Making TMDLs Work in Rural Watersheds

A Report on a Workshop Sponsored by the U.S. Environmental Protection Agency, The Ohio State University, and Michigan State University

April 26 and 27, 2001
Augusta, Michigan

Edited by Laila Racevskis, Sandra Batie, and Mary Schulz

Michigan State University

EPA-Universities Workshop Planning Committee

Name, Affiliation, and Address	Phone, Fax, and E-Mail
Sandra S. Batie Department of Agricultural Economics Michigan State University East Lansing, MI 48824-1039	Phone: 517-355-4705 Fax: 517-432-1800 batie@msu.edu
Gary Boersen Michigan Department of Agriculture P.O. Box 30017 Lansing, MI 48909	Phone: 517-335-3400 Fax: 517-335-1423 boerseng@msu.edu
Diana Holt Ohio Department of Natural Resources 23268 Stony Ridge Road Perrysburg, OH 43551-9695	Phone: 419-833-2010 Fax: 419-833-2020 dholt@amplex.net
Lawrence (Larry) W. Libby Dept. of Agricultural, Environmental, and Development Economics The Ohio State University 2120 Fyffe Road, Room 336 Columbus, OH 43210-1067	Phone: 614-688-4907 Fax: 614-688-3622 libby.7@osu.edu
David Macarus DRT-8J USEPA Region 5 77 West Jackson Boulevard Chicago, IL 60604-35507	Phone: 312-353-5814 Fax: 312-353-4788 macarus.david@epa.gov
Patricia E. Norris Department of Agricultural Economics Michigan State University East Lansing, MI 48824-1039	Phone: 517-353-7856 or 517-432-4129 Fax: 517-432-1800 norrisp@msu.edu
Vicki Pontz-Teachout Michigan Department of Agriculture P.O. Box 30017 Lansing, MI 48909	Phone: 517-355-3400 Fax: 517-335-1423 pontzv@state.mi.us
Larry G. Vance Division of Soil and Water Conservation Ohio Department of Natural Resources Fountain Square, Building E-2 Columbus, OH 43224	Phone: 614-265-6614 Fax: 614-262-2064 larry.vance@dnr.state.oh.us
Mark Wilson Ohio Department of Agriculture Livestock Permitting Division 8995 East Main Street Reynoldsburg, OH 43068	Phone: 614-387-0913 mwilson@odant.agri.state.oh.us

TABLE OF CONTENTS

Workshop Introduction and Summary

Sandra S. Batie
Workshop Co-Chair
Elton R. Smith Professor in Food and Agricultural Policy
Michigan State University

This workshop is the second of five annual workshops on the general theme of agro-environmental policy issues in the Great Lakes region. The series is sponsored by the U.S. Environmental Protection Agency (USEPA) with a grant program, as well as by Michigan State University, The Ohio State University, the Elton R. Smith Endowment in Food and Agricultural Policy at Michigan State, and the C. William Swank Program in Rural-Urban Policy at Ohio State. The planning committee members for this second workshop, listed on page two, bring expertise from state natural resource agencies in Michigan and Ohio, federal natural resource agencies, as well as academic research and education.

In July 2000, the U.S. Environmental Protection Agency (EPA) issued a final rule for implementing the Total Maximum Daily Load (TMDL) program. EPA describes a TMDL as a "pollution budget" designed to restore the health of a polluted body of water. Under the program, states are to identify polluted waters and establish a schedule for cleaning up these waters. For impaired waters, states are to identify the amount of pollutant allowable to meet standards and to determine the load reductions needed to meet standards. They then must allocate the load to various discharge sources and develop an implementation plan for reducing pollutants and meeting water quality standards.

Implementation of the TMDL program will be particularly challenging in rural watersheds, where a significant portion of discharges come from nonpoint sources, many of them privately-owned agricultural, forest, or mining lands. This workshop was designed to inform and foster conversations among agency personnel, academics, and stakeholders who will be involved in technical and policy issues related to making TMDLs work in rural watersheds. The purpose of the workshop was to serve as a catalyst for new ideas and approaches to implementing watershed-based water quality policy.

The workshop opened with two speeches addressing broad concepts. The first was from Dr. Peter (Pete) Richards on the current state of knowledge about nonpoint loadings. Dr. Richards is a Chemical Limnologist and Director of the Water Quality Laboratory at Heidelberg College. Dr. Richards' current research interests include the design of sampling programs for measuring nonpoint pollution in rivers and streams, the application of exploratory data analysis and statistics to environmental data, the detection of trends in environmental data, and the human and ecological health implications of pollutants in surface and ground waters.

Dr. Richards outlined the TMDL policy and the challenges it poses for rural watersheds. He noted that the very name, Total Maximum Daily Load, is a misnomer because Total is not necessarily "the total," Maximum is not necessarily "the maximum," Daily is not necessarily "daily," and Load is not necessarily "a load"! He then cautioned that while the TMDL approach is sound conceptually, it is often difficult to carry out in a specific watershed, especially when nonpoint sources are dominant. Specifically, nonpoint loads occur mostly during storm runoff events, but loads may not be the right measure for rivers and streams—concentrations are the appropriate measure. He then continued with a discussion of various monitoring and modeling methods available for load estimation, but cautioned that good, locally-reliable information is expensive to obtain. For load estimation from monitoring data, computer programs are available. He reminded the audience that accurate load estimates require adequate data that is intelligently collected. Furthermore, the entire process of developing and implementing TMDLs requires skill and the ability to work with people.

The second broad concepts presentation on finding the right tools for reducing discharges was given by Dr. Kurt Stephenson. Dr. Stephenson is an Associate Professor in the Department of Agricultural and Applied Economics at Virginia Polytechnic Institute and State University. Dr. Stephenson's research is in the areas of water resources and the use of economic incentives in environmental policy.

In his presentation, Dr. Stephenson noted that the goal of the TMDL program is the implementation of ambient water quality standards and that insight into implementing an ambient-oriented program can be gained from studying the Clean Air Act, a program that has been dealing with ambient goals for 30 years. Building on insights gained from studying air policies, Dr. Stephenson proposed that, in designing policies to achieve ambient water quality standards, water quality programs should strive to achieve two objectives. One, they should devise an effective means of establishing and maintaining an effluent load cap over time; and two, they should provide the discharger source the flexibility and incentives to respond to the changing demands of meeting an effluent load cap. He cautioned that there are several fundamental implementation challenges of an ambient water quality program in a rural area. This challenge of developing a performance-based implementation policy around discharge sources is costly to measure, monitor, verify, and track. A second challenge centers on overcoming a conventional focus on the installation of particular practices and technologies into one focused on discharger performance. He concluded by stating that there are opportunities to develop innovative approaches to nonpoint source implementation programs. The products of state and local efforts to manage rural watersheds is limited only by creativity and willingness to experiment. Innovative results can occur from borrowing ideas and meshing policies from different fields.

These broad conceptual speeches were then complemented by six case studies on policy and program innovations. Mr. John Folks with the Office of Water Policy Coordination in the Florida Department of Agriculture and Consumer Services presented a case on phosphorus monitoring and control in Florida. Mr. Folks presented some specific characteristics of the agricultural problems affecting Lake Okeechobee and the process of implementing a TMDL for the lake.

Lake Okeechobee is a regional multi-purpose water resource. It is the water supply source for both urban and agricultural uses. The lake is impacted strongly by high nutrient concentrations. Dairies are the main sources of phosphorous pollution. According to Mr. Folks, the key to the implementation of TMDLs will be the development of Basin Management Plans. Specific tasks include: basin assessment, coordinated monitoring, data analysis and TMDL development, basin management and plan development, and the implementation of a basin management plan.

The second case study on policy and program innovations was presented by attorney Robert Adler. Professor Adler is with the College of Law at the University of Utah. His presentation was on salinity control in the Colorado River. Specifically, Professor Adler discussed the Colorado River Basin Salinity Control Program which is divided into Upper and Lower Basin Programs. Under international treaties, the United States is obligated to deliver water of a certain quality to Mexico. The Lower Basin Program focuses on compliance with the treaty with Mexico, and involves large public works projects. The Upper Basin Program focuses on meeting interstate water quality standards. The program is enhanced because of its watershed focus. The program serves as a good analogy to the TMDL process. Although no formal TMDL standards have been developed for the Lower Basin Program, the process is driven by numeric water quality standards. Also, aggregate load reductions needed to meet the standards are calculated; projects are selected for funding based on projected reductions in salt loadings; and success is verified through ambient monitoring. By relying on an innovative bidding procedure, the program has considerably improved its cost-effectiveness.

As the evening banquet speaker, Ms. Jennifer Molloy with the Michigan Department of Environmental Quality brought the TMDL issues to the Michigan situation with her presentation on finding the most effective solutions for phosphorus reductions in the Kalamazoo River Watershed. Ms. Molloy shared her experiences of "walking the squiggly line" between the principles of watershed management and the requirements for TMDLs. She described watershed management as a community-driven process involving coalitions and partnerships of stakeholders involved in developing multi-faceted solutions designed to meet specific water quality based goals. The TMDL provides a framework from which to make water quality improvements while also providing a framework for watershed management.

