to reduce costs and improve the extent of coverage and accuracy of nonpoint source identification. These techniques are not new. However, their extensive use in identifying nonpoint sources is new.

TVA uses color infrared photography and personnel trained in the characterization of nonpoint source pollution from aerial photographs to identify animal waste runoff and failing septic tanks. In cooperation with the Soil Conservation Service (SCS) district conservationist, aerial photography and county soil survey information is also used to estimate soil erosion rates from individual farm fields.

Results of all TVA monitoring and data analysis are made available to the State regulatory agencies. TVA data complements the State's monitoring programs and helps to prioritize problem areas. When nonpoint source problems are identified, the Valley States initiate appropriate regulatory or voluntary cleanup actions and often TVA cooperates in the problem resolution process.

Catalyst for Solving Water Problems

When a nonpoint source water quality problem is identified, TVA works cooperatively with State and other Federal agencies to solve the problem. TVA uses the data collected during the problem identification phase to focus public attention on priority problems and issues. TVA encourages public involvement in controlling nonpoint sources. One approach that has been effective in correcting some of the more complex water quality problems in the Tennessee Valley has been the formation of an interagency task force to plan and direct cleanup activities. Federal agencies such as SCS, Agricultural Stabilization and Conservation Service (ASCS), U.S. Geological Survey, and EPA, along with the State regulatory agencies have worked cooperatively with TVA on nonpoint source pollution problems.

Demonstration of Solutions to Nonpoint Source Problems

Often the correction of a nonpoint source problem cannot proceed because cost-effective corrective techniques are not available. In the case of high-priority problems TVA develops and implements projects to demonstrate effective and economical solutions. TVA demonstrations also serve as an education tool to encourage participation in water quality improvement efforts. On one such project that involved reclamation of abandoned mineral mine lands, TVA developed a minimal land reclamation technique that controls offsite erosion at a low cost of $2,470/hectare ($1,000/acre) (Muncy, 1981). This demonstration encouraged the State's legislature to provide funding to the county governments to complete the project. The end result was the control of erosion from over 242 hectares (600 acres) of abandoned mine lands, erosion that was adversely affecting downstream water supplies and contributing to the siltation of TVA reservoirs.

In another project TVA is working with SCS, ASCS, and farmers to control animal waste runoff in a major tributary watershed. While helping farmers install animal waste systems TVA is developing information on the amount of cost-share necessary to stimulate landowner interest and identify the animal waste treatment components with the most water quality benefits. Through this demonstration animal waste treatment system designs have been improved and educational material on operation and maintenance of animal waste systems has been developed.

CONCLUSION

TVA's role as a steward for the water resources of the Tennessee Valley and its mission of resource enhancement dictates an active involvement in helping control nonpoint source pollution. The lack of direct regulatory responsibility for pollution control should not discourage water resources agencies in working cooperatively with others to resolve nonpoint source pollution problems. The fact that TVA is not burdened with regulatory responsibilities provides more opportunities and flexibility in dealing with nonpoint sources.

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COMPREHENSIVE PROTECTION FOR TWO MULTIPURPOSE RESERVOIRS IN CENTRAL NORTH CAROLINA—EPA'S NATIONAL NONPOINT SOURCE POLICY CAN WORK

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ABSTRACT

Federal, State, and local agencies are carrying out an aggressive watershed protection program to prevent degradation of two new multipurpose reservoirs in the Raleigh-Durham-Chapel Hill area of North Carolina. The U.S. Army Corps of Engineers impounded the B. Everett Jordan Lake and Falls of the Neuse Reservoirs in 1981 and 1983 for flood control, recreation, and water supply. With a drainage area of almost 6,500 km^2, the reservoirs have a combined surface area of 10,000 ha, and represent a potential raw water source of 200 million gallons per day. An interagency strategy was developed in response to growing public demands for water supply protection amid accelerating urban development and evidence of excessive nutrients in the reservoirs. The strategy is preventive in focus—none of the intended uses has yet been impaired. Phosphorus removal will be required from all new wastewater discharges, and from selected existing facilities in the watersheds. The North Carolina General Assembly will consider a statewide ban on the sale of phosphate-containing laundry detergents during its 1985 session. Cities and counties have enacted land use controls and a $2 million a year State-funded cost-share program is helping farmers finance much-needed agricultural BMP's in critical portions of the watersheds. Initial success of the overall strategy appears to support the principles of EPA's proposed National Nonpoint Source Policy.

