Recommendations for
Water Quality Monitoring of the
Michigan Agriculture Environmental Assurance Program

Final Report of the Water Quality Monitoring Subcommittee to the
Michigan Agriculture Environmental Assurance Program Advisory Council
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Black Star Farms
Traverse City, Michigan

Water Quality Monitoring Subcommittee
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Executive Summary

In Michigan Public Act 2 of 2011, the Director of the Michigan Department of Agriculture and Rural Development (Director) was authorized, though not mandated, to develop and establish "priorities, procedures, and protocols for the implementation of a surface water quality monitoring program that will promote voluntary water quality monitoring by farms as well as evaluate and benchmark the effectiveness of conservation practices and Michigan Agriculture Environmental Assurance Program (MAEAP) standards in cooperation with participating farmers."[1] The directors of the Michigan Department of Environmental Quality (MDEQ) and the Michigan Department of Agriculture and Rural Development (MDARD) asked the MAEAP Advisory Council to develop recommendations to address these two distinct ideas. The MAEAP Water Quality Monitoring Subcommittee was created and its members[2] were selected at the October 2011 meeting of the MAEAP Advisory Council. The group was asked to develop recommendations for the MAEAP Advisory Council to consider in fulfilling its charge.

To best inform the Subcommittee's recommendations, experts were invited to discuss the protocols, dynamics and challenges of establishing an effective water quality monitoring program and to identify the goals, purposes and potential data gaps of ongoing state and federal programs in Michigan. The group also reviewed current water quality monitoring programs being administered by state and federal agencies in the Great Lakes basin and elsewhere as well as research and demonstration projects being pursued by non-profit organizations and quasi-governmental organizations. We reviewed research studies on the effects of conservation practices from "edge of field" to watershed scale. While the review was not exhaustive, it served to bring the Subcommittee up to date with current and forward looking analyses, programs and projects related to assessing the water quality and ecosystem impacts of agricultural best management practices in Michigan, the Great Lakes region and across the nation.

There is a great deal of activity at all levels of government and among the private sector, non-profits and research institutions to assess and address water quality concerns in agriculturally dominated watersheds. Several trends of note include reductions in funding levels for monitoring activities at state and federal levels, efforts to develop tools, and the use of predictive and transactional models to assess the water quality impacts of conservation practices. Monitoring programs and associated analyses are useful for addressing the demand for demonstrating the benefits of conservation; however, modeling efforts that forecast the likely benefits of conservation are important as well. Tools and calculators have also been developed and tested that can give immediate feedback on the likely impacts of a conservation practice on groundwater recharge, nutrient and sediment loss, and water quality for the specific use of drinking water, irrigation, livestock, and environmental water in real time. Innovative approaches are being tested such as water quality trading, reverse auctions, and supply chain certifications that tie environmental outcomes to payments, instead of the current system of payments for practice implementation. There are lessons that can be drawn from each of these and may be applied to MAEAP in the future.

The first and most fundamental step in the development of any monitoring plan is to define the goals and objectives, or purposes, of the monitoring program. This report does not address what the water and environmental outcomes, goals or metrics should be for the MAEAP program, but puts forward recommendations to inform a water quality monitoring and assessment program. After careful review and thoughtful debate, Subcommittee has three primary recommendations that are put forward in this report.

[1] Natural Resources and Environmental Protection Act 451 of 1994, amended, Part 87
[2] Please see Appendix B for Subcommittee Members and Invited Experts

Recommendations

MAEAP should be a program of continuous improvements that keep pace with advancements in agricultural and environmental science, the changes in environmental conditions and agricultural practices, as well as the values of the citizenry, environmental standards and Generally Accepted Agricultural Management Practices (GAAMPs). To that end, we recommend the following actions:

1. **Establish Water Quality Monitoring and Assessment Collaboration Across Jurisdictions and Programs to include MAEAP**
   The objectives stated in PA 2 of 2011 for a MAEAP specific water quality monitoring program can best be met through continuing current water quality monitoring programs and targeted studies that focus on the practices that form the core of the MAEAP program. Efforts to assess the impacts of MAEAP standards should build upon current monitoring and research efforts and be undertaken in the full context of land uses, character and circumstances of the landscape. The strongest analyses of the program and the conservation practices that underpin it would come from carefully designed research studies that control and account for the various factors that can influence surface water quality, and could inform improvements over time. For these reasons, the subcommittee does not recommend creating a traditional water quality monitoring program specific to MAEAP. Rather, we recommend significantly enhancing collaboration among state and federal agencies, appropriate research institutions, and non-profit organizations to build upon current monitoring and assessment programs to assess and monitor MAEAP activities and the ecological outcomes in a landscape context.

2. **Interested Farmers Can Participate in Existing Voluntary Monitoring Programs**
   We recommend MDARD first gauge the interest and goals of farmers for a voluntary Water Quality Monitoring Program. If there is interest, we recommend MDARD encourage interested farmers to consider participating in currently existing volunteer monitoring programs within Michigan. The Michigan Clean Water Corps (MiCorps) is a network of volunteer monitoring programs in Michigan. It was created to assist the Department of Environmental Quality (DEQ) in collecting and sharing water quality data for use in water resources management programs. MiCorps has established monitoring programs for lakes and streams and could assist farmers or group of farmers interested in establishing a lake or stream monitoring program. Interested participants may rely on the clear guidance and assurances of MAEAP that voluntary water quality monitoring will not result in, or be used to support, enforcement actions. The voluntary and incentive-based approach of MAEAP has fostered significant trust and participation among farmers state-wide, and the MAEAP Partnership may play a primary role in this recommendation.

3. **Establish a Research and Monitoring Program to Determine Social and Economic Impacts of MAEAP to Society and the Farmer**
   The intent of this research and monitoring program should be to determine if and why MAEAP is resulting in changes by farmers and land managers in management practices that are predicted to reduce risk of environmental impacts and improve water and environmental quality. The greatest benefits of MAEAP to the environment and society can be achieved through maximum participation; therefore we recommend a monitoring program that investigates the motivations of, and impacts on, farmers and farming operations related to their participation in MAEAP.

Introduction

The Michigan Agriculture Environmental Assurance Program (MAEAP) is a voluntary, proactive, verification program that helps farms of all sizes and all commodities prevent or minimize agricultural pollution risks. MAEAP helps farmers evaluate their entire operation and make sustainable management decisions to achieve environmentally responsible agricultural production practices that seek to prevent environmental pollution, including groundwater and surface water contamination, by modifying management behaviors and implementing conservation practices. MAEAP standards encompass both requirements to ensure compliance with state and federal environmental laws and other best practices that have been demonstrated to reduce environmental risks and impacts Many MAEAP standards and conservation practices do not directly result in improvements to water or environmental quality, but are intended to indirectly benefit these values by reducing the risk of a significant spill or discharge of pollutants, or improving nutrient utilization thereby improving water quality and hydrology.

A farm may be MAEAP verified in one or more farm systems. Current systems include Livestock, Cropping, Farmstead, and Greenhouse. To become MAEAP-verified, farmers must complete three comprehensive steps: educational seminars, a thorough on-farm risk assessment coupled with the development and implementation of an action plan addressing environmental risks and finally, an inspection by MDARD staff. A trained technician conducts an on-farm risk assessment for one or more farm systems, reviewing program requirements related to applicable state and federal environmental regulations, Generally Accepted Agricultural Management Practices (GAAMPs), NRCS recommended management practices, and other sources of science-based guidance are met or provides guidance for correction. A MAEAP verifier employed by the Michigan Department of Agriculture and Rural Development conducts an on-farm review and, if the standards are being met, completes the verification.

On March 8, 2011, Governor Rick Snyder of Michigan signed two bills into law that codified MAEAP, which gave the program standing in law, established program requirements and provided incentives for participating farmers. The legislation also created the MAEAP Advisory Council (AC), to advise MDARD on key aspects of the program. The AC is charged with recommending MAEAP verification standards for approval by the Michigan Commission of Agriculture and Rural Development and to promote their implementation.

Since April 1, 2011, the AC has developed recommendations for program standards as well as protocols for verification, revocation of verifications, and for voluntary onsite evaluations. The standards and protocols were first presented and approved at the September 14, 2011 meeting of the Commission on Agriculture and Rural Development. At the August 2011 AC meeting, MDEQ Director Dan Wyant and then MDARD Director Keith Creagh directed the AC to address water quality and environmental monitoring as the next priority task. At the October 2011 AC meeting, the Water Quality Monitoring Subcommittee (Subcommittee) was created and charged with developing recommendations for the AC to consider in fulfilling its statutory charge to advise the MDARD Director on water quality and environmental monitoring for MAEAP.

Members of the Subcommittee conducted research into current water and environmental quality monitoring programs being administered by state and federal agencies around the Great Lakes as well as research and projects being pursued by research institutions and non-profit organizations. We invited experts to discuss the protocols, dynamics and challenges of establishing a water quality monitoring program specifically for MAEAP, as well as to identify the goals, purposes and data gaps of ongoing state and federal programs that could inform the Subcommittee's recommendations.

We also surveyed the region for new and existing voluntary agricultural programs that address water and environmental quality and any associated monitoring programs or protocols. We reviewed research and studies from "edge of field" to watershed scale monitoring of the effects of conservation practice implementation. While the review was not exhaustive, a meaningful survey was completed that brought Subcommittee members up to date with current and forward looking analyses, programs and projects related to assessing the water quality and ecosystem impacts of agricultural best management practices in Michigan, the Great Lakes region and across the nation.

Background

Agriculture, through its production of food, materials for fuel, clothing and shelter, and jobs, plays an important role in improving the quality of life for people across the United States, the Great Lakes and Michigan. The agricultural and food-handling sector is Michigan's second largest industry, generating $91.4 billion in total economic impacts for the state economy and employing approximately one million residents. The direct impact of the agribusiness and farm sector is $7.2 billion - or about 13.4 percent - of the sector. Most of the value-added activity in the sector is related to food processing, wholesaling and retailing (grocery, restaurant and food service). Additionally, Michigan's unique landscape produces more than 200 commercial commodities, making the state second only to California in terms of crop diversity. Some of the high-value specialty crops lead to spin-off industries such as culinary festivals and beverage production that provide social benefits and further economic development and jobs related to recreation and tourism.[3]

The quantity and quality of water for an agriculture area is extremely important for agriculture success. In some circumstances, water quality is not suitable for agriculture uses. High salt concentrations, present in some of Michigan's groundwater resources, limit the amount of water a plant can take up, resulting in high plant stress and decreased crop yields. High concentrations of metals also have negative effects on crop production.

Agricultural practices may also have negative impacts on surface and ground water quality. Improper agricultural methods may elevate concentrations of nutrients, pathogens, and sediment loads. Increased nutrient loading from animal waste can lead to eutrophication of surface water bodies which may eventually impair aquatic ecosystems. Animal waste may also introduce pathogens which threaten public and animal health. Grazing and other agriculture practices may intensify erosion processes, increasing sediment input to nearby water sources. Increased sediment loads make drinking water treatment more difficult while also negatively affecting fish and macroinvertebrates.