The fourth case on policy and program innovations looked at implementing water quality regulations in Oregon. This case was presented by Mr. Roger Wood with the Water Quality Division of the Oregon Department of Environmental Quality and Mr. Michael Wolf with the Water Quality Program in the Natural Resources Division of the Oregon Department of Agriculture. Mr. Wood described how the Oregon Plan was developed to bring together numerous state and community efforts to address water quality and habitat enhancement issues. Under the Oregon Plan, individuals, communities, and state and federal agencies have engaged in collaborative problem solving over watershed issues. Mr. Wolf described how Oregon's Agricultural Water Quality Program provides a statewide framework for a voluntary and regulatory program to be implemented on a watershed scale throughout the state. The program provides an outcome-based, non-prescriptive approach for agricultural landowners to meet water quality standards and goals. Because climate, water quality issues, and agricultural commodities are extremely diverse across the Oregon landscape, each watershed has different needs. The program is therefore implemented locally, based on watershed-specific approaches.

Two additional case studies on how communities can make TMDLs work were presented. Ms. Monica Ostrand with the Sandusky River Watershed Coalition presented the Sandusky River Watershed case. Ms. Ostrand highlighted the principal public watershed concerns for the Sandusky River Watershed as 1) agricultural impacts; 2) drainage and water quantity; 3) the need for more information; 4) wastewater disposal; 5) litter and spills; and 6) sprawl. The implementation of the TMDL will require public involvement, education, and a nonpoint source component. The coalition believes that watershed health equals community health. The program is trying to raise awareness and is working toward local control and gaining support from the government. Overall, the program is setting a good example for making TMDLs work in rural watersheds.

The final case study on how communities can make TMDLs work was presented by Ms. Kathy Evans with the Muskegon Conservation District. Ms. Evans presented the

Muskegon Lake Public Advisory Council case. The Muskegon Lake Public Advisory Council took a sub-basin approach to deal with its watershed problems. There are three TMDL tributaries: Ruddiman Creek, Ryerson Creek, and Bear Creek. Volunteers and students became more aware and involved through hands-on activities, newsletters, and articles. Dedicated citizens with local, state, and federal partners have become personally and professionally committed to the cleanup of the Muskegon River Watershed. Regardless of what the issues are, all watershed efforts require early and broad representation of all stakeholders.

The final session with Dr. Jo Ann Beckwith explored "How do we know when we are meeting TMDLs?" Dr. Beckwith is an Assistant Professor in the Department of Resource Development at Michigan State University. Her presentation reflected her expertise in the psychology of environmental decision-making. Dr. Beckwith noted that there is a technical context to TMDLs as well as a socio-political context that is critical to their implementation and success. The criteria of a good implementation plan include fairness or justice, efficiency, wisdom, and stability. As part of implementing the plan to reduce loads, we need to change behaviors. Implementation plans often identify the threats or hazards and present information on how to lessen the risks. They typically do not address beliefs and influences relative to the target behaviors. Clear action recommendations and steps to minimize barriers to action are needed. Gaining an understanding of beliefs and behavioral influences requires collaboration with local target audiences. It also requires their involvement in the planning and implementation phases.

Dr. Lawrence (Larry) Libby offered a closing response and summary of the workshop. He reminded us all that TMDL is a process as much as it is a product. "A collective effort is at the heart of successful water quality improvements."

Speakers did not prepare final papers. This workshop report presents the major points developed by each speaker and summarizes points offered from the floor. Speakers' slide presentations are accessible in the Seminars and Workshops section on the Michigan State University Elton R. Smith Endowment website at www.aec.msu.edu/agecon/smith_endowment/index.htm.

What Do We Know About the Nonpoint "L" in "TMDL"?

Pete Richards
Director, Water Quality Laboratory
Heidelberg College

The TMDL Concept

The TMDL concept is a broad concept that can be perceived in many different ways. There are various ways in which the acronym can be understood:

Total— This term can be interpreted as the total quantity, the portion that is biologically available, the accumulative amount or the amount above some threshold—but it usually includes the meaning "quantity from all sources."

Maximum— It may not always be the maximum that we are interested in; we may be interested in the minimum as well.

Daily— Are we concerned about the daily load, the annual load, or the load during the winter season or the warm season or the breeding season? High loads that occur during short periods of time may be what is important in some environments, whereas in others it is the long-term total load that is important.

Load— While TMDLs usually involve loads, they may instead involve concentrations, fluctuations, lack of fluctuations, accumulated deviations over time, or frequency/duration above a threshold (e.g., concentrations of herbicides must be maintained for a certain period of time to be damaging).

Also, the Total Maximum Daily Load has three parts:

TMDL = Loading Capacity = Waste Load Allocation (Point Sources) + Load Allocation (Nonpoint Sources) + Margin of Safety (Uncertainty)

The size of the Loading Capacity "pie" reflects the capacity of the system to absorb the load without damage. The focus of TMDL work lies in determining which of the three components of the Loading Capacity receives the largest portion of the load.

The TMDL process is a cyclical one that involves the following steps: 1) Identify water quality-limited waters, 2) Prioritize them for remediation, 3) Develop TMDLs, 4) Implement controls, and 5) Assess results. The TMDL development process requires identification of the problem, indicators of the problem, and numeric targets. It is also necessary to identify the sources of the loads and estimate the magnitude of the loads from each source, link sources with the numeric targets, and estimate loading capacity. Loads are then allocated among sources and a monitoring and review plan is developed. Finally, an implementation plan is developed. This process is not easy to carry out, and questions are often raised about its reliability.

The level of detail and difficulty involved in a TMDL tends to be greater in larger watersheds, when the problem involves use impairment rather than standards violations, when there are many sources of impairment, when nonpoint sources are an important component, when the processes involved are complex, and when the ecological principles involved are not well understood. Difficult TMDLs require more data and more resources.

Many points of contention may arise in the development of TMDLs:

- Is this water body really impaired? How do you know?
- What is causing the impairment?
- What should things really be like?
- Do you have the correct loading capacity?
- Have you identified the right sources and allocated the loading capacity in a reasonable fashion?
- Who is responsible for the nonpoint-source load?
- Who is going to pay for the clean up?

The process of TMDL development is usually carried out at the state level, and this adds complexity to the problem. Different states have different regulatory histories and philosophies, and different approaches and attitudes toward TMDLs. Interest groups and motivations differ among states whose economies are based on tourism, industry, or agriculture, forestry, and mining.

Nonpoint Source Processes and Water Quality

Nonpoint source processes are driven by the hydrologic cycle. These nonpoint processes are a direct consequence of rainfall and therefore are driven by storm events. In the Midwest, nonpoint processes are dominated by agriculture, because most of the rain falls on farmland. Rainfall falls on the land, picks up contaminants, and flows overland and through tile systems to streams and from there into larger rivers and ultimately into large lakes like the Great Lakes or into the ocean.

Rivers are highly variable systems. The day after a rainstorm, the water is loaded with sediment, and particles may travel many miles before settling. The sediment is a carrier of phosphorous, metals, and organic nitrogen. Nitrates enter the system primarily through tiles, and is carried in the dissolved state, not attached to sediment particles. The amount of discharge and contaminant transport varies greatly from storm event to storm event, in response to the amount and intensity of rainfall, the time of year, the condition of crops, the soil moisture content, and many other factors.

There are significant differences in doing a TMDL for a lake or for a river. TMDLs for lakes involve dealing with loads, whereas TMDLs for rivers and streams deal with concentrations. For a lake, tributary loads determine in-lake concentrations; they are often dominated by nonpoint runoff and follow the "80/20" rule (80% of loading occurs in 20% of the time with highest flows). For a river or stream, storm events are abnormal times, and stream organisms tend to take shelter and simply wait for them to pass. Processes during low-flow times are critical, and local point sources are often important for TMDLs in rivers or streams. Habitat quality is also important.

A Pre-TMDL TMDL Project—Fixing Lake Erie

Lake Erie was considered a "dead lake" in the 1970s. The problem was identified as anoxia in hypolimnion[1], and indicators were identified to be total phosphorous loads from both urban and rural nonpoint sources. The loading capacity was estimated as

11,000 metric tons per year, and loads were allocated among various sources. An implementation plan was developed that included Best Management Plans aimed at sediment and phosphorous; conservation tillage, buffer strips, and CRP programs; and fertilizer management. River monitoring and annual point source reporting was conducted and the loading goal was met in 1985. The assessment of results showed improvement in anoxia in hypolimnion, and the lake was well on its way to a successful recovery.

Before recovery was complete, however, the zebra mussel invaded Lake Erie, accelerating improvements in water clarity, but profoundly altering the ecosystem. Now the future state of health of Lake Erie is an open question once again, but for a different reason.

Some Tools for Assessing Nonpoint Loads

Tools used for assessing loads include either models or monitoring, both of which are costly when done thoroughly. Both have a place and should be used, but resource limitations often prevent the use of both methods. The following discussion addresses tools for determining loads when monitoring data are available.

The load is the mass of a substance that passes a point in a given interval of time and is measured as the continuous integral of flux over time. However, loads are not measured continuously. Rather, they are measured at discrete points in time. Therefore, it is difficult to determine what pattern the loads followed between the discrete time points that were not measured. Flux is measured as the product of concentration and flow. Usually more flow measurements are available than concentration measurements, because of analytical costs. The additional flow data tells us something about what happened between time characterized by concentration measurements. Therefore the main problem for load estimation is filling in the "missing" concentrations.