The B. Everett Jordan and Falls of the Neuse Reservoirs lie in North Carolina's piedmont physiographic province (Fig. 1). The U.S. Army Corps of Engineers impounded the lakes in 1981 and 1983 for flood control, recreation, and water supply. With a combined drainage area of 2,500 square miles, they represent a potential raw water source of 200 mgd for the Research Triangle area of Raleigh, Durham, and Chapel Hill, North Carolina.

Local officials and the general public recognizing the reservoirs' value to the region have demanded increased protection during an unprecedented period of economic growth and development. Although a great deal of public and editorial attention has focused on possible water quality effects of urbanization, none pf the intended uses of either lake have yet been impaired. The Falls/Jordan watershed efforts described here represent an important public commitment to preventive—rather than corrective—action.

Efforts begun in 1983 have resulted in several accomplishments:

- Phosphorus removal is now required at all new wastewater plants in the 2,500 square-mile watershed and at selected existing facilities.
- The North Carolina House of Representatives approved a ban on the sale of phosphate detergents (to be considered by the State Senate in 1986).
- Cities and counties have enacted aggressive and controversial land use controls for new development restricting sewer extension policies, impervious surface coverage, gross density, industrial siting, underground chemical and petroleum storage, and vegetated stream buffer requirements.
- The North Carolina General Assembly created a State-funded cost-share program for agricultural conservation practices, and provided a two million dollar biennial appropriation for use by 15 counties in the State's designated Nutrient Sensitive Watersheds.

THE WATERSHEDS

Table 1 highlights several features of the Falls and Jordan watersheds. Both lakes are shallow, with mean depths of 12 and 16 feet, respectively. Wastewater treatment plant effluent equals or exceeds the volume of natural streamflow entering the lakes during low flow periods. Both watersheds are large and heavily populated, containing about 10 percent of North Carolina's total population (Div. Environ. Manage. 1983).

Figure 2 depicts gross land use and phosphorus loading. Approximately 63 percent of the land is forested, and 28 percent is in agricultural use (tobacco, corn, poultry, dairy, and hog production). The relatively small proportion (9 percent) of urbanized land is replacing forested and agricultural areas at an increasing rate. The largest fraction of phosphorus input (55 percent) comes from municipal wastewater plants, none of which removed phosphorus before the current initiative (Div. Environ. Manage. 1983).

Falls and Jordan Lakes are two of the most highly enriched water bodies in North Carolina, but their quality tends to be typical of mainstem piedmont reservoirs in the southeastern United States. Low Secchi depths are due to high algal biomass and inorganic sediment; pH and dissolved oxygen data reflect the high productivity, photosynthesis, and thermal stratification of hot summer conditions. Phosphorus and chlorophyll *a* concentrations, which clearly exceed "acceptable" levels for northern

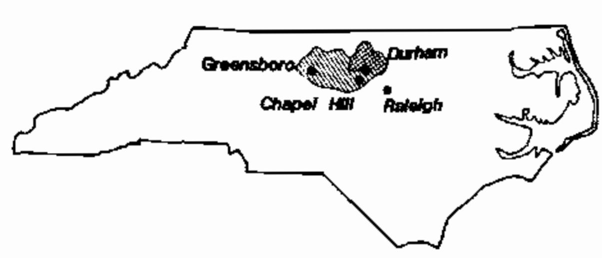

Figure 1.—Location map of Falls and Jordan Lake watersheds, North Carolina.

Table 1.—Selected hydrologic and morphometric features of the Falls and Jordan Lake watersheds, North Carolina (Div. Environ. Manage. 1983).