The effects of agriculture on aquatic ecosystems and freshwater biodiversity have been extensively studied and documented. Studies have consistently shown that various practices associated with row-crop agriculture and livestock production, including vegetative clearing, soil compaction, water withdrawal, channelization, and irrigation can significantly alter flow regimes, physical habitat, water quality and the plants, animals and fish that depend on these systems.

Over the years, farmers and state and federal governments have developed programs, policies, and funding mechanisms to improve the sustainability and profitability of agriculture and to reduce the impacts of agriculture on water quality and wildlife habitat. In recent years there has been increased interest in a more thorough understanding and accounting of these programs' environmental benefits, particularly in response to the significant increase in funding for conservation programs that was

[3] MSU Product Center 2012 Economic Impact Report and MSU Product Center 2012 Economic Impact Report Summary

authorized under the 2002 Farm Bill. Decision-makers want quantifiable assurances that the investments being made in these programs are indeed making a difference, but they also seek to gain efficiencies and the greatest impact for the investment.

Brief History of EPA and USDA Water Quality Monitoring in Agricultural Watersheds

Over the past three decades, considerable resources have been invested in implementing farm-related conservation practices in an effort to reduce the impacts of nonpoint source (NPS) pollution on waters in the United States, to restore and protect soil and water quality, and to ensure continued agricultural productivity.

The United States Department of Agriculture (USDA) and the United States Environmental Protection Agency (EPA) have worked together since 1977 on NPS water quality management plans under the Clean Water Act. They developed the "Model Implementation Program," which used existing USDA and EPA programs and resulted in recommendations that were incorporated into another program called the "Rural Clean Water Program" and used state-of-the-art best management practices. It was one of the earliest national NPS control programs that combined land treatment and water quality monitoring in order to document its effectiveness at the watershed scale. The study advanced knowledge about NPS source and transport, control measures, conservation practice effectiveness, water quality monitoring, and the ability of voluntary cost share programs to assist farmers.

In the early '90s, the USDA initiated two additional projects:

- Hydrologic Unit Area: that focused on remediation of documented water quality problems through education, technical and financial assistance to support adoption of USDA's Natural Resources Conservation Service (NRCS) approved practices by farmers
- Demonstration Projects: that were located in areas of actual or potential water quality impairment and combined demonstration of innovative practices with education efforts to promote wider adoption by farmers

As these projects were wrapping up, the USDA conducted an analysis to determine the progress toward improving and protecting water quality from agricultural NPS. Unfortunately, few of the projects were able to *convincingly* demonstrate success in achieving water quality goals.[4]

The Clean Water Act's Section 319 "National Nonpoint Source Monitoring Program" was established in 1991 to improve technical understanding of NPS pollution, document the feasibility of NPS control, and to scientifically evaluate effectiveness of conservation practices designed to control NPS pollution. An analysis of this program a decade later found that many of these projects could indeed demonstrate significant success on the effectiveness of grazing management, erosion and sediment control, nutrient management, urban runoff control, and stream restoration for improving water quality at the watershed scale.

It's challenging to quantify the benefits of conservation programs and BMPs, but the USDA is undertaking the effort. In 2003, they initiated the Conservation Effects Assessment Project (CEAP) with an overall goal to improve the efficacy of conservation practices and programs by quantifying

[4] Soil and Water Conservation Society. 2012. "How to Build Better Agricultural Conservation Programs to Protect Water Quality."

conservation effects and providing the science and education base needed to improve future conservation planning, implementation, management decisions, and policy.[5]

The ongoing CEAP program estimated that between 2003 and 2006 farmers reduced wind erosion by 44 percent, sediment in surface water runoff by 47 percent, nitrogen in surface water by 43 percent, and increased the percentage of cropping acres gaining soil organic carbon from 27 to 46 percent.

The study found that 19 percent of the cropped acreage in the Great Lakes basin had a high level of need for additional conservation treatment, based on estimated losses of sediment and nutrients, and another 34 percent had a moderate need for more conservation treatment. Additional erosion control and nutrient management practices on the 7.9 million acres with a high or moderate treatment need would further reduce losses of sediment, nitrogen, and phosphorous by significant amounts.[6]

To date, the ongoing CEAP modeling effort has found that farmers have reduced onsite and offsite environmental problems stemming from agricultural activities, but significant additional progress can be achieved, particularly through more rigorous application of nutrient management in combination with erosion-control practices.

While practices improved water quality, problems persisted in watersheds. The dissociation was believed to occur because:

- Practices were not targeted at critical sources or pathways of contaminants;
- Sediment in streams originated more from channel and bank erosion than from farm field soil erosion; and
- Time lags, historical legacies, and shifting weather and climate masked the effects of practice implementation.

Water quality monitoring has been a significant part of water resource management in general and in NPS watershed projects in particular for more than 35 years. Water resource management has evolved from problem identification to documentation of water body status and trends to the present emphasis on accountability. The difficulty of assessing resource benefits from improved management practices through water quality monitoring has left fundamental questions unanswered: Have conservation programs been effective? Have resources been well utilized?

The Soil and Water Conservation Society (SWCS) published a book in the spring of 2012 titled: "How to Build Better Agricultural Conservation Programs to Protect Water Quality." This book was based on the analyses of a handful of watershed based projects and found that the most successful projects consisted of a network of stakeholders and information providers who worked together to develop and follow clear goals, included farmer input, applied sound science, and provided information effectively to change behavior. It also revealed that implementation of conservation practices to address water quality issues is far more than a technical or financial exercise in design, construction, and cost-share. Some of the findings included:

- Cost-share and other incentives are usually necessary but are seldom sufficient to drive implementation.

[5] $27.25 million was invested in 2004 and $28.8 million in 2005. More recent budget figures were not be found, but in 2012 the USDA planned to increase the CEAP budget by $7 million. Canada has spent $9 million (Canadian) to estimate conservation benefits in 7 watersheds. (Watershed Evaluation of Beneficial Management Practices: www.agr.gc.ca)

[6] Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Great Lakes Region, NRCS, 2011

- Sociological factors that enhance or inhibit adoption of conservation practices have been identified but are rarely objectively factored into planning efforts.
- Perhaps most important to note is that educational and technical support provided by a local, trusted, and dedicated person is often more effective than other formats, although this kind of assistance is in decline due to budget constraints.
- Farmer-to-farmer information exchange is also crucial to the adoption process.

SWCS's final recommendation in the book is that state and federal agencies, as well as research institutions and nonprofit organizations and the agricultural community, must build upon the knowledge gained from the NIFA–CEAP and past watershed water quality programs, and that many of the lessons learned are essentially those observed in the Rural Clean Water Program and the Hydrologic Unit Area Program from the '80s and '90s. New programs need to move beyond these old lessons to the next level.

Water Quality Monitoring and Analysis Trends in Michigan

Water quality is vital for the success of our state, including our diverse agricultural sector. Proper agriculture management practices are necessary to meet water quality standards and provide for ecosystem health. Cooperation among water users is necessary to provide adequate water quality for all. The 2010 Water Quality and Pollution Control in Michigan: Integrated Report prepared for the EPA by the Michigan Department of Environmental Quality found that:

> "In general, the open waters of the Great Lakes have good to excellent water quality. The inland waters of Michigan's Upper Peninsula and the northern half of the Lower Peninsula support diverse aquatic communities and are commonly found to have good to excellent water quality. Many lakes and rivers in this mostly forested area of the state support coldwater fish populations. Lakes and rivers in the southern half of Michigan's Lower Peninsula generally have good water quality and support warmwater biological communities as well as some coldwater fish populations. The southern portion of the state contains Michigan's major urban areas with much of the rural land in agricultural production. Recent years have witnessed rapid rates of urbanization and housing development that influence pollutant and hydrologic loadings to surface waters tributary to the Great Lakes. Many of Michigan's rivers and lakes receive direct discharge of treated effluent from municipal and industrial sources as well as runoff from urbanized areas, construction sites, and agricultural areas. Sedimentation, nutrient enrichment, and toxic pollutant loading are problems associated with runoff that can impact surface water quality. Surface water quality is generally showing improvement where programs are in place to correct problems and restore water quality." [7, 8]

Agricultural practices are one of a number of sources which have been tied to the growth in algae blooms in Lake Erie and elsewhere in the Great Lakes. Scientist note that improved nutrient management techniques from agriculture and other sources will be needed to avoid continuation of these conditions in the future. [9]

The EPA and States use comprehensive water quality monitoring and assessment information on environmental conditions and changes over time to help set levels of protection in water quality standards and to identify problems that are emerging or that need additional regulatory and non-regulatory actions

[7] http://www.michigan.gov/documents/deq/wb-swas-final-2010IR_316320_7.pdf
[8] "Record-setting algal bloom in Lake Erie caused by agricultural and meteorological trends consistent with expected future conditions." 2013 Proceedings of the National Academy of Sciences of the United States of America: http://www.pnas.org/content/early/2013/03/28/1216006110.abstract
[9] Center of Excellence for Great Lakes and Human Health: http://www.glerl.noaa.gov/res/Centers/HABS/faqs_causes_habs.html

to support water quality management decisions. These data also inform state and federal agency decision makers, Legislators and the Congress, and other stakeholders, including the public, of the progress in protecting human health and the environment. Without this information, it is difficult to set priorities, evaluate the success of programs and activities, or report on accomplishments in a credible and informed way.

States may receive Clean Water Act funds only if they are carrying out a specific plan and operating the appropriate devices, methods, systems and procedures necessary to monitor, compile and analyze data on water quality. The EPA's "Elements of State Water Monitoring and Assessment Program" offers guidance to help the EPA and States determine whether their monitoring program meets the requirements. The EPA recommends that States develop a monitoring programming that addresses the 10 elements outlined below:

1. Monitoring Program Strategy: The State has a comprehensive monitoring program strategy that serves all water quality management needs and addresses all water body types
2. Monitoring Objectives: The State has identified monitoring objectives critical to the design of a monitoring program that is efficient and effective in generating data that serve its management decision needs
3. Monitoring Design: The State has an approach and rationale for selection of monitoring designs and sample sites that best serve its objectives
4. Core and Supplemental Water Quality Indicators: The State should use a tiered approach to monitoring that includes a core set of baseline indicators selected to represent each applicable designed use plus supplemental indicators for site specific criteria
5. Quality Assurance: Quality management plans and quality assurance project plans are developed, maintained, and peer reviewed in accordance with EPA policy
6. Data Management: The State uses an accessible electronic data system for water quality, fish tissue, toxicity, sediment chemistry, habitat and biological data
7. Data Analysis/Assessment: The State has a methodology for assessing attainment of water quality standards based on analysis of various types of data for various sources for all water body types
8. Reporting: The State produces timely and complete water quality reports and lists
9. Program Evaluation: The State, conducts periodic reviews of each aspect of its program to determine how well it serves its water quality decision needs for all water body types
10. General Support and Infrastructure Planning: The State identifies current and future monitoring resources it needs to fully implement its monitoring program strategy

The MDEQ participates in this program and has developed a surface water quality monitoring program with the overall goal of collecting the monitoring information needed to answer fundamental questions concerning Michigan's water quality and provide the foundation for sound water resource policy and management. The MDEQ produced a document in 1997 entitled, "A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters" (Strategy), which was updated in April 2005. The Strategy describes the resources and the new and expanded activities necessary to implement a comprehensive water quality monitoring program to satisfy four goals: assess the current status and condition of waters of the state and determine whether Michigan Water Quality Standards are being met; measure spatial and temporal water quality trends; evaluate the effectiveness of water quality prevention and protection programs; and identify new and emerging water quality problems. The Strategy consists of nine interrelated elements: fish contaminants, water chemistry, sediment chemistry, biological surveys, wildlife contaminants, bathing beaches, inland lake quality, stream flow, and volunteer monitoring.