Estimating loads from monitoring data can be approached in at least four different ways. The first approach is numeric integration. Each concentration is multiplied by the flow at the time of the sample, and by the time between samples, to obtain a load represented by the sample. These loads are summed to obtain the total load (e.g., an annual or monthly load). This approach is easy to understand and calculate and can be done with a spreadsheet. However, it is unreliable unless sampling is frequent enough to resolve peak loading times.

The second method of calculating loads is a regression approach, in which a relationship is developed, during a "calibration period," to predict concentrations using other parameters, especially flow. This approach provides a statistical model that can be used in the future to estimate concentrations for each day of the year. It has relatively small data demands, yields an uncertainty estimate and can be done with a spreadsheet. Its disadvantages are that there is often a retransformation bias, and the results can be misleading if the assumptions of the regression approach are not met.

The third approach uses ratio estimators that are usually used with flow and/or seasonally stratified sampling. This method is biased in its simplest form, but the Beale Ratio Estimator, widely used for load calculations in the Great Lakes tributaries, includes a bias correction term.

The last approach calculates loads by multiplying average flow by average concentration. It is a method that should be avoided. The results are often severely biased and will be low if flow and concentration are positively correlated and high if they are negatively correlated. Loads calculated in this way can easily be off by a factor of two when compared to the true loads.

Computer programs are available to calculate loads by each of the first three approaches. A guidance document describing preferred methods for calculating loads is available (as of this writing) at www5.bae.ncsu.edu/programs/extension/wqg/issues/loadestimation.pdf.

Summary

The TMDL approach is sound conceptually, but it is often difficult to carry out in a specific watershed, especially when nonpoint sources are dominant. Nonpoint loads occur mostly during storm runoff events, but loads may not be the right measure for rivers and streams. Monitoring and modeling are the available methods for load estimation, but good, locally-reliable information is expensive to obtain using either approach. For load estimation from monitoring data, computer programs are available to carry out the preferred methods. Accurate load estimates require adequate data that is intelligently collected. The entire process of developing and implementing TMDLs requires skill and the ability to work with people.

Additional points from discussion

- The sediment carried in a watershed results in settling, embeddedness in gravel, siltation and problems for fish.
- The total quantity of the sediment may be irrelevant. Only a piece of the load is important in the stream.
- Qualitative practice versus numerical: Are we trying to quantify something that is not quantifiable? Relevance of a practice-based standard versus a numerical-based standard in terms of nonpoint source pollution?
- When using surrogate measures, one should have some idea of lag time of system response and assume a linkage exists between implementations and outcomes.
- Is the strategy to implement practice and then evaluate the results? That is, to put practices in, and then observe results. Answer: yes, and the cyclic nature of the TMDL process means that you observe the results in order to modify the practices if necessary, then observe and modify further until the desired outcome is achieved.

(Footnote)

[1] In the summertime, large bodies of water such as Lake Erie develop a three level structure, with warm water on top and cold water on the bottom and a transition zone in the middle. This is called stratification. The bottom water is basically isolated from the surface until cooling in the autumn brings the surface water back to the temperature of the bottom water. The top level is called the epilimnion, the bottom layer is called the hypolimnion, and the transition middle layer is called the thermocline.

Finding the Right Tools for Implementing TMDLs in Rural Watersheds: Avoiding the Square Peg-Round Hole Dilemma

Kurt Stephenson
Department of Agricultural and Applied Economics
Virginia Tech

There are lessons to be learned about implementing TMDLs from programs other than the water quality program. Because these lessons have largely been left unexplored, the dilemma of the "square peg in a round hole" has been avoided. However, there is much to learn by sharing implementation experiences across different nonpoint source programs.

Ambient Water Quality Standards

The goal of the water program is the implementation of ambient water quality standards. Insight into running an ambient-oriented program can be gained from studying the Clean Air Act, a program that has been dealing with ambient goals for 30 years.

The Clean Air Act aims to maintain air quality standards in order to protect human health. The air criteria and objectives established by the EPA are clearly identified, uniform, and centralized. The water program, however, should not follow this course. Water criteria are more likely to be non-uniform and have decentralized objectives. The objectives of the Clean Water Act are to restore the biological, chemical, and physical integrity of the nation's waters and make them "fishable and swimmable." However, more specific goals need to be established. The overall goal encompasses the protection of human health as well as the designation of waters for recreational, ecological, and biological uses. There is less direction and more latitude in identifying and defining designated uses for water than for air.

Designated water uses and water quality goals should not be expected to be uniform across watersheds. Rural residents in agricultural areas cannot be expected to meet the same water quality standards as those who live in less developed areas that have large tracts of undisturbed land. The EPA does not have a delegated responsibility to establish uses and criteria for water quality goals. Therefore, this responsibility should lie with states and localities. To date, however, relatively few resources have been devoted by any level of government to develop strategies for devising or revising water quality standards. It seems as though implementation of TMDLs has been rushed without considering the prior question of why they are being done.

Attempting to implement standards that do not make sense to the people asked to implement them will not result in long term success. It is much more important to build local support for the water program than it was for the air program. Implementation will be even more difficult without defensible ambient goals that have the support of local communities. Water quality goals need to be built from the ground up, not the top down.

An ambient water quality program requires the identification of waters that fail to meet water quality criteria. However, this identification process requires the establishment of many detailed rules and criteria. These issues are currently being addressed by the EPA and states as part of the TMDL program. The air program has 30 years of experience in dealing with the rules of meeting air quality standards, however there has been little communication between the air and water programs on this issue.

Implementation Policy for Managing Discharges in Rural Watersheds

In designing policies to achieve ambient water quality standards, water quality programs should strive to achieve the following two objectives:

1) devise an effective means of establishing and maintaining an effluent load cap over time; and
2) provide the discharger source the flexibility and incentives to respond to the changing demands of meeting an effluent load cap.

One fundamental implementation challenge of an ambient water quality program in a rural area is developing a performance-based implementation policy around sources whose discharge is costly to measure, monitor, verify, and track. A second challenge centers on overcoming a conventional focus on the installation of particular practices and technologies to one focused more on discharger performance.

There are things to learn in terms of both successes and difficulties from other programs. There is not a perfectly transferable model or policy that is waiting to be discovered. Rather, there are elements of other programs that can be instructive for nonpoint source situations.

The point source NPDES permit program is ill-equipped for addressing nonpoint sources in an ambient-oriented program. It presents implementation difficulties because it is fundamentally about installing and maintaining individual technologies. The program creates disincentives for pollution prevention and is criticized for being costly and inflexible. There is not much opportunity within the program to achieve the objectives of implementing an ambient water quality program or to overcome the obstacles of implementing such a program.

One obvious challenge of a nonpoint source program is monitoring, tracking, and verifying nonpoint source activity and loads in a cost effective and comprehensive manner. Part of the problem is that discharge sources are numerous and dispersed. Yet, these challenges are encountered in many environmental regulatory programs. How do other programs strive to bring a large number of dispersed and largely unaccounted sources into a management program? The state of Massachusetts was able to bring many small sources of air emissions into one regulatory program, for example. The Environmental Results Program registered small and medium dischargers and was able to consolidate performance and compliance into one program in a low cost way. The program places the responsibility for compliance on the dischargers who are required to report discharge levels annually. The system is analogous to the tax system in that it is up to the dischargers to comply or be identified as evaders.

Effluent allowance markets allow voluntary load reallocations by permitting dischargers to buy and sell their rights to discharge. There are a limited number of allowances that sum to equal the effluent load cap, or the sum of wasteload and load allocations. A well functioning market requires clearly defined rules, property rights, discretion to respond to price signals, and low transaction costs. The air program created an allowance market for SO_2 that successfully reduced emissions and has had no compliance problems. However, there are other emission trading programs created by the air program that have not been as successful. There is much to be learned from the air program about establishing markets for tradable discharge rights.

Trades with unregulated sources generally involve exchanges between regulated point sources and unregulated nonpoint sources. There is debate about how to make equivalent reductions between the two sources and how to assure that controls on the unregulated nonpoint source will actually occur. The current approach lies in a regulator-identification of equivalent loads and enforcement occurs by putting conditions for the nonpoint source in the point source's permit. The initial development of a market for carbon sequestration credits can provide alternative measurement, monitoring, and enforcement strategies for a nonpoint source trading program. Achieving ambient goals does not necessarily have to be about reducing effluent load. It can also be about increasing the assimilative capacity of the system to absorb these loads.

Concluding Thoughts

Avoiding the risk of the "square peg-round hole" dilemma will be easier if we have a clear idea of what we want out of our watersheds and seek implementation programs that emphasize performance and flexibility. There are many related experiences and programs that have not been explored and there are opportunities to develop innovative approaches to nonpoint source implementation programs. The products of state and local efforts to manage rural watersheds is limited only by creativity and willingness to experiment. Innovative results can occur from borrowing ideas and meshing policies from different fields.