	Falls	Jordan
Surface Area (ac)	12,500	14,300
Volume (ac–ft)	154,000	235,000
Mean Depth (ft)	12.3	16.4
Streamflow (cfs)		
Mean annual	800	1700
7Q10	17	76
WWTP Flow (cfs)	16	143
Watershed (sq mi)	770	1690
Population	150,000	460,000

Table 2.—Generalized summertime water quality data, Falls and Jordan Lakes, North Carolina (Correale, 1985).

	Surface	Bottom
Conductivity	100	250
Secchi (ft)	2.5	—
pH	9.3	6.5
D.O. (% sat.)	130	0
Total P (μg/L)	80	350
Chl *a* (μg/L)	100	—

temperate lakes, have not resulted in algal mat formation, and do not represent nuisance conditions in Falls and Jordan Reservoirs. Table 2 displays generalized water quality data representing surface and bottom conditions typical of hot summer periods.

In addition to nutrients, watershed protection strategies have focused on sediment loads and the possible presence of toxic materials. The North Carolina Environmental Management Commission classified both reservoirs as public water supply sources but will not authorize the potable use of Jordan Lake until more data are gathered about trace metals and synthetic organic chemicals present in the watershed (Environ. Manage. Comm. 1983). Local officials and the general public have consistently demanded assurances that the potential 200 mgd water supply will be safe for consumption. To date, no synthetic organic chemicals have been measurable in either Falls or Jordan Lake (Div. Environ. Manage. 1985a).

PUBLIC CONCERN

A high and sustained public concern expressed by local governing bodies, newspaper editorials, and radio/TV features was an important factor behind the Falls/Jordan watershed protection effort. The reservoirs' recent impoundment occurred during a period of unprecedented growth in the Research Triangle area. A proliferation of new subdivisions, office parks, and shopping centers had heightened the public's awareness of potential water quality effects on their new reservoirs.

Chronology

The period from impoundment to active protection encompassed several activities in the following order:

Construction/Impoundment. Jordan and Falls Reservoirs were filled in 1981 and 1983, respectively.

Call for Action. A resounding call for action, as described above, received a quick and positive election year response from cabinet level state officials.

Steering Committee. The Secretary of North Carolina's Department of Natural Resources and Community Development (NRCD) created a Steering Committee of mayors and county board chairmen from each of the 16 political jurisdictions in the Falls and Jordan watersheds.

Nutrient Sensitive Designation. The North Carolina Environmental Management Commission classified the Falls and Jordan watersheds "Nutrient Sensitive," providing an explicit regulatory mechanism for point source phosphorus control.

Point and Nonpoint Tradeoffs. The Secretary of NRCD proposed a basic tradeoff: "If you (local governments) take certain actions to reduce nonpoint runoff in your jurisdictions, then we (State government) might not have to require phosphorus removal at your treatment plants . . ."

State-Local Action Plan. State and local officials agreed to a semi-formal "action agenda" setting basic goals and responsibilities for the participants.

Implementation.