In November 1998, the citizens of Michigan approved the Clean Michigan Initiative (CMI), a $675 million bond to clean up, protect, and enhance Michigan's environmental quality, natural resources, and infrastructure. The MDEQ reserved $45 million of the $90 million Clean Water Fund (CWF) portion of

the CMI specifically for the implementation of the Strategy over a period of at least 15 years to ensure long-term monitoring. Implementation has been primarily through grants and contracts with outside entities.

CMI-CWF funding has afforded the MDEQ substantial monitoring that is needed to study and manage Michigan's aquatic resources and protect human health. Since 2002, the state Legislature has annually appropriated more than $3 million of the bond money for water quality monitoring. The MDEQ continues to enhance its water quality monitoring program, but budget cuts at the state and federal levels will directly impact monitoring programs, and challenge the MDEQ to find ways to address its continuing vital monitoring and assessment activities. With bond money running out, the department will need to identify new sources of funding to support water quality monitoring programs. This is particularly important since the historic data becomes less valuable if ongoing measurements are not made to chart progress or areas that need greater attention by department personnel.

Other States, Nongovernmental and Research Institution Activities

There is a great deal of activity at all levels of government and among the private sector, non-profits and research institutions to address water quality. Several trends of note include efforts to develop tools, models and transaction that can be used to assess and address water quality through the application of conservation practices. Monitoring programs and the associated analyses are useful for addressing the demand for demonstrating the benefits of conservation; however, some believe that modeling efforts based on sound ecosystem research that forecast the benefits of conservation are of equal importance. Modeling tools and calculators have been developed and tested that can give immediate feedback on the likely impacts of a conservation practice on groundwater recharge, as well as nutrient and sediment loss. Another web based tool helps citizens evaluate the quality of water for use for drinking, irrigation, livestock, and generally in the environment for fish and wildlife. Innovative transactions are being tested such as water quality trading, reverse auctions, and supply chain certifications that tie environmental outcomes payments, instead of the current system of paying for practice implementation based on federal program priorities. Below are a few examples and brief explanation of some of the programs that may be of interest to the MDEQ and MDARD Directors and others.[10]

- OHIO: There is a great deal of activity in Ohio, including Ohio Livestock Environmental Assurance Program, Ohio Clean Lakes Initiative's 4R Certified Nutrient Stewardship Program and the Ohio River Basin Water Quality Project Pilot Trading Plan. The Ohio Livestock Coalition developed Ohio Livestock Environmental Assurance Program (LEAP), which is a voluntary and confidential environmental assurance program for all major livestock species in Ohio designed to help livestock and poultry producers manage environmental challenges and assess how farmstead practices affect water quality.[11] Ohio Clean Lakes Initiative: 4R Certified Nutrient Stewardship Program is a voluntary program to promote the right source, amount, placement and timing of fertilizer applications.[12] Additionally, the Ohio River Basin Trading Project is a first-of its-kind interstate multi-credit trading program and represents a comprehensive approach to improving regional water quality and minimizing costs to the public and stakeholders. The project focus is on designing and developing pilot water quality trading markets for nitrogen and phosphorus discharges and greenhouse gas emissions in the states of Indiana, Kentucky and Ohio. A market based approach may provide businesses and municipalities a more economically viable option to reduce nitrogen and phosphorus loadings.

[10] See Appendix E for greater detail on these projects and programs, plus additional examples.
[11] Ohio Livestock Environmental Assurance Program: www.ohleap.orgwww.ohleap.org
[12] Ohio's Ag Water Quality Recommendations 'Officially' Announced, by: Chris Kick, March 15, 2012, http://www.farmanddairy.com/news/ohios-ag-water-quality-recommendations-officially-announced/35585.html

A team of Ohio and Michigan academic researchers recently published a study in the journal *Environmental Science and Technology*[13], examining dissolved phosphorus and its contribution to harmful algal blooms in Lake Erie. The value of this research comes from its emphasis on specific practices and how they may impact water quality. In this case, the study examines no till practices and their impact on dissolved phosphorus in runoff. The model results emphasized the need to focus on and adjust on agricultural practices due to their impact on water quality. For instance, the use of no-till practices under some conditions results in an increase in dissolved phosphorus runoff, suggesting incorporation of fertilizers versus broadcast applications or periodic rotational tillage to reduce phosphorus loss. Also of interest is their documentation of changes in weather patterns and the timing of storms in the Midwest and how that has changed over the last decade. Excerpts of the report can be found in Appendix G.

- MINNESOTA: This state was selected as the "nation's first test site" of a federal initiative to protect water called the "Agricultural Water Quality Certification." It mirrors similar goals and values of MAEAP. The initiative will aid farmers in the implementation of practices and provide an incentive of protection against potential and emerging regulations. In exchange, they would get financial and technical support and be protected against any new environmental requirements during the life of their agreement, perhaps as long as 10 years.

- WISCONSIN: Discovery Farms in Wisconsin is a farmer-led program organized and established for the purpose of gathering field-scale information to quantify the impact of a variety of farming enterprises across Wisconsin. The mission of the program is to collect water quality information under real-world conditions and provide practical, credible, and site-specific information to support better farm management decisions. Led by USGS, a powerful study was released which illuminated the impacts of large storms: "Surface runoff from a single storm can provide over 90% of the sediment loss and up to 80% of total phosphorus and nitrogen loss for the entire field year; Tile flow from a single storm can contribute over 90% of the sediment loss, 40% of total phosphorus loss, and almost 30% of total nitrogen loss for the entire field year; and the highest single event loss of sediment, phosphorus, and nitrogen percentage is higher than the flow percentage for the event."[14]

- IOWA: The Iowa Nutrient Reduction Strategy is a science and technology-based framework to assess and reduce nutrients to Iowa waters and the Gulf of Mexico. It was developed in response to the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force's 2008 Action Plan recommendations. The State of Iowa's strategy to address nutrient transport from nonpoint sources uses a comprehensive, first of its kind scientific assessment of conservation practices and associated costs to reduce loading of nutrients to Iowa surface waters.

- UTAH: Utah State University Extension's Water Quality Interpretation Tool[15] is designed for citizens to participate in monitoring and is a cooperative effort to acquire better baseline data for Utah's waterways. The Utah State University water quality interpretation toolkit was developed to help any

[13] Irem Daloğlu; et al. 2012. E*valuating Causes of Trends in Long-Term Dissolved Reactive Phosphorus Loads to Lake Erie.* Environmental Science and Technology, 46, 10660-10666, dx.doi.org/10.1021/es302315d

[14] Cooley, Eric, Aaron Wunderlin, Amber Radatz, and Dennis Frame. 2011. "Fact Sheet 11: Understanding Nutrient and Sediment Loss at Pagel's Ponderosa Dairy: Single storm event loss comparison to total annual sediment and nutrient loss." University of Wisconsin Extension/Discovery Farms Program. UW-Madison: Accessed March 19, 2013 at www.uwdiscoveryfarms.org

[15] USU Water Quality Interpretation Tool access here: http://extension.usu.edu/waterquality/htm/wqtoolhttp://extension.usu.edu/waterquality/htm/wqtool

Utah citizen evaluate the quality of their drinking, irrigation , livestock water, and environmental water and is worth looking at as a potential model for a confidential MAEAP farmer water quality monitoring program.

- MICHIGAN: The Nature Conservancy (TNC), Michigan State University (MSU) and their partners seek to provide the science and innovative tools necessary to assess and forecast the benefits of NRCS conservation practices to stream based fish communities to help advance the conservation of freshwater biodiversity across the agricultural regions of the southern Great Lakes. Monitoring programs and the associated analyses are useful for addressing the demand for demonstrating the benefits of conservation; however, they believe that modeling efforts that forecast the likely benefits of conservation are of equal importance. They will be working with Conservation Districts, farmers and others to test these tools[16] and BMP prescriptions in the field.

Recommendations with Discussion of Underlying Rationale

MAEAP should be an adaptive program and a program of continuous improvements that keeps pace with advancements in agricultural and environmental science, changes in environmental conditions and agricultural practices, the values of the citizenry, and the evolution of environmental standards. The Subcommittee has three primary recommendations:

1. Establish Water Quality Monitoring and Assessment Collaboration across Jurisdictions and Programs to include MAEAP

A tremendous amount of data exists showing the positive effects of conservation practices on water quality, and we urge that the existing process to evaluate and update MAEAP standards take into consideration current research findings, the changing climate, and other risk factors. This cannot be accomplished through a MAEAP-specific water quality monitoring program. The strongest analyses of the MAEAP program and the conservation practices that underpin it would come from carefully designed research studies that control and account for the various factors that can influence surface water quality, and could inform improvements over time. Efforts to assess the impacts of MAEAP should build upon current monitoring and research efforts and be undertaken in the full context of land uses, practices and programs, character and circumstances of the landscape. For these reasons the subcommittee does not recommend creating a traditional water quality monitoring program specific to MAEAP, but we do recommend the development of monitoring and assessment collaboration between state and federal agencies, as well as appropriate research institutions and non-profit organizations, to assess and monitor activities that include MAEAP as well as the ecological outcomes in a landscape context.

There is strong desire for collaborative goal setting and adaptive implementation of programming given the challenges posed by complex ecological systems, fragmentation of resources, agency specialization, and multiple, sometimes overlapping, jurisdictions. For the past century, water quality, urban storm water runoff, flood control, fish and wildlife habitat, and other natural resource concerns have been managed by individual, single-function, federal and state agencies. They pursue their respective legal mandates in isolated decision-making processes, focusing on specific types of pollution or areas within a watershed, rather than the watershed or landscape as a whole. There is no reason to believe, therefore, that where each agency seeks to optimize results within its jurisdiction, that the results will be a solution that is optimized overall.[17] Moreover, budget trends at the federal and state level may forestall the creation of a

[16] See Appendix F for instructions to test two of these calculator tools.
[17] Sabatier, Paul (editor), et al. 2005. *Swimming Upstream: Collaborative Approaches to Watershed Management.* Cambridge, MA: MIT Press.

new water monitoring program, dictating a new manner of implementing existing programs to meet our state's water and environmental monitoring and analysis needs.