Additional points from discussion

- Why would homeowners want to be held responsible?
  Homeowners are responsible for stormwater discharges in Virginia, this may not apply to all situations. There needs to be regulation, otherwise there will be free riders. Mechanisms assess homeowners by geographic location.
- There is an already existing tension between TMDLs and the zero discharge goal in the CWA. It does not have a large impact, yet regulators behave on that component, which is at odds with the TMDL concept. The zero discharge goal is not an operable one, but people interpret it as operable. It is operable for a particular category of point source discharge.
- There is a trade-off between localized information and an organizing entity at the county level.
- TMDLs are sometimes on water segments 100 to 200 yards long. The system is unmanageable if broken into too many small components; the scale needs to be larger.
- There is an optimal load that is not zero, but that is not in conflict with the NPDES system.
- The use designation dialog needs to take place at the state level. Sometimes it needs to be acknowledged that we will not achieve use designations. The streams across states will have different uses, and we need to discuss and acknowledge this.
- There are tiered uses in Ohio but not in Virginia. We need to have tiered uses in more states.

TMDLs in Florida: The Okeechobee Story

John Folks
Florida Department of Agriculture and Consumer Sciences, Director
Lake Okeechobee Restoration Program

Background and Scientific Facts

Rivers and streams in Florida account for 20,000 miles of listed segments and lakes account for another 300,000 acres. Sediments, nutrients, pathogens, metals, and dissolved oxygen are pollutants that have a basis for being listed nationwide. Eutrophication has been identified as the main cause of impaired surface water quality in Florida, and the intensification of animal operations have contributed to regional nutrient imbalances.

TMDL Legislation

Following the Clean Water Act Section 303(d) listing requirements, a list of waters that do not meet applicable water quality standards was submitted to EPA. Under the CWA requirements, TMDLs need to be established and implemented for these waters on a prioritized schedule. The original planning list for Lake Okeechobee was submitted April 1, 1998, and approved on November 24 of the same year. The approved list contains 711 segments, or approximately 590 water bodies.

The 1999 Florida Watershed Restoration Act clarified statutory authority for TMDLs and defined the approval process. It also establishes that the 303(d) list of impaired waters submitted to EPA is for planning purposes only. The Watershed Restoration Act requires the Florida Department of Environmental Protection (FDEP) to adopt listing criteria by rule, to validate the impairment of listed waters, establish basin-specific lists and to adopt these lists by Secretarial Order. The legislation also requires the FDEP to coordinate with the five water management districts, the Florida Department of Agriculture and Consumer Services (FDACS), regulated parties, environmental groups, and others during all phases of TMDL implementation. The FDEP is required to adopt TMDLs, including allocation by rule. The legislation directs FDACS to develop interim measures and Best Management Practices (BMPs) to address agricultural nonpoint sources. If adopted by rule and FDEP verifies that the practices are effective, then implementation provides presumption of compliance with water quality standards.

The key to the implementation of TMDLs will be the development of Basin Management Plans. Specific tasks include: basin assessment, coordinated monitoring, data analysis and TMDL development, basin management and plan development, and the implementation of a basin management plan. Effective TMDL implementation in Florida will only be realized when cooperatively developed by the FDEP, FDACS, and WMDs. Basin stakeholders must come to the table to participate in the development of scientifically sound and rational BMPs to meet state water quality goals.

Florida's First TMDL: Lake Okeechobee

Lake Okeechobee is a regional multi-purpose water resource. It is the source of Class I water supply for both urban and agricultural uses. Class I water sources meet maximum water quality requirements and standards. The lake is used to keep salt water from intruding on ground water, it is a holding pond for storm water, and it is used for drinking water and irrigation. The lake also provides flood protection and wildlife habitat and is used for navigation, fishing, and recreation.

The lake has a large surface area, but it is relatively shallow, measuring approximately 1,800 square kilometers with a mean depth of three meters. It is impounded by a dike with gates and locks. Water levels can be controlled in part by discharges determined by a "regulation schedule." The total annual load is 593 metric tons, and this load needs to be reduced by 75 percent.

Nutrients

The lake is impacted strongly by high nutrient concentrations. There have been high phosphorous loads in the last 50 years. Dairies are the main sources of phosphorous pollution. Since Florida started a dairy buyout program, the number of dairies has decreased, but the number of cows has increased, and phosphorous concentrations have not changed significantly. Dairies make up two percent of the land area around Lake Okeechobee, and pollution has been attributed to the dairies. However, the major contributor to the pollution is more likely to be the pastures and not the dairy operations.

Best Management Practices (BMPs) are being examined on every agricultural operation. An agricultural nutrient management assessment for each operation in the area will be conducted to determine the inputs, outputs, and BMPs for each. Other watershed initiatives include tributary sediment removal, isolated wetland restoration, and urban BMPs. There are numerous projects currently proceeding for Lake Okeechobee, including two pilot stormwater treatment areas, ten isolated wetland restorations, and agricultural and urban BMP implementation. Current in-lake nutrient studies include a sediment removal feasibility study, pilot dredging study, and investigation of dredging impacts on internal loading. Water quality and hydrodynamic models are also in development, and long-term ecological monitoring is being conducted.

FDACS will use existing cow/calf BMPs, citrus BMPs, and University of Florida generated BMPs as interim measures. BMPs will be developed in conjunction with producers, FDEP, and WMDs for specific agricultural operations. If water quality problems are detected despite BMP implementation, operation, and maintenance, FDACS will reevaluate the BMPs or other measures.

There are several critical issues involving phosphorous. All existing phosphorous data is in concentration and those in compliance under concentration are not in compliance with load. There is no flow data, and the source of the phosphorous has not been clearly determined. A cost effective treatment needs to be developed.

Additional points from discussion

- Is there an adaptive management process in place to inform decision-makers in the future? There has been record-keeping and the action plan has been documented. We do not know where the increased P flow is coming from and will invest a great amount addressing dairies, but we still will not know if this is the right thing to do.

- Remote sensing is being used to determine the phosphorous content of the soil.
- Soil samples indicate where watering troughs and feeders were located. No consolidated records show where sludge is coming from nor its amount.
- BMPs are implemented, each operation is assessed, and technologies are applied to reduce loads. Allocations are made back to sub-basin level to determine which operation is in compliance.

The Colorado River Basin Salinity Control Program: Lessons for Nonpoint Source TMDLs

Robert W. Adler
Wallace Stegner Center for Land, Resources and the Environment
University of Utah College of Law

Watershed Characteristics

The Colorado River Basin is a large and diverse watershed measuring 157 million acres, or 1/12 of the continental United States. The area is physiographically and environmentally diverse, ranging from the Rocky Mountains in the northeastern portions of the watershed to the Sonoran Desert region in the southwest. Most of the basin is arid, requiring extensive irrigation for agriculture. The natural hydrology is extremely seasonal, and the water needs to be stored in reservoirs if it is to be used for irrigation and other human uses. There has been tremendous growth in concentrated urban uses.

Impacts of Water Storage and Use

The Colorado River is the most managed water system in North America. The massive artificial storage system in the watershed can hold four times the average annual flow of the river, the largest such ratio of any watershed in the world. Water storage and use has caused major transformations in the hydrology and ecology of the area. Water flow patterns, sediment flow patterns, and temperature regimes have changed significantly, causing or contributing to the extinction or near extinction of endemic species.

Salinity

The Colorado River system is naturally saline, but diverse human alterations have roughly doubled natural salinity concentrations, with large increases in salinity as the river flows south to the Mexican border. The largest artificial sources of increased salinity are inefficient irrigation systems and practices. Over-irrigation of crops and unlined canals cause excess water to enter the soil, which leaches salts from ancient marine shales and soils. Point sources of salinity include oil and gas wells, mining operations, and sewage treatment plants. Salinity can also result from erosion caused by land use changes (e.g., grazing, road construction, and development) and consumptive water use.

An impact of salinity is reduced crop yields and increased production costs for tile drains, leveling, and other such activities. In extreme situations, agriculture may even be eliminated. Economic costs of salinity damage to agriculture and other human uses are estimated to be at least $750 million per year.

Salinity Control Program

The Colorado River Basin Salinity Control Program—divided into Upper and Lower Basin Programs—involves cooperation among the U.S. Bureau of Reclamation, the Colorado River Basin Salinity Control Forum, and other federal agencies such as the Bureau of Land Management, the U.S. Department of Agriculture, the U.S. Environmental

Protection Agency, the U.S. Fish and Wildlife Service, and the U.S. Geological Service. Over $700 million has been spent on the program since the early 1970s.

Under international treaties, the United States is obligated to deliver water of a certain quality to Mexico. The Lower Basin Program focuses on compliance with the treaty with Mexico, and involves large public works projects. These projects have included the diversion of saline irrigation drainage and delivery of replacement water through ground-water pumping and lining of major irrigation canals. There is also a massive desalination plant at the border in Yuma, Arizona, although that facility has never been operated due to the effects of other programs. On-farm assistance programs in the 1970s and 1980s implemented irrigation efficiency improvements and land use retirement.

The Upper Basin Program focuses on meeting interstate water quality standards based on flow-weighted averages that are mass-based as opposed to concentration-based. In the original program, salinity sources were identified throughout the basin and "salinity control units" were selected for targeted spending. Point source controls have been implemented, such as "well plugging" and saline ground water diversion. Efficiency improvements have been achieved through canal lining and on-farm irrigation improvements such as sprinkler installation, which is more efficient than flooding.