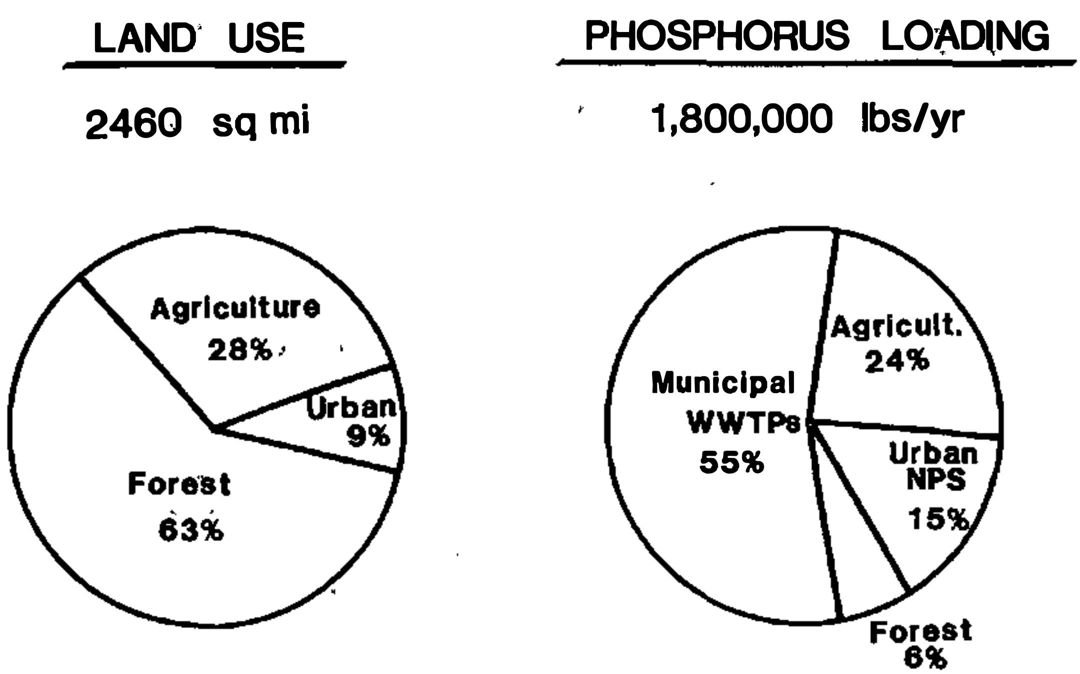

Figure 2.—Gross land use and phosphorus loading, Falls and Jordan Lake watersheds (combined data), North Carolina (Div. Environ. Manage. 1983).

THE STATE-LOCAL ACTION PLAN

As noted in Table 3, basic targets of the Action Plan were agricultural and urban runoff, point source phosphorus, and hazardous materials leaks and spills.

One of the most significant accomplishments to date has been the passage of a $2 million biennial state cost-share program which provides up to 75 percent funding for agricultural best management practices (BMP's). (The Orange Water and Sewer Authority, serving Chapel Hill, also offers up to 50 percent of the remaining costs, thereby reducing the private share to 12.5 percent of total BMP cost in certain portions of the Jordan watershed.) Another area of substantial progress has been the adoption of aggressive land use controls by nearby cities and counties.

LOCAL LAND USE GUIDELINES—MANAGING THE TYPE AND LOCATION OF NEW DEVELOPMENT

The Triangle J Council of Governments developed a three-tiered set of recommendations for the type and location of new development in the watersheds based on the principle of providing greater protection to areas closest to the lakes (Triangle J, 1984). The three tiers correspond generally to distance from the reservoirs:

- *Water Quality Critical Areas*—Land within one mile of the shoreline.
- *Limited Industry Areas*—Land beyond the Critical Areas, but within public water supply portions of the watershed.
- *Basinwide Guidelines*—All land throughout the Falls and Jordan watersheds.

Water Quality Critical Areas. The strictest and most controversial recommendations applied to the Critical Areas within 1 mile of each lake. The primary goal was to minimize urban runoff and the risk of chemical spills by maintaining the patterns of low intensity rural residential development that already existed. Accordingly, the guidelines called for a 6 percent limit on impervious coverage; no new industrial development whatsoever; and, no municipal sewer extensions into the Water Quality Critical Areas.

Limited Industry Areas. Beyond the Critical Areas, but within water supply portions of the watersheds, the guidelines were less restrictive, and focused on special safeguards for industries that use, produce, store, or transport specified amounts of certain hazardous materials. Before receiving a local development permit in a Limited Industry Area, the applicant would have to provide detailed information on materials present on site, special plans for containing and cleaning up any spills, and compliance with siting and monitoring standards for chemical storage tanks.

Basinwide Guidelines. Beyond the Water Quality Critical and Limited Industry Areas, certain recommendations applied to new development throughout the 2,500 square mile watershed. These included controlling 1/2 inch of runoff from all impervious surfaces (preferably through natural infiltration), maintaining 50-foot vegetated buffers along all streams, and adopting 12 and 30 percent impervious limits for sewered and unsewered areas, respectively.

Nearby cities and counties have made substantial progress incorporating these often unpopular guidelines into local zoning ordinances and subdivision regulations. Details of local programs in the Falls and Jordan watersheds are reported elsewhere (Triangle J, 1985).