To insure MAEAP is a continuously evolving and effective program that can capitalize on changes in our understanding of best management practices, the GAAMPs and current watershed level monitoring programs, we recommend the MDARD Director work with counterparts within the state and with federal agencies to establish a monitoring collaboration program or team that measures the effectiveness of MAEAP through multiple lines of information already available and to identify gaps and future needs. These multiple lines of information should include, but should not be limited to, on-going research evaluating best management practices, tracking application of agricultural BMPs and MAEAP participation, and coordinating that information with current water quality monitoring and assessment programs.

Evaluation of watershed-level effects is complex and requires expertise in a variety of fields, such as hydrology, soils, ecology, biology, physics, chemistry, and modeling. No one agency or institution has the expertise, resources, and time to carry out such complex research and evaluation. It is for this reason; the subcommittee recommends a monitoring coordination program that promotes continued cooperation and collaboration between state and federal agencies, as well as appropriate research institutions and non-profit organizations. By coordinating and tracking these efforts, the information developed from researchers and other stakeholders can be used in a continuous feedback system, to not only monitor the effectiveness of MAEAP, but to also to identify changes needed to improve and advance MAEAP.

The monitoring collaboration program should work with stakeholders to track on-going scientific based research conducted to measure the effectiveness of GAAMPs. Not only should on-going research be tracked, but research needs should be identified along with potential funding opportunities. Research such as; under what circumstance are the various GAAMPs most and least effective. By continually reevaluating GAAMPs effectiveness, the MAEAP coordinator will be able to recommend additional changes to continually improve MAEAP.

I In order for the feedback system to be effective, MDARD will need to establish and maintain a geographic information system (GIS) that can adequately map not only MAEAP verified farms, but individual practices being implemented within each farm. Additionally, tracking implementation of conservation practices on non-MAEAP verified farms will be instrumental for understanding system changes. Finally, it will be important for this system to track overall watershed land use. This MAEAP GIS database can then be compared to current water quality monitoring program databases to identify watersheds where MAEAP practices might be most effective and locations for potential research opportunities.

2. Interested Farmers Can Participate in Existing Voluntary Monitoring Programs

We recommend MDARD first gauge the interest and goals of farmers for a voluntary Water Quality Monitoring Program. If there is interest, we recommend MDARD encourage interested farmers to consider participating in currently existing volunteer monitoring programs within Michigan. The Michigan Clean Water Corps (MiCorps) [18] is a network of volunteer monitoring programs in Michigan. It was created to assist the Department of Environmental Quality (DEQ) in collecting water quality data for use in water resources management programs. MiCorps has established monitoring programs for lakes and streams and could assist farmers or group of farmers interested in establishing a lake or stream monitoring program. Interested participants may rely on the clear guidance and assurances of MAEAP

[18] AmeriCorps: http://www.micorps.net/index.hml

that voluntary water quality monitoring will not result in, or be used to support, enforcement actions. [19] The voluntary and incentive-based approach of MAEAP has fostered significant trust and participation among farmers state-wide, and the MAEAP Partnership may play a primary role in this recommendation.

Farmers who monitor and evaluate the impact of their practices on water quality may have an increased awareness that could lead to improved management decisions and water quality, and greater uptake of programs across their community. There is also interest on the part of some farmers to conduct high quality surface water monitoring in order to compare the results with those obtained by state agencies or third parties interested in water quality in agricultural areas or in providing data under a number of different dry and wet weather conditions.

One of the challenges with implementing voluntary monitoring programs is that monitoring at a very local level, such as a stream reach crossing an individual field or farm, may not detect changes in water quality even when water quality is improved from changes in land management practices. The natural variability of surface water quality, related to weather and stream runoff variability, may diminish the ability to detect changes in water quality over time or distance with certainty. In other words, we may not be able to tell if the system has improved from any one change or program. Within certain contexts and purposes, however, a voluntary educational program that enables interested farmers to monitor local surface water quality may be valuable. Two examples of voluntary monitoring programs that may be instructive to implementing this recommendation are:

1. Gull Lake
2. Discovery Farms program in Wisconsin.

Gull Lake Quality Organization (GLQO) and the Four Township Water Resources Council (FTWRC) are watershed focused organizations that have been working together on monitoring and protecting water quality in the Gull Lake region of Michigan. Gull Lake sits in two counties and four townships. The Gull Lake Quality Organization was formed in the 1960's, initially as a riparian based volunteer organization. With the decline in Gull Lake's water quality in the 1970's, the GLQO focused on the creation of a sewer system around the lake. The resulting change in Gull Lake's water quality was significant, and today it has some of the cleanest water in Southwest Michigan.

The Four Township Water Resources Council is a group of concerned citizens dedicated to protecting water quality in Barry and Prairieville Townships in Barry County, and Richland and Ross Townships in Kalamazoo County. The group was organized in 1994 as an informal group to discuss and address common land use and water quality issues on a watershed basis. The FTWRC is a resource for local governments to work closely with government officials to assist with the adoption of land use policies to proactively manage growth for the environmental and economic benefit of the community.

A few years ago, three concentrated animal feeding operations (CAFOs) located in the Gull Lake Watershed sought to expand their operations. GLQO and FTWRC organized a series of stakeholder meetings to learn about the CAFO expansion plans, and to share concerns related to the operations as well as the potential for impairment of surface and groundwater quality. Owners of the CAFOs, along with the farmers who spread the liquid manure, landowners where the manure is applied, MDEQ, MDARD, MSU, officials from the counties and townships, along with the Boards of both organizations met to share information. The discussions resulted in several activities designed to minimize environmental impairment, including the development of contractual provisions between the landowners and the applicators regarding buffers around surface water features, application by injection, and limitations on application during frozen ground conditions. Most notably, the concern about the land use around the lake

[19] Natural Resources and Environmental Protection Act 451 of 1994, amended, Part 87.

as it relates to water quality, the CAFO operations in particular, resulted in a comprehensive annual monitoring program funded by the GLQO and conducted by researchers at Kellogg Biological Station (KBS).[20]

The Discovery Farms project conducted by the University of Wisconsin Extension provides an out-of-state example that illustrates a trusting relationship between farmers and a partner, similar to the association that a Michigan farmer has with the partnering organizations of MAEAP. Discovery Farms' mission statement reads:

> "The Discovery Farms program develops on-farm and related research to determine the economic and environmental effects of agricultural practices on a diverse group of Wisconsin farms; and educates and improves communications among the agricultural community, consumers, researchers and policy-makers to better identify and implement effective environmental management practices that are compatible with profitable agriculture."

Through participation in Discovery Farms, a Wisconsin farmer agrees to participate in on-farm research that in conjunction with other farms, explores agricultural tile drainage, manure management considerations, and cropping systems management. Discovery Farms has implemented projects on a watershed scale basis and utilizes real-time data to identify results. If a farmer water quality monitoring program is developed by the Department, utilizing partners and maintaining the program as voluntary will be important.

3. Establish a Research and Monitoring Program to Determine Social and Economic Impacts of MAEAP to Society and the Farmer

The intent of this monitoring program should be to determine how MAEAP is resulting in farmers and land managers making changes to management practices that are predicted to reduce risk of environmental impacts and improve water and environmental quality. The greatest benefits of MAEAP to the environment and society can be achieved through maximum participation; therefore we recommend a monitoring program that investigates the motivations of, and impacts on, farmers and farming operations related to their participation in MAEAP.

MAEAP is based on two principles: risk abatement and pollution prevention. Research informs what practices are most effective in reducing pollution from farming practices and many are included in MAEAP standards. Intuitively, we know that more conservation on the ground is better for watershed health. Ongoing research seeks to identify where conservation needs to take place and how much conservation needs to take place to improve the health of local fish communities. Participation in conservation programs becomes a significant efficacy proxy; therefore we recommend a monitoring program that investigates the motivations and economic impacts on farmers and farming operations related to participation in MAEAP. This monitoring program should result in social and economic analysis that quantifies the impacts of participation in MAEAP, including:

a. What social, economic and personal values influence a farmer's decision to participate?
b. How much does it cost a farmer to become verified and maintain reverification? (short-term and long-term financial impacts on a farm operation)

[20] These reports can be found on the GLQO website, and include a significant amount of data that has been collected by KBS over the past several years. Further, one of the CAFO owners has agreed to provide their soil monitoring data to include in the KBS monitoring work. The monitoring effort includes *E. coli* testing (in cooperation with the Kalamazoo County Health Department), and last year included some speciation of the *E. coli* bacteria. http://www.glqo.net/publications/

c. What are the motivations of participation or non-participation in the MAEAP program?
d. What are the key behaviors, motivators and practices of farmers in their land management decision making?

Appendix A: Excerpts from Public Act 2 of 2011

Statutory reference charging MAEAP AC with developing Water Quality Monitoring Recommendations: Excerpts from Public Act 2 of 2011

MCL 324.8708

Section 8708
(3) The environmental assurance advisory council shall advise the director on, but not limited to, the following:

(a) MAEAP standards.
(b) On-site evaluations for verification of specific aspects of a farming operation.
(c) Water quality and environmental monitoring.
(d) Protocols for verification and revocation of verification.
(e) MAEAP activities.
(f) Interagency coordination of conservation programs.
(g) The use of money in the clean water fund created in section 8807 and other funding sources to promote MAEAP and activities to encourage more MAEAP-verified farms.
(h) Options to increase assistance to assist small- and medium-sized farms in achieving MAEAP standards.
(i) The creation of subcommittees as needed to address emerging and ongoing issues.

MCL 324.8713

Section 8713
(1) The director, in conjunction with the department of environmental quality and the department of community health, shall develop and establish priorities, procedures, and protocols for the implementation of a water quality monitoring program to do all of the following:

(a) Provide general screening of groundwater or surface water, or both.
(b) Determine the relative risk of groundwater contamination at different locations.
(c) Perform envelope monitoring.

(2) The director shall, in a timely manner, notify affected well owners of their monitoring results from the monitoring conducted pursuant to this section, including the method detection limits and associated water resource protection levels.
(3) The monitoring program conducted pursuant to this section may provide for modifications of sampling density and analyses to reflect regional groundwater impact potential.
(4) The monitoring conducted pursuant to this section shall be conducted utilizing generally accepted scientific practices.
(5) The department shall establish a method detection limit goal for monitoring conducted pursuant to this section set at 10% of a compound's groundwater resource response level.
(6) Agencies conducting monitoring for pesticides or fertilizers pursuant to this section shall notify the director, on forms provided by or in a format approved by the director, of the location, procedure, and concentration of all pesticide detections or nitrate concentrations in excess of 10 parts per million. Information received by the director shall be evaluated based upon accepted protocols and procedures established under this part.

(7) The director shall establish by rule laboratory confirmation mechanisms used under this part.
(8) The director shall establish by rule risk assessment protocols for the development of groundwater resource protection levels.

MCL 324.8713a

Sec. 8713a
(1) The director, in consultation with the environmental assurance advisory council, may develop and establish priorities, procedures, and protocols for the implementation of a surface water quality monitoring program to do both of the following:
    (a) Promote voluntary water quality monitoring by farms.
    (b) Monitor and benchmark the effectiveness of conservation practices and MAEAP standards in cooperation with participating farmers.
(2) Water quality information collected under this section by the department in cooperation with farmers shall be aggregated and made available to the commission of agriculture and rural development. Specific locations or persons involved in water quality information collection are exempt from disclosure under the freedom of information act, 1976 PA 442, MCL 15.231 to 15.246.