Program Results and Subsequent Modifications

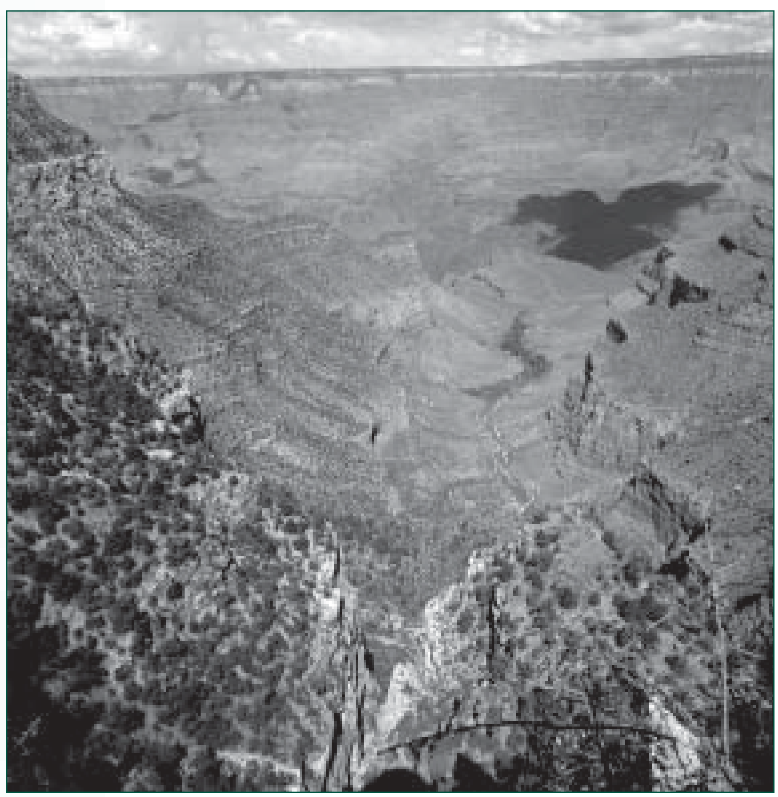
By 1994, approximately $360 million had been spent on the salinity control program. Numeric salinity standards and treaty requirements had been met and program officials estimated salinity reductions of 341,000 tons per year. However, the cost-effectiveness of the program varied widely (from $5 to $138 per ton). There was little incentive to save money because almost all costs were reimbursable. Relatively little focus was placed on on-farm improvements.

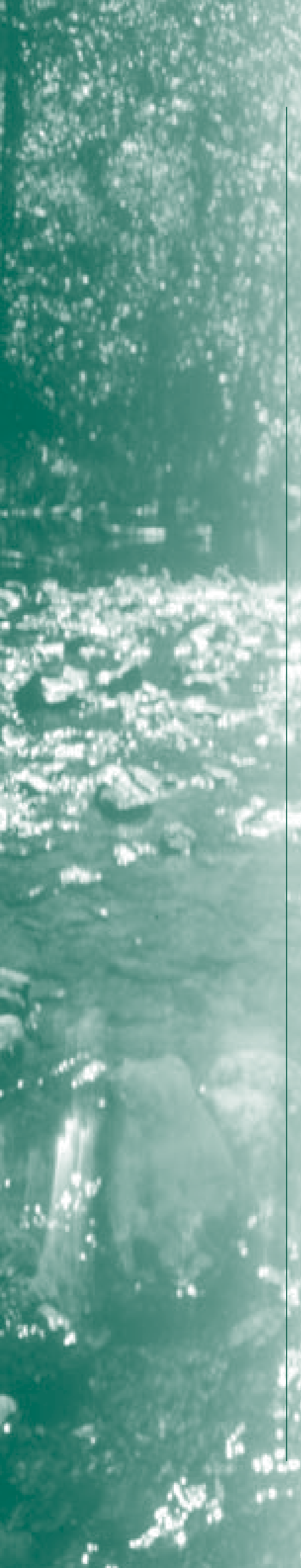
An amendment by Congress in 1995 authorized a basinwide program which eliminated the need for project-specific legislation and allowed private as well as public projects. In response, program officials developed a competitive bidding program designed to identify the most cost-effective means of future salinity control. The program induced private markets to come up with control projects that are less expensive than public works projects. Cost effectiveness was successfully improved (average project costs have dropped in half per ton of estimated salt removal) and partnerships were stimulated that would not have occurred previously.

Additional points from discussion

- The program is enhanced because of its watershed focus. The program works through a cooperative, interstate decision-making body and control targets are identified through basinwide resource assessments. The program strives to achieve integrated consideration of water quality, water quantity, and other environmental factors.
- The program serves as a good analogy to the TMDL process. No formal TMDL standards have been developed. However, the process is driven by numeric water quality standards; aggregate load reductions needed to meet the standards are calculated; projects are selected for funding based on projected reductions in salt loadings; and success is verified through ambient monitoring.

- Competitive bidding has improved the cost-effectiveness of public spending and encourages project innovation. Bids are submitted by both private and public organizations. Coalitions of interests are developing and submitting bids cooperatively because it is in their mutual interest. Small companies are preparing bids for farmers who otherwise would lack the capacity to compete in the program.
- Significant limitations to the program remain. Despite competitive bidding it is not a true "market" program because it is still based largely on public funds and depends heavily on stable program funding. Benefits have a long lead time and accountability is uncertain due to questions about the adequacy of monitoring and modeling efforts and significant environmental variability. Some projects are limited by institutional uncertainty. For example, environmental groups have submitted bids to reduce salinity by retiring farmland, but these projects have not been funded because they are considered high risk due to uncertainty in the applicability of western water law.





The Kalamazoo River Watershed:
Balancing Watershed Management Principles and TMDL Requirements

Jenny Molloy
Michigan Department of Environmental Quality

The Kalamazoo River watershed occupies 2,000 square miles and spans 10 counties. The watershed consists of urban, suburban, and agricultural areas. One hundred years ago this was a high quality watershed. Also, at one time there were 15 paper mills in the area that contributed to the pollution of the river ecosystem. As a result, geographically, this watershed is now the longest Superfund site in the country. This particular TMDL is a phosphorus TMDL for Lake Allegan, an impoundment of the Kalamazoo River.

Watershed Management Principles

Watershed management is a community-driven process involving coalitions and partnerships of stakeholders involved in developing multi-faceted solutions designed to meet specific water quality based goals. The principles of watershed management are:

1. Assessment of the nature and status of the watershed ecosystem;
2. Define short and long term goals;
3. Determine objectives and actions needed to achieve selected goals;
4. Consider benefits and costs of each action;
5. Document plan and obtain commitment for actions;
6. Implement actions; and
7. Evaluate effects of actions and progress toward goals.

Community TMDL Development Process for Lake Allegan

Lake Allegan is a shallow lake that measures 1,500 acres and lies in a 1,600 square mile watershed. It is eutrophic, with high phosphorus concentrations. Considerable water quality sampling has been done in the lake.

The TMDL provides a framework from which to make water quality improvements. It also provides a framework for watershed management, which becomes more of a community-driven process.

Committees were convened early in the TMDL process. A technical committee was established to review existing water quality data and to estimate the assimilative capacity of Lake Allegan. The committee explored the multiple variables influencing phosphorus inputs and the likelihood of reductions from various sources. An implementation committee developed a phosphorus reduction plan. The reduction targets require a 23 percent reduction in phosphorus from point sources in July, August, and September. An aggressive 50 percent target was set for nonpoint sources, which are the source of most of the largest phosphorus loads. Additionally, the need to allow for increased capacities at municipal waste water treatment facilities was identified.

The cooperative agreement with operators of NPDES-permitted facilities calls for each to collectively meet the 23 percent reduction allocation, and to meet with others and provide annual reports to the community and Michigan Department of Environmental Quality (MDEQ) as to individual and collective progress meeting the TMDL wasteload allocation. They also agree to assist in nonpoint source reduction planning and implementation. MDEQ agrees to keep current phosphorus limits in permits for one permit cycle (five years) and to continue seasonal monitoring of the Kalamazoo River and Lake Allegan.

To date, point source efforts in the nonpoint source reduction efforts include facilitating a workshop for nonpoint source planning, river monitoring, and funding for the nonpoint source modeling effort.

The EPA is looking for reasonable assurance. In this watershed there are myriad of activities related to phosphorus reduction. Many BMPs are being implemented as well as education programs. Approval of the TMDL is expected soon.

Additional points from discussion

- Some people never buy into cooperative agreements. Momentum is needed to get a critical mass of people to move toward a goal. There is a critical mass in this watershed.
- There is a water quality trading demonstration project that is doing careful monitoring to determine how to develop credits from water quality trading. No actual trades have been exacted, but the state rules have been preliminarily approved.

Implementing Water Quality Regulations in Oregon—Perspectives from Oregon Department of Agriculture and Oregon Department of Environmental Quality

Michael Wolf
Oregon Department of Agriculture and
Roger Wood
Oregon Department of Environmental Quality

Under the leadership of Oregon's Governor, the Oregon Plan was developed to bring together numerous state and community efforts to address water quality and habitat enhancement issues. Under the Oregon Plan, individuals, communities, and state and federal agencies have been brought together to engage in collaborative problem solving over watershed issues. It includes commitments by state and federal agencies to conduct management programs in a manner that contributes to watershed health and salmon recovery.