Table 3.—Major elements of the State-local action plan for Falls and Jordan Lakes, North Carolina (Grimsley, 1983).

Agricultural runoff
- State funding for agricultural cost-share program

Urban runoff from new development
- Stricter zoning and land use controls by local governments
- Stormwater management requirements for water quality control
- Local erosion & sediment programs for new construction

Point source phosphorus removal
- Phosphate detergent ban
- Phosphorus removal to 1 mg/Lg at selected treatment plants

Hazardous materials
- Local inventories of use, storage, production
- Contingency response plans for leaks and spills
- Additional toxics research and monitoring by state agencies

OTHER ACCOMPLISHMENTS

In addition to aggressive local development controls and the agricultural cost-share program, other accomplishments are notable:

Phosphate Detergent Ban. The North Carolina House of Representatives passed legislation banning the sale of household detergents containing more than 0.5 percent phosphorus in the Falls and Jordan watersheds. The detergent ban has been widely supported by citizens and local governments, but is vigorously opposed by industry groups led by the Soap and Detergent Association. The legislation will be considered by North Carolina's Senate in 1986.

Expanded Toxics Program. Concern about the possible presence of toxic chemicals in the water of Falls and Jordan Lakes highlighted a statewide need for additional chemical and biological monitoring of North Carolina's waters. In response, the General Assembly appropriated funds to expand the State's water quality monitoring network and analytical capability for toxic substances.

Increased Public Awareness. An important result of the Falls/Jordan initiative has been the greater awareness, support, and commitment to a sophisticated menu of water quality issues by the general public and elected officials of the Research Triangle area.

FACTORS FOR SUCCESS

In terms of substantial State and local efforts focused on a complex problem and an action-oriented commitment by a wide range of agencies and interest groups, the Falls/Jordan watershed project has been more successful than other initiatives in North Carolina and elsewhere. Several factors contributed to these accomplishments.

Common Perception of A Problem. The overall reservoir strategy has been preventive. To date, none of the intended uses of either lake have been impaired by water quality problems. Nevertheless, watershed efforts drew strength from a sustained and widespread sense of public urgency, due in part to the general awareness that Raleigh would soon depend solely on Falls Lake for its water supply, and that the region's spectacular economic growth included some unwanted side effects: unsightly commercial development, traffic congestion, and water pollution. Much of the urgency to "do something" was expressed in the deliberations of local policy board and in editorials of local newspapers.

Effective Political Leadership. A quick and incisive response by Governor James B. Hunt, Jr. and Natural Resources Secretary Joseph W. Grimsley created an ad hoc steering committee of mayors and county board chairmen from 16 jurisdictions in the watersheds, and mobilized the resources of state and local government into a working partnership. The clear commitment of key State and local leaders provided the administrative momentum for overcoming traditional bureaucratic barriers.

Expertise in Place. Technical work and policy recommendations for the Falls/Jordan strategy were drafted by existing State, Federal, and local staff well versed in the array of land use–water quality issues. Most of the technical information on nutrient loading, sediment sources, and hydrology had been developed previously by the North Carolina Division of Environmental Management, the USDA Soil Conservation Service, county Soil and Water Conservation Districts, and the Triangle J Council of Governments. Given the top level political commitment for action, it remained only to organize relevant technical information into a coherent policy framework and implementation program.

The 208 Experience. Many key agencies and individuals at both the State and areawide levels had developed their water quality management expertise and familiarity with nonpoint pollution issues through EPA's 208 process. In some ways, Falls and Jordan became the "main event" for which earlier 208 exercises were the warmup.

CONCLUSIONS

A comprehensive program for protecting the 2,500 square mile watershed of two multipurpose reservoirs is being accomplished by State and local governments in central North Carolina. The preventive strategy includes phosphorus removal at selected treatment plants; a phosphate detergent ban; State-funded cost-share program for agricultural BMP's; local development restrictions on impervious coverage, density, industrial siting, hazardous materials storage, and utility extension policies. State and local political leaders effectively mobilized existing expertise and public concern about the effects of rapid economic growth on the region's two new reservoirs.

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