Appendix B: Water Quality Monitoring Subcommittee Members

First	Last	Organization	e-mail	phone	Member Role
Mike	Alexander	Michigan Department of Environmental Quality	Alexanderm2@michigan.gov	(517) 335-4189	Alternate for Bill Creal
Jon	Bartholic	Michigan State University	bartholi@msu.edu	(517) 353-9785	Invited Expert
James	Clift	Michigan Environmental Council	james@environmentalcouncil.org	(517) 487-9539	MAEAP AC Member
Tom	Coon	Michigan State University Extension	coontg@anr.msu.edu	(517) 355-2308	MAEAP AC Co-Chair
Bill	Creal	Michigan Department of Environmental Quality	CREALW@michigan.gov		MAEAP AC Member
Lauri	Elbing	The Nature Conservancy	lelbing@tnc.org	(517) 316-2260	WQM Subcommittee Chair MAEAP AC Member
Gary	Kohlhepp	Michigan Department of Environmental Quality	KOHLHEPPG@michigan.gov	(517) 335-1289	Alternate for Bill Creal
Bob	Pigg	Michigan Department of Agriculture & Rural Development	piggr@michigan.gov	(517) 373-6893	Invited Expert
Scott	Piggott	Michigan Farm Bureau	spiggot@michfb.com	(517) 323-7000	MAEAP AC Co-Chair
Emily	Ries	Michigan Farm Bureau	eries@michfb.com	(517) 323-7000	Alternate for Scott Piggott
Ruth	Shaffer	USDA: Natural Resource Conservation Service	ruth.shaffer@mi.usda.gov	(517) 324-5239	Invited Expert
Jan	Wilford	Michigan Department of Agriculture & Rural Development	wilfordj9@michigan.gov	(517) 241-4730	Invited Expert
Paul	Zugger	Michigan United Conservation Clubs	pzugger@mucc.org	(517) 346-6453	MAEAP AC Member

Appendix C: EPA Guidance on Designing Monitoring Program

It is important to clearly state and understand the objective of a proposed water quality monitoring program *before* data collection begins. Identifying the objective assists in determining the experimental design and assessment tools that should be used in the program. All subsequent decisions about the monitoring program follow directly from the monitoring objectives.

Note that often there are multiple monitoring objectives within a monitoring program; therefore it is important to design such programs to meet individual and aggregate objectives.

A review and comparison of different monitoring programs required to meet different objectives within a watershed may result in combining some field or analytical efforts for more efficiency, but the individual monitoring programs should remain distinct to assure that specific project monitoring objectives are met. The most fundamental step in the development of a monitoring plan is to define the goals and objectives, or purpose, of the monitoring program.

In general, monitoring goals are broad statements such as "to measure improvements in Elephant Butte Reservoir" or "to verify nutrient load reductions into the Chesapeake Bay." Designing a monitoring plan also includes selecting sampling variables, a sampling strategy, station locations, data analysis techniques, the length of the monitoring program, and the overall level of effort to be invested.

Monitoring programs can be grouped according to the following general purposes or expectations:

- Describing status and trends
- Describing and ranking existing and emerging problems
- Designing management and regulatory programs
- Evaluating program effectiveness
- Responding to emergencies
- Describing the implementation of best management practices
- Validating a proposed water quality model
- Performing research

The remainder of the program framework includes coordination and collaboration, design, implementation, interpretation, evaluation of the monitoring program, and communication. Numerous guidance documents have been developed by EPA and others to assist in the development and implementation of monitoring programs.

Once the monitoring goals have been established, existing data and constraints should be considered. The review should help determine whether existing data provide sufficient information to address the monitoring goals and what data gaps exist.

Monitoring for individual BMPs can typically be conducted at the field scale, whereas monitoring for BMP systems, such as MAEAP, is usually conducted on a watershed scale to incorporate the combined effect of multiple BMPs being investigated. Studies of some individual practices can be conducted in a relatively short time (less than 5 years), while others might take longer.

Evaluation of BMP systems is typically conducted over a long term (more than 5 years) because BMP implementation can take years to affect water quality. This type of monitoring is difficult due to the presence of pollutant reserves in soil and sediments, the effect of many land uses within a study area, the

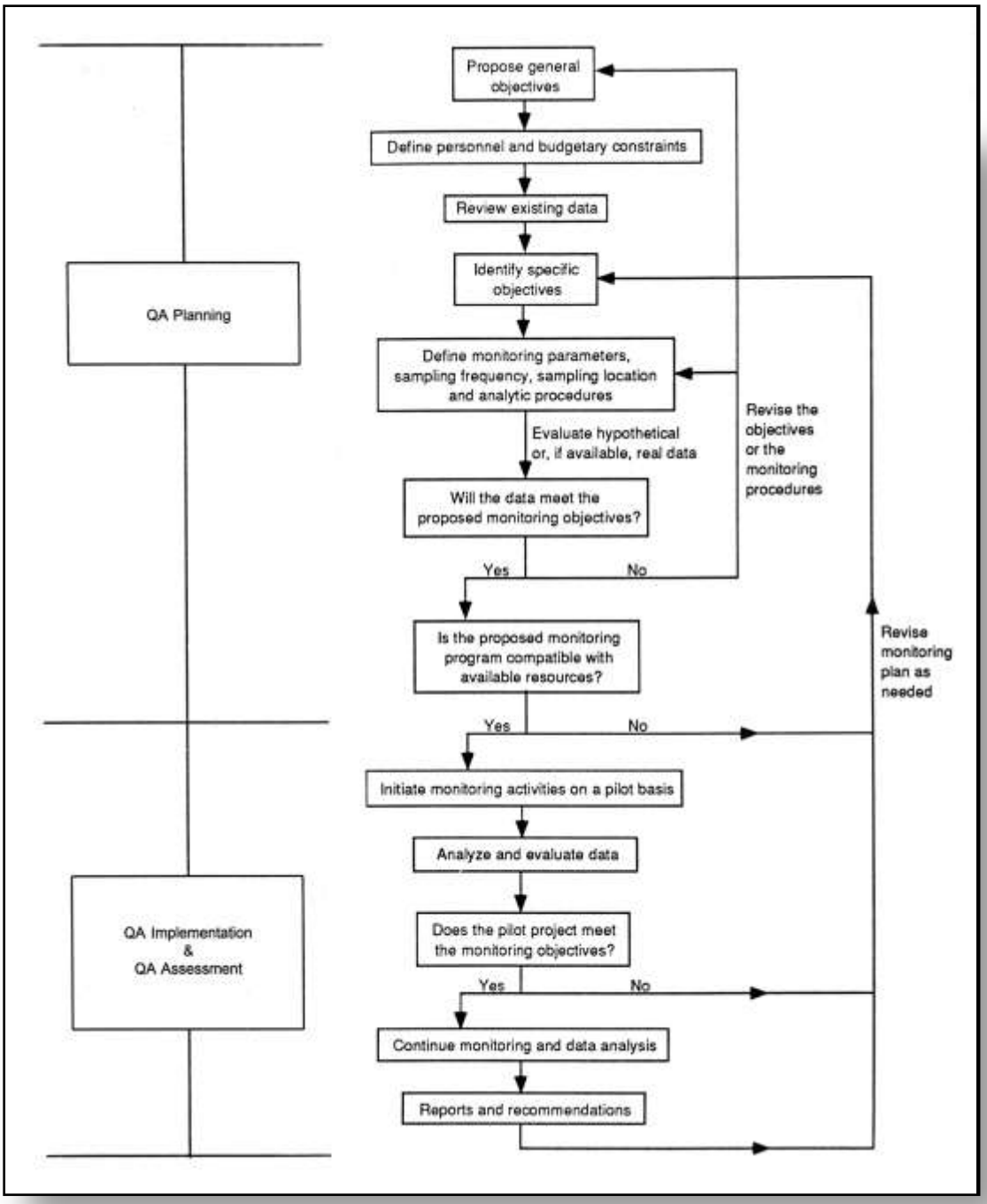
variety of approaches that landowners use to implement similar systems of BMPs, and the need to track land management as well as water quality and climatic variables.[21]

When seeking to analyze trends, the objective is to answer the question, "Is water quality changing over time?" Baseline monitoring of key indicators is part of trend analysis because establishing a baseline is essential to analyzing trends. However, baseline monitoring is generally thought of as determining a condition prior to pollutant entry or prior to a change in water body condition, whether beneficial or detrimental.

Controlling for influencing factors such as climate is necessary if baseline monitoring is to be used as a reference point for trend analysis and management decisions. The ability to relate water quality changes to changes in land management depends on the quality and quantity of data collected on land management practices. Below is a diagram that provides guidance from USEPA, which is recommended by two MSU professors who are experts in water quality monitoring systems.

[21] http://water.epa.gov/polwaste/nps/success319/upload/monitoring_chap2_1997.pdf

Developing a Monitoring Plan



Appendix D: Existing Water Quality Monitoring Programs

Federal Government

US Environmental Protection Agency (EPA)
The Federal Water Pollution Control Act of 1948 was the first major U.S. law to address water pollution. Growing public awareness and concern for controlling water pollution led to sweeping amendments in 1972. As amended in 1972, the law became commonly known as the Clean Water Act (CWA). The 1972 amendments:

- Established the basic structure for regulating pollutants discharges into the waters of the United States.
- Gave EPA the authority to implement pollution control programs such as setting wastewater standards for industry.
- Maintained existing requirements to set water quality standards for all contaminants in surface waters.
- Made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions.
- Funded the construction of sewage treatment plants under the construction grants program.
- Recognized the need for planning to address the critical problems posed by nonpoint source pollution.

Subsequent amendments modified some of the earlier CWA provisions. Revisions in 1981 streamlined the municipal construction grants process, improving the capabilities of treatment plants built under the program. Changes in 1987 phased out the construction grants program, replacing it with the State Water Pollution Control Revolving Fund, more commonly known as the Clean Water State Revolving Fund. This new funding strategy addressed water quality needs by building on EPA-state partnerships. EPA works with its federal, state and tribal regulatory partners to assure compliance with the CWA. Several different approaches are utilized by EPA, and include:

- National Pollutant Discharge Elimination System (NPDES) - Compliance monitoring in the NPDES program encompasses analyses of Discharge Monitoring Reports (DMRs) which provide continuous monitoring information from permitted facilities on the characteristics of their effluent discharges, guidance to state and EPA regional inspectors on how and when to conduct inspections, and inspector training.
- Pretreatment of Wastewater (Industrial Users) - EPA and states conduct periodic inspections and audits of the Publicly Owned Treatment Works (POTW) pretreatment implementation programs to ensure that the programs are being properly implemented.
- Biosolids (POTW sludge) - When treated and processed, sewage sludge becomes biosolids which can be recycled and applied as fertilizer to soils. EPA conducts inspections of POTW and other industrial facilities that generate, store, transport and dispose of biosolids.
- Oil Spill Prevention - EPA conducts inspections of facilities that storage oil to insure that the facility satisfies requirements designed to prevent oil spills.
- Industrial Storm Water - EPA conducts inspections of three types of facility operations subject to the storm water regulations: construction sites, industrial sites, and municipal separate storm sewer systems (MS4). For MS4 operations, EPA also conducts audits designed as a comprehensive review of all facets of the Control Authority's storm water program.
- Concentrated Animal Feeding Operations (CAFOs) - EPA and its regulatory partners monitor CAFOs through inspections, report and record reviews, and self-auditing.