The goal of the Oregon Plan is to identify and implement community based solutions to improve water quality, to improve the condition of riparian areas, and to ultimately remove species from lists of threatened and endangered species. It is an attempt to recognize the importance of attitudes, beliefs, values (that is, how we view our place in the world), and therefore, the effort involves sociology as well as the physical and biological sciences. Under the Oregon Plan, there has been a high degree of cooperation among local partners, regional agency teams, state implementation outreach and monitoring teams and others. The Oregon Plan has established 92 Watershed Councils in the state, covering almost all of the state's land surface area. Local residents are appointed to the Watershed Councils by local government. The formation of the councils was not mandated and council responsibilities are not defined in statute, but Oregon has developed guidelines under which they operate.

Oregon's Agricultural Water Quality Program provides a statewide framework for a voluntary and regulatory program to be implemented on a watershed scale throughout the state. The program provides an outcome-based, non-prescriptive approach for agricultural landowners to meet water quality standards and goals. Because climate, water quality issues, and agricultural commodities are extremely diverse across the Oregon landscape, each watershed has different needs. The program is therefore implemented locally, based on watershed-specific approaches.

Agricultural landowners are offered flexibility in choices of best management practices to implement on their individual operations. There are voluntary opportunities to comply. Performance-based conditions have been established that must be achieved by all landowners. A menu of practices is offered to landowners, such as cover crops, sediment retention ponds, conservation tillage, or buffer strips to deal with erosion control. Any of these practices can be chosen, as long as the landowner achieves the necessary conditions on the land. Regulatory "backstops" to assure compliance with performance-based conditions are available and enforceable by the Oregon Department of Agriculture, if efforts to achieve compliance voluntarily fail and it is necessary to enforce compliance.

Diverse water quality issues and geographic conditions, along with a highly diverse agriculture in Oregon, provide for a highly complex and challenging environment. Addressing water quality and habitat enhancement issues requires a long-term, sustainable effort. It is essential to recognize the diversity of the landscape, the diversity of the public, and the limits of science and government when developing landscape based approaches. Public understanding, support, and involvement over the long term are needed. Water quality program goals and objectives need to be clearly defined. Choices and flexibility in selection of site-specific solutions that work within their management structure is critical for landowners. Steady progress is important, patience in achieving biological improvements at the watershed scale is essential, and adaptive management approaches will be needed as new information becomes available and as effectiveness of current efforts can be evaluated.

The merits of Oregon's program are that it provides flexibility for landowners and engages them in a creative problem-solving process at the local level. The program offers the opportunity for generating initiative, creativity, and innovation by allowing landowners to come into voluntary compliance with the desired outcomes and watershed goals.

There are some important issues and concerns regarding Oregon's program and approach that need to be considered. Federal agencies have expressed reservations about the "outcome-based" approach. This approach can be more difficult to quantify and implement than a prescription or practice-based approach because it requires more monitoring, adaptive management, and the ongoing direct involvement of all parties in collaborative problem solving. There are also landowner concerns about the new regulatory environment. Landowners want assurance that their individual and cumulative efforts will achieve the desired watershed goals. It takes time to see results in terms of changes in biological ecosystems, and monitoring—for water quality and habitat improvement trends, and for effectiveness—is important. TMDLs should not be developed in isolation or out of context, and it is important to integrate TMDL development and implementation efforts with watershed-based groups and to work together and leverage efforts and resources with other conservation initiatives to achieve mutual program goals.

Additional points from discussion

- Small scale monitoring projects in a limited number of watersheds where the program has been implemented over the past five years show improving trends over time in ambient water quality. Resources have been generally targeted toward the sub-basins providing the highest loadings of nutrients and sediment and those with relatively low dissolved oxygen levels. There have been significant reductions in total phosphorous in these sub-basins over the past five years.
- The Agricultural Water Quality program requires that watershed-based plans and rules be evaluated every two years to determine whether adjustments are necessary to achieve original goals or to address newly identified water quality issues.
- Dealing with watersheds across state boundaries complicates relationships and multiplies the number of parties and necessary negotiations. EPA is playing a major role in coordinating efforts in the tri-state Snake River area TMDL involving Oregon, Washington, and Idaho.

The Sandusky River Watershed Coalition Case

Monica Ostrand
Sandusky River Watershed Coalition
Fremont, Ohio

The Sandusky River Watershed consists of 2,575 total miles of rivers and streams that flow to Lake Erie. The area of the watershed is 1,200,000 acres and holds a population of 218,000. It is the least densely populated watershed in Ohio, because it contains no major metropolitan areas. Twelve counties are encompassed by the watershed, all of which have relatively stable populations. The average annual per capita income of the area is $23,000. The manufacturing industry provides the largest income base. Agriculture accounts for 84 percent of land use in the watershed, but agriculture only contributes two to seven percent to the income base. Row crops are the dominant form of agriculture. There are many acres drained by tiles due to poorly draining soils. Sewage overflows are a problem, and water is polluted with effluent during high flow periods.

The Sandusky River Watershed coalition consists of men and women of varying ages from various sectors, including educators, farmers, federal employees, state and local government employees, and the general public. Five committees have been formed to address stream flow and habitat, education, agriculture, water supply, and wastewater issues. The mission of the group is to provide information and opportunities for public participation in the stewardship of the Sandusky River Watershed.

Principal public watershed concerns have been identified as the following: 1) Agricultural impacts; 2) Drainage and water quantity; 3) Need for more information; 4) Wastewater; 5) Litter and spills; and 6) Sprawl. Resources are being placed in community education, people are participating in citizen monitoring, there are active county commissioners, and river towns are getting local officials involved in watershed issues. The Ohio Farm Bureau is starting to take more of a leadership role in the process.

The implementation of the TMDL will require public involvement, education, and a nonpoint source component. The coalition believes that watershed health equals community health. The coalition has become more citizen-based. Determining whether the group is an independent advocacy group or whether its purpose is to fulfill the mandates of agencies is not an easy process. Community support is needed as well as funding support. The program is trying to raise awareness and is working toward local control and gaining support from the government. Overall, the program is setting a good example for making TMDLs work in rural watersheds.

Additional points from discussion

- There are limestone quarries in the area, but they do not lead to heavy metal problems. There are minor amounts of sulfides in the water.
- There is dialog about the ecological effects of dam removal, it can cause nutrient loads to increase. There is currently a statewide initiative to remove dams in Ohio.
- EPA is primarily responsible for determining load allocations. The coalition will be monitoring at about 100 sites and handling the monitoring component.

The Muskegon Lake Public Advisory Council Case

Kathy Evans
Muskegon Conservation District
Muskegon, Michigan

Muskegon Lake is one out of 42 internationally designated “areas of concern” in the Great Lakes basin. The lake receives drainage from its own 70 square mile watershed and from the 2,350 square mile Muskegon River Watershed. It has been designated as an area of concern because of historical contamination from past industrial dumping, polluted runoff, and the past dredging and filling of the lake’s nearshore wetlands and shallow water habitats.

The Muskegon Lake Public Advisory Council has taken a sub-basin approach to dealing with these watershed problems. There are three TMDL tributaries. Ruddiman Creek is a 2,994 acre watershed that is highly urbanized and has industrial, commercial, and residential uses. It is very polluted. Ryerson Creek is a 5,193 acre watershed in which there is considerable urban sprawl and development pressure. Residential and open space need to be protected in this sub-basin. Bear Creek is a 21,160 acre watershed with a mix of urban, forested, open space and rural land uses as well as rapidly expanding residential development. A section 319 watershed plan (provided under the Clean Water Act) has been proposed for this area.

Water quality is monitored on Ruddiman, Ryerson, and Bear Creeks for total phosphorous, nitrates, E. coli, and macroinvertebrates. The water quality and monitoring program was designed to provide information to the Department of Environmental Quality, local agencies, resource managers, and the public on the current state of three Muskegon Lake TMDL tributaries. Data gathered are useful to identify problem areas in the watersheds, to instigate early corrective action and stewardship, and to determine improvements in volunteer water quality monitoring programs. The project is currently funded by the Michigan Department of Environmental Quality-Surface Water Quality Division (MDEQ-SWQD) with a grant to the Muskegon Conservation District. Additional support is through the Muskegon Area Intermediate School District’s Math and Science Center and the Muskegon County Wastewater Management System. The volunteer water quality monitoring program benefits the TMDL process by involving and educating the public, building local support to restore water quality and prevent pollution, and strengthening partnerships with agencies and organizations.

The Ruddiman Creek Task Force was formed to address its water quality problems. A study by the Muskegon Lake Conservation District showed elevated levels of heavy metals, oil, grease, and bacteria in Ruddiman and Ryerson Creeks. Public information meetings are held to educate and involve local community members and state and federal officials. The Phase I assessment involved the public to ensure that nothing was missed in locating the contamination. A technical team was formed to provide input to the various assessment phases and to the sampling plan. Volunteers and students became more aware and involved through hands-on activities, newsletters, and articles. Dedicated citizens with local, state, and federal partners have become personally and professionally committed to the cleanup of Ruddiman Creek’s contaminated sediments.

The Ryerson Creek watershed is representative of the rapidly developing urban growth area of the Muskegon Lake watershed in Muskegon County. A diversity of land uses are present in this watershed, and there are natural features with ecological, economic, and recreational values. These resources include wooded riparian corridors, open space, prairie/dune pockets, groundwater infiltration areas, coastal marsh wetlands, and floodplains. A stormwater management plan is being developed with local units of government. However, existing water quality is not well understood, and local governments lack watershed management tools. The community is not prepared for Phase II stormwater requirements. Existing infrastructure limits are not well understood, and existing natural areas and wetlands are not well protected. The community lacks a general understanding of the watershed, but the Ryerson Creek Stormwater Plan needs to move forward.

Public forums have been held to inform people about the Muskegon County Phase II Stormwater Initiative, how to meet its requirements, and how it should be funded. A Muskegon County Stormwater Committee was formed in 2001 to explore watershed based stormwater management strategies for Muskegon County. Water quality education needs to continue for residents and developers. Subwatershed approaches involve local communities for sustained natural resources stewardship. High profile issues and problems (that are locally publicized) are opportunities to organize and educate. Regardless of what the issues are, all watershed efforts require early and broad representation of all stakeholders.

Additional points from discussion

- Potential changes in zoning may be to adopt stormwater ordinances and integrate better design into stormwater retention.
- There is a trade-off between allowing some low level of degradation in some watersheds versus maintaining one pristine watershed.

Meeting TMDLs: How Do We Know When We Get There?

Jo Ann Beckwith
Department of Resource Development
Michigan State University

There is a technical side to TMDLs, but there is also a socio-political context that is equally critical to their implementation and success.

The EPA uses the term "reasonable assurance" to emphasize that implementation of the allocations in TMDLs is critical to the ultimate attainment of standards in impaired water bodies. Reasonable assurance is defined as "a demonstration that TMDLs will be implemented through regulatory or voluntary actions, by Federal, State or local governments, authorized tribes or individuals" (EPA, 2000).

However, there are public concerns that the definition is too prescriptive and that the voluntary nature of nonpoint source programs is not recognized. The definition forces states to adopt regulatory controls on nonpoint sources, although they may have limited authority to do so. Many argue that voluntary, incentive-based programs should be acceptable as reasonable assurance, and a nonpoint source program or management plan should in itself constitute reasonable assurance. Additionally, states may not be able to guarantee full funding to implement the TMDL at the time a TMDL is established. It would be difficult for the EPA to evaluate whether a state has demonstrated "adequate funding."

TMDL Implementation Plan

The EPA requires that states develop an implementation plan as part of the TMDL process, and this plan would be subject to EPA approval. If reasonable assurance cannot be provided, the EPA may disapprove the TMDL process. There is a perceived threat that if reasonable assurance is not achieved, then the government will take away control.

The required implementation plan is to be a well thought out plan, but there is recognition that there are uncertainties; and, flexibility for making changes is allowed. All implementation plans contain a schedule of implementation actions, the date by which the plan will attain water quality standards, a modeling or monitoring plan, interim measurable criteria for progress, and TMDL revision needs.

The EPA test of reasonable assurance for nonpoint sources implementing actions must be: specific to that pollutant and water body; implemented as expeditiously as practicable; accomplished through reliable delivery mechanisms; and supported by adequate funding.

Criteria of a Good Implementation Plan

Some criteria of a good implementation plan include fairness or justice, efficiency, wisdom, and stability. Justice may be distributive, meaning it focuses on the distribution of outcomes from a decision, or it may be procedural, which means it focuses on the fairness of the process used to arrive at a decision. However, the potential exists for conflicts over different concepts of justice. Additionally, there may be different perceptions of the fairness of the process. Sometimes a solution can be found that meets everybody's needs, but this outcome is difficult to accomplish. If the stakeholders think the process is fair, they will tend to invest in the solution and vice versa. A better process produces a more efficient as well as a fairer outcome. It is important to maintain momentum to keep public consciousness and energy at high levels. Wisdom comes from the knowledge of past experiences with what does and does not work, but wisdom is difficult to attain when scientific knowledge, context, specific knowledge or experience are lacking. Finally, the solution may be unstable for a variety of reasons. It may not be feasibly implemented, the implementation timetable may be unrealistic, commitments by parties may be overstated, relationships may not be strong, and there may be no provision for renegotiation.

Risk Assessment and Risk Management

There are two phases of TMDLs: risk assessment, i.e., characterizing the problem, and risk management, i.e., determining what to do about the problem. A scientifically sound risk assessment is essential for good decision making. While the information used in a risk assessment may be incomplete, it should be scientifically sound and based on expert judgement. However, risk assessments often must be conducted under conditions of scientific uncertainty. Additionally, due to different value systems, different people looking at the same set of scientific data and information can come to different conclusions. Risk management is influenced by the level of risk, fairness, benefits, control, trust, and voluntariness.

As part of implementing the plan to reduce loads, we need to change behaviors. Implementation plans often identify the threats or hazards and present information on how to lessen the risks. They typically do not address beliefs and influences relative to the target behaviors. Clear action recommendations and steps to minimize barriers to action are needed. Gaining an understanding of beliefs and behavioral influences requires collaboration with local target audiences. It also requires their involvement in the planning and implementation phases.

People consider the implications of their actions before they decide to engage or not engage in certain behaviors. By understanding the influences on behavior, we can identify how and where to target strategies for changing behavior. Decision making depends on the predicted outcome, approval of others who are respected and personal ability to carry out the change. There are barriers to changing behavior. Perceptions of control may be influenced by past experiences, anticipation of upcoming circumstances and the attitudes of influential referents. Control factors include skills and abilities, information, emotions, money, and time.

Criteria for success are the following: meeting target loads; community understanding of the problem; fairness and justness of the process; ownership of the solutions by the community; reduced barriers to behavioral change; and accommodation by the process of changing scientific knowledge and socio-political circumstances. The situation is dynamic, and it is important to be able to incorporate new information and new situations. The process needs to be flexible enough to address unforeseen situations. Situations of uncertainty create opportunities for creativity, and the process can be an exciting and rewarding one.

Additional points from discussion

- The process should be kept as flexible as possible. We still need science to know where we want to go, and we need that rationale to get people to want to change.
- It is important to focus on interim targets that are achievable and create a sense of momentum and eventually get to the bigger target through intermediate ones.
- There need to be criteria for success, but numbers should not be the sole focus, the criteria should be qualitative as well.
- Don't move too fast and leave constituents and players behind. It is important to keep moving and be seen to be moving positively.

RESPONSE AND CLOSURE

Larry Libby
Workshop Co-Chair
C. William Swank Professor in Rural-Urban Policy
Department of Agricultural, Environmental, and Development Economics
The Ohio State University

It is not clear how the relationships between TMDLs and farming will be resolved. People can see that rivers are still polluted, and they know that agriculture is a part of the problem. They expect to see improvement and will demand that farmers participate in some way. The issue will get hotter before it gets cooler.

Pete Richards presented what we know and what we do not know about TMDLs. The procedure for implementing TMDLs was established, and his presentation set the stage for the case studies that followed.

Kurt Stephenson addressed the "square peg-round hole" dilemma and focused on the relationship between the Clean Air and Clean Water Acts. Many things have been learned from the Clean Air Act that are not being effectively applied to the water quality problem. Ideas for possible institutional change were presented, such as the Environmental Results Program, effluent allowance markets, and farmers working collectively. These institutional innovations are important to pursue.

John Folks related the problem of multiple uses of Lake Okeechobee in Florida. There are many expectations from the various users of the lake and determining these expectations is crucial for moving forward. The number of dairy farms decreased as the "buy out" program was undertaken, but there was no impact on the number of cows. The solution lies in determining a nutrient scheme specific to each dairy operation.

Bob Adler presented an application from the Colorado River Basin. Insights from dealing with salinity were presented as relevant to TMDL determinations. A cost-sharing treatment was presented and the importance of numeric standards as a way of driving the management system was emphasized.

Jenny Molloy related the experience of real people and problems in the Kalamazoo River Watershed in Michigan. This presentation approached people's decisions and actions more closely and described the way the resource in question is used.

Roger Wood and Mike Wolf described the structure of the Oregon Plan and how it relates to other states. The presentation related the valuable experiences of the initiatives in Oregon to improve and maintain water quality in rural areas.

The case studies provided valuable information about applications at the local level in Ohio and Michigan.

There are important difficulties of load estimation and various technical problems as well as the cost of the whole process. There are institutional innovations that provide ways to pool people and to establish effluent markets. TMDL is a <u>process</u> as much as it is a product. A collective effort is at the heart of successful water quality improvements.

Key points from concluding comments

- There is a commonality of experience, and people around the country are dealing with similar issues in similar ways.
- It is difficult to say what is in the water, and there are difficulties in saying what the water should look like. It would be beneficial to see work done on this issue.
- How do the visual characteristics of water, the amount of wildlife, plants and vegetation translate into actual change?
- We are dealing with an environmental issue that involves people, and we need hard science as well as people skills to address these problems.
- Uncertainty remains about the TMDL process, but methods of addressing nonpoint source pollution are being fostered.
- There will be heavy development of TMDLs in Ohio and Michigan in the next year or two, but the template for the process may not yet be well established.
- We have not addressed the political environment.
- Perhaps the correct question to ask is not "Will TMDLs work?" but "Will TMDLs help?" The process and the science are not perfect, but that does not mean they should not be done. They are tools for driving the process of addressing nonpoint source pollution.
- TMDLs can be an excellent catalyst for the public participation process. They are excellent tools for motivating change and have fostered a lot of outreach.
- TMDLs got people concerned about water quality.
- There remain tremendous uncertainty and stochastic issues related to variations in loadings. The EPA's method of dealing with uncertainty is based on a traditional point source mind set. Uncertainties need to be made more explicit, but this can conflict with the way some rules are written.