- Municipal Storm water: Combined Sewer Overflows (CSOs), Sanitary Sewer Overflows (SSOs) - CSOs and SSOs present important concerns for public health and the environment. To address these concerns, EPA and state agencies work to identify and address public health and environmental threats posed by overflows from municipal sewer collection systems.
- Wetlands (Section 404) - EPA conducts inspections of sites to determine whether dredged or fill material is being illegally dumped into wetlands in violation of the regulations and statute; to verify whether and if facilities/sites have a wetlands permit and are complying with it; and whether steps are being taken to minimize or avoid wetland impacts where practicable.
- Wastewater Trading Program - This program allows facilities facing high pollution control costs to meet their regulatory obligations by purchasing environmentally equivalent (or superior) pollution reductions from another source at lower cost.
- Discharge Monitoring Report-Quality Assurance Study Program - An annual quality assurance (QA) study conducted to evaluate the analytical and reporting ability of permittees and laboratories routinely performing inorganic chemistry and whole-effluent toxicity self-monitoring analyses required in NPDES permits.[22]

US Department of Agriculture - Natural Resources Conservation Service (NRCS)
The U.S. Department of Agriculture initiated the Conservation Effects Assessment Project (CEAP) in 2003 to determine the effects and effectiveness of soil and water conservation practices on agricultural lands. The CEAP report *Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Great Lakes Region* is the third in a series of studies covering the major river basins and water resource regions of the contiguous 48 United States. It was designed to quantify the effects of conservation practices commonly used on cultivated cropland in the Chesapeake Bay Watershed, evaluate the need for additional conservation treatment in the region, and estimate the potential gains that could be attained with additional conservation treatment. In 2004, watershed assessment studies were begun in fourteen agricultural watersheds with varying cropping systems, landscapes, climate, and water quality concerns.

- Upper Mississippi River Basin (released June 2010)
- Chesapeake Bay Region (released March 2011)
- Great Lakes Region (released September 2011)
- Ohio-Tennessee River Basin
- Missouri River Basin
- Arkansas-White-Red River Basins
- Lower Mississippi River Basin
- Delaware River Watershed
- Northeast Region
- South Atlantic-Gulf Region
- Texas Gulf Water Resource Region
- Souris-Red-Rainy Water Resource Regions
- Pacific Northwest and Western Water Resource Regions

All of the reports in the series are based on computer modeled simulations of conservation outcomes derived from the use of farming and conservation practices as reported by farmers during the period 2003 to 2006.

[22] EPA, Clean Water Act Compliance Monitoring: http://www.epa.gov/compliance/monitoring/programs/cwa/index.htmlhttp://www.epa.gov/compliance/monitoring/programs/cwa/index.html

CEAP modeling efforts found that farmers have reduced onsite and offsite environmental problems stemming from agricultural activities. Even so, significant additional progress can be achieved, particularly through more rigorous application of nutrient management in combination with erosion-control practices. Simulation modeling showed that conservation practices in the region have reduced edge-of-field losses of sediment, nitrogen, and phosphorus as well as loadings of these materials in rivers, streams, and the Lakes. The resource concern with the most widespread need for additional conservation treatment related to cropland in the region is nitrogen loss in subsurface flows. Additional conservation practices to address excessive phosphorus loss (sediment adsorbed and soluble) from fields are also important but the need for these practices occurs on a smaller proportion of the cropland than treatment needs for nitrogen loss.

Study goals included modeling and field research to assess practices, and evaluation of practice placement in watersheds. Not all goals were met within five years but important lessons were learned. While practices improved water quality, problems persisted in larger watersheds. This dissociation between practice-focused and watershed-scale assessments occurred because:

1. Conservation practices were not targeted at critical sources/pathways of contaminants
2. Sediment in streams originated more from channel and bank erosion than from soil erosion
3. Timing lags, historical legacies, and shifting climate combined to mask effects of practice implementation
4. Water quality management strategies addressed single contaminants with little regard for trade-offs among contaminants

These lessons could help improve conservation strategies and set water quality goals with realistic timelines. Continued research on agricultural water quality could better integrate modeling and monitoring capabilities, and address ecosystem services.[23]

A simulation model was used to estimate the effects of conservation practices that were in use during the period 2003 to 2006, but does not capture practices implemented since then. The NRCS National Resources Inventory, a statistical survey of conditions and trends in soil, water, and related resources on U.S. non-Federal land, provided the statistical framework. Information on farming activities and conservation practices was obtained from a farmer survey. Using those data, conservation practice effects were evaluated in terms of:

- Reductions in losses of sediment, nutrients, and pesticides from farm fields;
- Enhancement of soil quality through increases in soil organic carbon in the field; and
- Reductions in in-stream loads of sediment, nutrients and pesticides in the region's rivers and streams.

The physical process models used in this study are mathematical representations of the real world designed to estimate complex and varying environmental events and conditions. To estimate the effects of conservation practices, model simulation results were used to make relative comparisons between two model runs—one that includes conservation practices and one that excludes conservation practices. All other aspects of the input data and the model parameters were held constant. Model results are scientifically defensible to the level of 4-digit hydrologic unit code watersheds.

[23] Tomer, M. D., and M. A. Locke. The Challenge of Documenting Water Quality Benefits of Conservation Practices: a review of USDA-ARS's conservation effects assessment project watershed studies. 2011, Water Science & Technology 64(1) 300–310 http://naldc.nal.usda.gov/download/49869/PDF

The assessment includes conservation practices in use regardless of how or why they came to be in use. It is not restricted to only those practices associated with Federal conservation programs; the assessment also includes the conservation efforts of States, independent organizations, and individual landowners and farm operators. The Subcommittee was not able to discern if MAEAP standards were used in the Great Lakes CEAP Assessment.

US Department of the Interior - US Geological Survey (USGS)
The USGS Federal-State Cooperative Program funds statewide, regional, and local monitoring and interpretive projects that are relevant to the cooperator and to national interests and needs. The USGS may provide up to 50 percent of the funding for this cooperative work. About 80 percent of the USGS Michigan Water Science Center's work is funded through the Federal-State Cooperative Program. The name of this program is somewhat misleading, because public agencies of any size and Indian tribes can participate in this cooperative program.

The USGS operates and maintains stream gages and water level monitoring wells with support from state and local partners. USGS staff played a central role in the design of the Michigan Water Withdrawal Assessment Tool. The USGS has also carried out a number of water quality monitoring studies in the state, covering topics such as emerging contaminants, agrichemical contaminants in groundwater and surface water, and coliform bacteria. One study of particular interest to MAEAP is the 2011 U.S. Geological Survey Scientific Investigations Report: "Precipitation-runoff relations and water-quality characteristics at edge-of-field stations, Discovery Farms and Pioneer Farm, Wisconsin." [24]

USGS, the University of Wisconsin (UW)–Madison Discovery Farms program (Discovery Farms), and the UW–Platteville Pioneer Farm program (Pioneer Farm) developed a cooperative study to identify typical ranges and magnitudes, temporal distributions, and principal factors affecting concentrations and yields of sediment, nutrients, and other selected constituents in runoff from agricultural fields. Hydrologic and water-quality data were collected year-round at 23 edge-of-field monitoring stations on 5 privately owned Discovery Farms and on Pioneer Farm during water years 2003–2008. The studied farms represented landscapes, soils, and farming systems typical of livestock farms throughout southern Wisconsin. Each farm employed a variety of soil, nutrient, and water-conservation practices to help minimize sediment and nutrient losses from fields and to improve crop productivity. This report summarizes the precipitation-runoff relations and water-quality characteristics measured in edge-of-field runoff for 26 "farm years" (aggregate years of averaged station data from all 6 farms for varying monitoring periods).

A relatively wide range of constituents typically found in agricultural runoff were measured: suspended sediment, phosphorus, and nitrogen, chloride, total solids, total suspended solids, total volatile suspended solids, and total dissolved solids.

- Mean annual precipitation was 32.8 inches for the study period, about 3 percent less than the 30-year mean. Overall mean annual runoff was 2.55 inches per year (about 8 percent of precipitation) and the distribution was nearly equal between periods of frozen ground (54 percent) and unfrozen ground (46 percent). Mean monthly runoff was highest during two periods: February to March and May to June. Ninety percent of annual runoff occurred between January and the end of June.

- Event mean concentrations of suspended sediment in runoff during unfrozen-ground periods were significantly higher ($p<0.05$) than those during frozen-ground periods. Mean annual suspended-

[24] http://pubs.usgs.gov/sir/2011/5008/

sediment yields ranged from about 3 to nearly 5,000 pounds per acre (lb/acre), with a mean yield of 667 lb/acre. Ninety percent of suspended sediment was yielded in runoff during unfrozen-ground periods. May and June alone contributed more than 80 percent of the overall yield.

- Phosphorus concentrations and yields were also affected by the ground conditions at the time of runoff; however, unlike suspended sediment, phosphorus was usually available for transport in runoff regardless of ground condition. Mean annual total-phosphorus yields ranged from 0.03 to 7.0 lb/acre, with a mean yield of about 2.0 lb/acre.

- Nitrogen in runoff followed similar patterns to phosphorus in that concentrations were highest during unfrozen-ground periods, yields were highest during months of highest runoff, and speciation was affected by the ground conditions at the time of runoff. Mean annual total-nitrogen yields ranged from 0.11 to 19.2 lb/acre, and the mean was 7.2 lb/acre. Mean monthly total-nitrogen yields were strongly correlated with mean monthly total-phosphorus yields ($r2 = 0.92$), indicating that the sources of nitrogen and phosphorus in runoff were likely similar.

Analysis of runoff, concentration, and yield data on annual, monthly, and seasonal time scales, when combined with precipitation, soil moisture, soil temperature, and on-farm field-activity information, revealed conditions in which runoff was most likely. The analysis also revealed the effects that field conditions and the timing of field-management activities—most notably, manure applications and tillage—had on the quantity and quality of surface runoff from agricultural fields. [25]

State of Michigan

Michigan Department of Agriculture and Rural Development (MDARD)
The mission of the MDARD's water monitoring program is to determine the nature and extent of pesticide and nitrogen fertilizer contamination in Michigan's water, to reduce the potential for negative health impacts associated with the use of low-quality water, and to use the information gathered to improve the way we communicate the risks to water resources associated with different land-uses. Until 2011 the program focused exclusively on groundwater, which is reflected in the program activities.

The program has sampled wells across the state to provide data on groundwater quality, so that decisions can be based on accurate and timely information. Samples have been analyzed using laboratory methods such as gas chromatography and mass spectroscopy (GC/MS), and screening methods such as enzyme-linked immunosorbent assay (ELISA, also known as immunoassay). The program has also sampled wells to develop a statistically valid analysis of pesticide and fertilizer contamination in private water supplies.

The MDARD water monitoring program also tests private wells throughout Michigan to meet the monitoring requirements of Michigan's State Pesticide Management Plans (PMP) and to retain pesticide product registrations where those products can be used without negative impacts on groundwater quality. Wells in areas of high PMP chemical use are sampled to determine their impact on Michigan's groundwater.

When a pesticide contamination is detected the water monitoring program carries out the sampling and envelope monitoring necessary to complete site investigations and activity plans. Envelope monitoring

[25] Stuntebeck, T.D., Komiskey, M.J., Peppler, M.C., Owens, D.W., and Frame, D.R., 2011, Precipitation-runoff relations and water-quality characteristics at edge-of-field stations, Discovery Farms and Pioneer Farm, Wisconsin, 2003–8: U.S. Geological Survey Scientific Investigations Report 2011–5008, 46 p., plus five appendixes. http://pubs.usgs.gov/sir/2011/5008/ http://pubs.usgs.gov/sir/2011/5008/

refers to the sampling of wells around a known contamination in order to determine the extent of the contamination.

MDARD manages MAEAP, formerly known as the Michigan Water Stewardship Program, as well as the MAEAP Water Monitoring Program that targets private wells. MAEAP includes a technical assistance (MAEAP TA) component, which provides information and assessment tools for farmers that help identify risks to groundwater and surface water associated with their agricultural practices, including pesticide and nitrogen fertilizer use practices, and coordinates local, state, and federal resources to help individuals reduce those risks. MAEAP TA is designed to be voluntary, to be locally driven, to address the concerns of individuals, and to maintain a focus on the financial and technical constraints which drive real-world decisions.

The MAEAP Water Monitoring Program is relatively narrow in focus, addressing risks to water resources associated with pesticide and nitrogen fertilizer use by sampling private wells across the state for general chemistry, pesticides and volatile organic compounds to meet state and federal program objectives. Well sampling under the program is designed to meet specific information needs. The program has sampled more than 4,500 wells to date. In 2011, the enabling legislation was amended, allowing the program to sample surface water for the first time.

The Water Monitoring Program supports the EPA Pesticide State Management Plan process by providing data on private drinking water well quality to retain pesticide product registrations where those products can be used without negative impacts on groundwater quality. The program provides data on nitrate and pesticide concentrations to well users, investigates the nature and extent of pesticide contamination at contaminated sites, coordinates information on potential health impacts from the use of contaminated water supplies, and provides alternate water supplies including well replacement for private well owners with pesticide levels above public drinking water standards. Emerging issues include the chemistry and toxicity of pesticide metabolites, the toxicity of mixtures of pesticides, nitrate contamination of vulnerable aquifers, and determining the impacts of best management plans on water quality.

Michigan Department of Environmental Quality (MDEQ)

The federal Water Pollution Control Act, also known as the Clean Water Act (CWA), requires states to provide the EPA with an assessment of the quality of their waters and a list of waters that do not support their designated uses or attain water quality standards (WQS) and require the development of total maximum daily loads (TMDLs), and an assessment of status and trends of publicly owned lakes.

Michigan's WQS are consistent with the Great Lakes Initiative, establish minimum water quality requirements by which the waters of the state are to be managed, and provide the primary regulatory framework that guides the MDEQ's water quality monitoring, assessment and water protection activities.

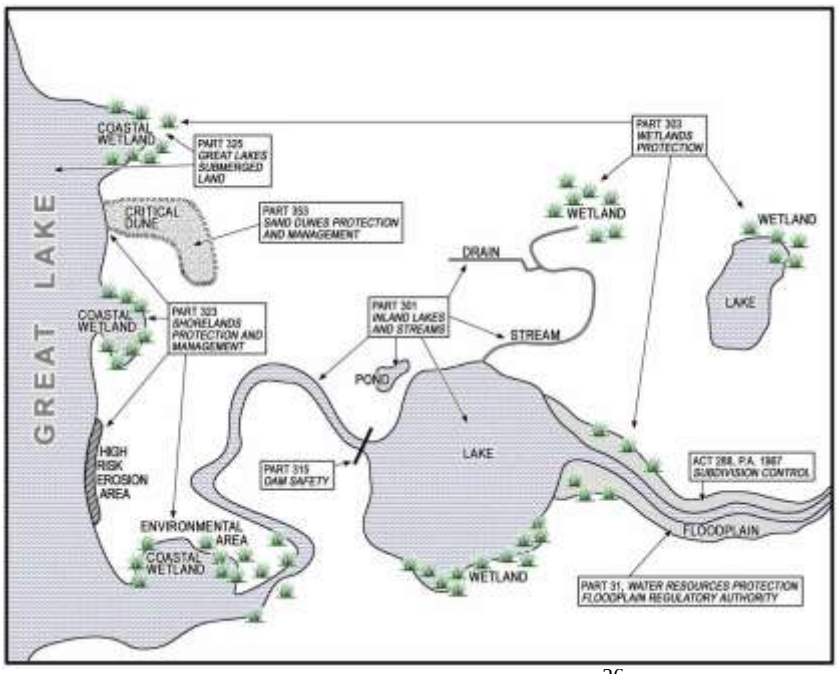
The mission of the MDEQ's Water Resources Division is to make Michigan's waters safe and clean for recreating, fishing, drinking, and healthy aquatic ecosystems. Five major goals provide definition to this mission: (1) Enhance Recreational Waters; (2) Ensure Consumable Fish; (3) Protect and Restore Aquatic Ecosystems; (4) Ensure Safe Drinking Water; and (5) Protect Public Safety.

In January of 1997, the MDEQ completed a monitoring plan as required by the CWA, titled "A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters" (Strategy), which describes the monitoring activities for a comprehensive assessment of water quality in Michigan's surface waters. It was developed specifically to identify the activities and resources needed to establish a comprehensive, state-of-the-art water quality monitoring program, and has guided Michigan's monitoring program implementation. The Strategy consists of nine interrelated elements: fish contaminants, water chemistry, sediment chemistry, biological integrity, wildlife contaminants, bathing beaches, inland lake quality and eutrophication, stream flow, and volunteer monitoring. It also set four monitoring goals:

1. Assess the current status and condition of waters of the state and determine whether water quality standards are being met;
2. Measure spatial and temporal water quality trends;
3. Evaluate the effectiveness of water quality prevention and protection programs; and
4. Identify new and emerging water quality problems.

The Strategy also incorporates several key principles widely recognized as essential to effective monitoring. These include:

- Integrate and coordinate the use of scarce monitoring resources with other parties collecting water quality data;
- Maximize the use of local units of government and citizen volunteers to monitor water quality;
- Ensure that new and expanded monitoring activities are consistent with the DEQ's 5-year watershed permitting process;
- Generate data that are scientifically defensible and relevant to the decision-making process;
- Manage and report data in a way that is meaningful to intended audiences.



Michigan Laws Administered by MDEQ[26]

Environmental monitoring is an essential component of the MDEQ mission and while it is the lead state agency responsible for monitoring, assessing, and managing the state's surface water and groundwater, wherever possible, the MDEQ strives to organize and direct the resources and energies created by partnerships through a "watershed approach" to protect the quality and quantity of the state's water resources.

Many MDEQ water quality monitoring and water pollution control programs are integrated and implemented according to a five-year rotating watershed cycle to facilitate effective watershed

[26] Kohlhepp, Gary. "A Monitoring Overview" *Natural Resources and Environmental Protection Act, PA 451 of 1994 & Related Statutes* http://www.michigan.gov/documents/deq/wrd-what-we-do_332677_7.pdf

management. Michigan has 57 major watersheds based on the USGS's 8-digit Hydrologic Unit Codes (HUC). Water quality assessment efforts focus on a subset (approximately 20%) of these major watersheds each year.

As part of the DEQ's water quality monitoring program, sites for biological integrity and water chemistry monitoring are selected using both targeted and probabilistic study designs.

- The probabilistic monitoring approach is used to address statewide and regional questions about water quality.
- Targeted monitoring is used to fulfill specific monitoring requests, assess known or potential problem areas or areas where more information is needed, achieve assessment coverage of a watershed, and provide information to support and evaluate the effectiveness of DEQ water protection programs (e.g., NPDES, NPS, and Site Remediation).
- All site-specific data are considered to determine designated use support. Generally, the other types of monitoring are conducted using targeted study designs.

To ensure acceptable data quality, the DEQ also requires all grantees or vendors receiving state or federal money for the purpose of conducting water quality monitoring to prepare Quality Assurance Project Plans prior to sample collection. Other data, such as data submitted by outside agencies or the public, must satisfy the DEQ's quality assurance/quality control requirements to be used to make designated use support determinations of supporting or not supporting, to change the designated use support, or to reassign water bodies to different categories. Data that do not fully satisfy the DEQ's quality assurance/quality control requirements or data that are collected and analyzed using techniques that are less rigorous than techniques used by the DEQ to make designated use support determinations may be used to list a water body for further evaluation (i.e., as insufficient information).[27]

Abandoned Well Management

Unplugged abandoned wells threaten the quality of drinking water obtained from privately owned and publicly owned drinking water supply wells. The MDEQ Water Bureau has implemented a comprehensive Abandoned Well Management Program to coordinate statewide abandoned well location and plugging activities. Plugging abandoned wells protects the groundwater source aquifers that are used by nearly one-half of Michigan's citizens for drinking water. The goal of the Abandoned Well Management Program is to identify and properly plug as many abandoned wells as possible.

The Water Bureau also administers an Abandoned Well Management Grants Program that is funded by the Clean Michigan Initiative (CMI). Abandoned well management grants target and fund the location and plugging of abandoned wells in community public water supply wellhead protection areas.

The MDEQ conducts training and public education/outreach activities to raise the level of public awareness concerning the environmental and public health threats associated with unplugged abandoned wells. Groundwater protection seminars that include abandoned well related topics are sponsored for general audiences. Technical training programs covering abandoned well plugging techniques and requirements are conducted for registered water well drilling contractors, local health department staff members, environmental consultants, and other state of Michigan departments.

Conservation Reserve Enhancement

[27] Water Quality and Pollution Control in Michigan 2010 Sections 303(D), 305(B), and 314 Integrated Report http://www.michigan.gov/documents/deq/wb-swas-final-2010IR_316320_7.pdf

The MDEQ works closely with the MDARD to implement the Conservation Reserve Enhancement Program, a federal-state-local conservation partnership designed to reduce significant environmental effects related to agriculture. The Conservation Reserve Enhancement Program is being implemented in four critical watersheds (Saginaw Bay, Macatawa River, River Raisin, and western Lake Erie basin) that have intense agricultural land use. The objectives of the program are to improve and protect water quality and to promote and enhance wildlife habitat by providing incentives to Michigan citizens for implementing conservation practices for a period of 15 years. Eligible conservation practices include grass plantings, filter strips, riparian buffer strips, field windbreaks, and wetland restoration. The MDEQ also supplies Section 319 and CMI funds for livestock exclusion, implementation of Natural Resources Conservation Service approved conservation practices, Conservation Reserve Enhancement Program technical assistance, and permanent conservation easements.