TMDL Conference Participants

Name/Affiliation/Address	Telephone	E-mail
Robert Adler College of Law University of Utah 332 S. 1400 Salt Lake City, UT 84112	801-581-3791	adlerr@law.utah.edu
Radha Ayalasomayajula The Ohio State University 2120 Fyffe Rd. Columbus, OH 43210	614-292-2853	rayabs@hotmail.com
Jon Bartholic Institute of Water Research Michigan State University 115 Manly Miles Bldg. East Lansing, MI 48823	517-353-9785	bartholi@msu.edu
Sandra Batie Dept. of Agricultural Economics Michigan State University 204 Agriculture Hall East Lansing, MI 48824	517-355-4705	batie@msu.edu
Jo Ann Beckwith Dept. of Resource Development Michigan State University 323 Natural Resources Bldg. East Lansing, MI 48824	517-432-7733	beckwi21@msu.edu
Charamy Butterworth Michigan Dept. of Environmental Quality 350 Ottawa, NW Grand Rapids, MI 49503	616-356-0210	butterwc@state.mi.us
Beth Clawson MSU Extension Van Buren County 801 Hazen St., #A Paw Paw, MI 49079	616-657-7745	clawsonb@msue.msu.edu
Jenny Crawford Consumers Energy Company 1945 W. Parnall Rd. Jackson, MI 49201	517-788-1469	jacrawfo@cmsenergy.com
Brady Deaton Dept. of Agricultural Economics Michigan State University 135 S. Kedzie St., #12 East Lansing, MI 48823	517-432-7194	deatonbr@msu.edu

Name/Affiliation/Address	Telephone	E-mail
Douglas Denison Smith Group JJR, Inc. 110 Miller Ann Arbor, MI 48104	734-669-2662	ddenison@smithgroup.com
Alyssa Dodd Dept. of Agricultural Economics & Rural Sociology Penn State University 305 Armsby Bldg. University Park, PA 16803	814-861-1637	ARD108@psu.edu
Abigail Eaton Michigan Dept. of Agriculture Environmental Stewardship Division P.O. Box 30017 Lansing, MI 48909	517-241-2483	eatona@state.mi.us
Elizabeth Erickson Dept. of Economics University of Akron Akron, OH 44325	330-972-7973	eerickson@uakron.edu
Kathy Evans Muskegon Conservation District 101 E. Wesley Muskegon, MI 49442	231-773-0008	KEvansMCD@aol.com
Jerald Fletcher West Virginia University P.O. Box 6108 2004 Ag Science Bldg. Morgantown, WV 26506	304-293-4832	jfletch@wvu.edu
John Folks Florida Dept. of Agriculture & Consumer Services 3125 Conner Blvd. Tallahassee, FL 32399	850-488-6249	folksj@doacss.state.fl
Michael Gregg Michigan Dept. of Agriculture Environmental Stewardship Division P.O. Box 30017 Lansing, MI 48909	517-373-9802	greggm@state.mi.us
Marc Grossman Ohio Environmental Council 1207 Grandview Ave., #201 Columbus, OH 43212	614-487-7506	marc@theoec.org

Name/Affiliation/Address	Telephone	E-mail
Peggy Kirk Hall AED Economics/Swank Program The Ohio State University 2120 Fyffe Rd. Columbus, OH 43210	614-247-7898	aglaw@osu.edu
Jane Herbert Kellogg Biological Station Extension Land & Water Program 3700 E. Gull Lake Rd. Hickory Corners, MI 49060	616-671-2412	herberj@msue.msu.edu
Sarah Hippensteel Little Miami River Partnership 777 Columbus Ave., #5B Lebanon, OH 45036	513-695-1187	shippensteel@go-concepts.com
John Hoch Michigan Agri Business 1558 Lakeshore Rd. Manistee, MI 49660	231-398-3057	johnhoch@traverse.net
Sarah Hypio Annis Water Resources Institute Grand Valley State University 118 Padnos Allendale, MI 49401	616-895-3789	hypios@grsu.edu
Satish Joshi Dept. of Agricultural Economics Michigan State University 82 Agriculture Hall East Lansing, MI 48824	517-432-9802	satish@msu.edu
Michael Kaplowitz Dept. of Resource Development Michigan State University 311-A Natural Resources Bldg. East Lansing, MI 48824	517-355-0101	kaplowit@msu.edu
Janet Kauffman Bean Creek Watershed 14671 W. Cadmus Hudson, MI 49247	517-448-4973	
Tam Kutzmark Darby Creek Watershed Joint Board 1375 Highway 42, SE, #C London, OH 43140	740-852-4004	tam-kutzmark@oh.ncadnet.org
Larry Libby Dept. of AED Economics The Ohio State University 2120 Fyffe Rd., #336 Columbus, OH 43210	614-688-4907	libby.7@osu.edu

Name/Affiliation/Address	Telephone	E-mail
David Marcus Office of Strategic Environ. Analysis U.S. Environmental Protection Agency, Reg. 5 77 W. Jackson Blvd. Chicago, IL 60604	312-353-5814	Marcus.David@epamail.epa.gov
Jenny Molloy Michigan Dept. of Environmental Quality 7953 Adobe Rd. Kalamazoo, MI 49009	616-567-3579	Molloyj@state.mi.us
Greg Mund c/o 1001 E. Wesley Muskegon, MI 49442	231-773-0008	greg.mund@mi.usda.gov
Patricia Norris Dept. of Agricultural Economics Michigan State University 211 Agriculture Hall East Lansing, MI 48824	517-353-7856	norrisp@msu.edu
Monica Ostrand Sandusky River Watershed Coalition 219 S. Front St. P.O. Box 590 Fremont, OH 43420	419-334-5016	monica_ostrand@hotmail.com
Scott Piggott Michigan Farm Bureau 7373 W. Saginaw Lansing, MI 48909	517-323-7000	piggotts@hotmail.com
Vicki Pontz-Teachout Michigan Dept. of Agriculture P.O. Box 30017 Lansing, MI 48909	517-335-3400	pontzv@state.mi.us
Rosida Porter Ohio Dept. of Natural Resources 1939 Fountain Sq. Ct. Columbus, OH 43224	614-265-6647	rosida.porter@dnr.state.oh.us
Bruce Rabe Environmental Resources Management 3352 128th Ave. Holland, MI 49424	616-738-7308	bruce_rabe@erm.com
Laila Racevskis Dept. of Agricultural Economics Michigan State University 205 Cook Hall East Lansing, MI 48824	517-353-9596	racevsk1@msu.edu

Name/Affiliation/Address	Telephone	E-mail
Natalie Rector MSU Extension 315 W. Green, #I-700 Marshall, MI 49068	616-781-0784	rector@msu.edu
R. Peter Richards Water Quality Lab Heidelberg College 310 E. Market St. Tiffin, OH 44883	419-448-2240	prichard@heidelberg.edu
Mary Schulz Dept. of Agricultural Economics Michigan State University 212 Agriculture Hall East Lansing, MI 48824	517-355-2160	schulzm2@msu.edu
Jeff Simcoe West Virginia University 1659 Brookhaven Rd. Morgantown, WV 26508	304-296-6082	jsimcoe@wvu.edu
J.D. Snyder Institute of Water Research Michigan State University 115 Manly Miles Bldg. East Lansing, MI 48823	517-353-9785	
Lorie Srivastava Dept. of Agricultural Economics Michigan State University 12 Cook Hall East Lansing, MI 48824	517-353-4545	srivast3@msu.edu
Kurt Stephenson Dept. of Applied Economics Virginia Tech Blacksburg, VA 24061	540-231-5381	kurts@vt.edu
Nichol Stout Annis Water Resources Institute Grand Valley State University One Campus Dr., 118 Padnos Allendale, MI 49401	616-895-3092	stoutn@gvsu.edu
Scott Swinton Dept. of Agricultural Economics Michigan State University 304 Agriculture Hall East Lansing, MI 48824	517-353-7218	swintons@msu.edu

Name/Affiliation/Address	Telephone	E-mail
Eileen vanRavenswaay Dept. of Agricultural Economics Michigan State University 301 Agriculture Hall East Lansing, MI 48824	517-353-8628	raven@msu.edu
Sarah Whitney Great Lakes Commission 400 Fourth St. Ann Arbor, MI 48103	734-665-9135	swhitney@glc.org
Kevin Wickey Natural Resources Conservation Service 3001 Collidge Rd., #250 East Lansing, MI 48823	517-324-5279	kevin.wickey@mi.usda.gov
Jan Wilford Michigan Dept. of Agriculture P.O. Box 30017 Lansing, MI 48909	517-241-4730	wilfordj9@state.mi.us
Mark Wilson Ohio Dept. of Agriculture Livestock Permitting Division 8995 E. Main St. Reynoldsburg, OH 43068	614-387-0913	mwilson@odant.agri.state.oh.us
Michael Wolf Oregon Dept. of Agriculture 635 Capitol St., NE Salem, OR 97301	503-986-4711	mwolf@state.or.us
Roger Wood Governor's Natural Resources Office 900 Court St., NE, #160 Salem, OR 97301	503-378-3589	roger.wood@state.or.us