Non-Point Source (NPS) Control

The NPS Program assists local units of government, nonprofit entities, and other state, federal, and local partners to reduce NPS pollution statewide. The basis for the program is watershed management; the MDEQ provides assistance and funding to develop watershed management plans (WMPs) and to implement NPS control activities in these plans. The NPS Program consists of five parts:

- Technical assistance to help organizations develop and implement WMPs, including BMP selection, land use planning activities, and engineering review of site plans.
- Information and education, including activities/tools created by the MDNRE and grantees, to educate people about NPS of pollution.
- Grants to implement BMPs, land use planning tools, and information/education activities.
- Compliance and Enforcement, including response and investigation of complaints, follow-up requiring corrective actions, and occasionally participating in escalated enforcement actions.
- Monitoring and field investigations to identify NPS problems and evaluate the effectiveness of corrective or preventive actions.

Additional Water Quality Monitoring and Assessment Programs Administered by MDEQ:

- Beach Water Monitoring: The Michigan public beaches and recreational-use waterways program contains information about beach closings, monitoring efforts and E. coli test results. Data located on this site is entered and maintained by local health department offices.
- Assessment of Michigan Waters: The Surface Water Assessment Section oversees the protection of the quality of surface waters throughout the State.
- Inland Lakes Monitoring: The MDEQ, in partnership with the Michigan Lake and Stream Associations, Inc., developed the Cooperative Lakes Monitoring Program as a cost-effective method for citizens to monitor water quality and to document changes in lake quality over time.
- Michigan Surface Water Information Management: This application is an interactive map-based system that allows users to view information about Michigan's surface water. It was developed through a cooperative effort by the Michigan Department of Technology, Management, and Budget, MDEQ, and DNR. Users are able to view and download data collected by the DEQ and DNR from surface water monitoring sites located throughout Michigan, and includes:
    1. Environmental Monitoring - This layer contains water/sediment chemistry, aquatic macroinvertebrate community and physical habitat data that have been collected by the MDEQ (or its contractors/grantees) for various Michigan surface waters.
    2. Beach/River E-coli - This layer contains bacteriological data that have been collected by the MDEQ and local county health departments for various Michigan surface waters, including public bathing beaches. Information about beach closings and water quality standard exceedances is also provided.
    3. Fish Contaminant - This layer contains fish contaminant data that have been collected by the MDEQ (or its contractors/grantees) for various Michigan surface waters. Fish

contaminant data are used by the MDEQ to: determine whether fish from specific water bodies are safe for human and wildlife consumption, assess spatial and temporal water quality trends, and as surrogate measures of bioaccumulative chemical concentrations in surface water.

4. USGS Gage Stations - This layer contains location information for the United State Geological Survey (USGS) flow gage stations in Michigan. Daily flow values summarized from time-series flow measurements taken each day for the period of record at the USGS gage stations are also provided.
5. High Flow - Data from the DEQ's High Flow Discharge Information database.
6. Low Flow - Data from the DEQ's Low Flow Discharge Information database.
7. Wastewater Discharges - This layer contains location and other information for all permitted discharges of wastewater to Michigan surface waters and groundwater. Anyone discharging, or proposing to discharge wastewater into Michigan surface water or groundwater is required by law to obtain a National Pollutant Discharge Elimination System (NPDES) or a State Groundwater permit.
8. Non-Point Source (NPS) Grants - This layer contains location and other information about non-point source water quality protection grants that have been awarded by the MDEQ to local units of government and nonprofit entities in Michigan.
9. Septage Haulers - This layer contains location and other information about the domestic septage land application sites in Michigan. The licensing and handling of domestic septage is regulated under 2004 Public Act 381, which amended Part 117, Septage Waste Services, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
10. Lakes & Streams/Rivers - General information regarding lakes, streams, and rivers, collected and summarized by the DNR. Lake name, surface area, maximum depth, perimeter, fetch (longest unobstructed distance across the lake), type of waterbody, Town-Range-Section, and lake ID code.
11. Valley Segments - Michigan rivers and streams have been subdivided into ecologically similar units called Valley Segments. Within each Valley Segment, the river has a similar drainage area, discharge (flow, in cubic feet per second), nutrient concentration, summer water temperature, valley character, channel character, and key fish species. More information on Valley Segments is in the 1997 DNR report by Seelbach and colleagues.[28]
12. Coldwater Streams - Designated Trout Streams show those portions of rivers and streams officially designated as trout streams by a Fisheries Order of the Director of the MDNR as set forth in DNR-DFI 101 FO-210.01.
13. Natural Rivers - Natural Rivers are officially designated portions of rivers protected under the DNR Natural Rivers Program, established by the Natural River Act (Part 305 of P.A. 451 of 1994). The purpose of Natural Rivers designation is to preserve and enhance a river's values for a variety of reasons, including aesthetics, free-flowing condition, recreation, boating, historic, water conservation, floodplain, and fisheries and wildlife habitat.
14. Reports - DNR Fisheries Division reports about that waterbody.
15. Fish Stocking Information - The number of fish stocked in that waterbody by date and species.
16. Fish Species - List of game fish species found in that waterbody by Fisheries Division.

[28] Can be found at: http://rivers.snre.umich.edu/mri/2036rr.pdf

Appendix E: What Other States, Non-Profits and Research Institutions Are Doing

As American agriculture faces the challenge of increasing productivity, there remains a necessity to protect water quality. As partners and supporters of Michigan agriculture have offered farmers voluntary risk abatement and environmental assurance through MAEAP, it is also important to recognize the efforts of activities in surrounding states.

Michigan

The Michigan Clean Water Corps (MiCorps)

MiCorps was created through Michigan Executive Order to assist the MDEQ in collecting and sharing water quality data for use in water resources management and protection programs. The Great Lakes Commission was selected by the MDEQ to assist in establishing MiCorps. The Commission is partnering with the Huron River Watershed Council to develop, implement and administer the program, under the direction of MDEQ and with the advice of a steering committee. MiCorps is building upon existing volunteer monitoring programs established by the MDEQ, including the Volunteer Stream Monitoring Grant Program and the Cooperative Lakes Monitoring Program.

MiCorps solicits for, organizes and trains volunteers around the state to participate in water quality monitoring activities. MiCorps will provide training for stream and lake monitoring; disseminate methods for accurate data collection; implement effective quality assurance practices; facilitate data reporting and information sharing online; and provide a forum for communication and support among volunteer monitoring groups in Michigan.

The mission of MiCorps is to network and expand volunteer water quality monitoring organizations statewide for the purpose of collecting, sharing and using reliable data; educate and inform the public about water quality issues; and foster water resources stewardship to facilitate the preservation and protection of Michigan's water resources.[29]

The Nature Conservancy (TNC) and Michigan State University (MSU)

The demand for demonstrating the benefits of conservation, particularly to biological endpoints, has increased sharply in recent years. Some of the economic and ecological benefits of improved water quality and flows include: the reduction in the cost of community water treatments, prevention of flooding, increased native fish populations and more resilient watershed ecosystems. Monitoring programs and the associated analyses are useful for addressing this demand; however, TNC believes that modeling efforts that forecast the likely benefits of conservation are of equal importance. By developing the science to forecast how much and where the application of BMPs impact ecosystem health and by working with farmers to test the application of this suite of BMPs in the field, water quality and water flows can be improved in agricultural landscapes. This work also provides a framework to assess the impacts of conservation practices, measure results and better target conservation and restoration efforts.

TNC and its partners seek to provide the science and innovative tools necessary to assess and forecast the benefits of NRCS conservation practices to stream-based fish communities to help advance the conservation of freshwater biodiversity across the agricultural regions of the southern Great Lakes. TNC will be working with Conservation Districts, farmers and others to test these tools and BMP prescriptions in the field.

[29] http://www.micorps.net/index.html

The Nature Conservancy's Cass River Pilot Project may be of particular interest to those who would like to see Farm Bill conservation programs that would set performance goals through measuring ecological outcomes as opposed to the number of contracts and acres enrolled.

Flowing into the Saginaw River just downstream from the mouth of the Shiawassee, the Cass River is one of many rivers that form the Saginaw Bay watershed. The Cass River's watershed, spans 908 square miles and is dominated by agriculture (57 percent of the land use) in the upper reaches, and by forested and natural land cover (37 percent) in the middle to lower regions.

The Cass River is one of many rivers that form the Saginaw Bay watershed. The Nature Conservancy has identified the Cass River watershed as a focus area for implementing strategic agricultural conservation (also called best management practices or "BMPs") as part of its Saginaw Bay Watershed Project. Using results from the Conservancy's recently developed 'How Much is Enough?' computer modeling tool, resource managers will be able to set performance goals and target BMPs in specific areas of the watershed that will result in the largest return on ecological investment as measured by improvement of river and stream fish community health.

Results of the 'How Much is Enough?' modeling work for the Cass River suggest that the health of the fish community where the river empties into the Saginaw River is predominantly impaired by late spring phosphorous levels. However, in the upper reaches of the Cass River watershed, where agricultural land use is most intense, tributary fish communities are impaired by a wider variety of water quality variables.

Agricultural BMPs— including nutrient management plans, filter strips, cover crops, conservation tillage, hay plantings, and wetland restoration — are all practices that can reduce sediment and nutrient runoff to local waterways and improve the health of fish communities.

The model can also be used to determine where BMPs should be targeted throughout the watershed to produce the most substantial benefits to local water quality, and consequently fish populations.
To help test the functionality of this concept, the Conservancy recently partnered with the Sanilac and Tuscola Conservation Districts, following a collaborative project model established through the Conservancy's Paw Paw River Pilot Project. As part of the is collaboration, the Conservancy worked with conservation technicians to ensure they understood model results and used the modeling tool to identify specific areas of the watershed for targeted implementation of BMPs.

In these selected areas, the conservation districts will conduct increased community outreach to ensure that landowners understand the important role they play in improving the health of the Cass River watershed ecosystem, and will encourage them to undertake agricultural BMPs on their land. Where appropriate, technicians will help land owners access financial assistance for implementing these practices through the US Department of Agriculture's Natural Resource Conservation Service and Farm Service Agency.

To complement the 'How Much is Enough?' modeling work , by the end of 2013 the Conservancy and Michigan State University's Institute of Water Research will have completed several online tools which will enable technicians and landowners to calculate reductions of sediment and nutrients and increases in groundwater recharge as a result of implementing various BMPs on individual fields. The calculators will also track the installation of BMPs a cross the watershed, allowing us to monitor cumulative progress and, eventually, to calibrate more precisely our watershed - scale predictive models.

Minnesota

National Agricultural Water Quality Certification Program
Minnesota was selected as the "nation's first test site" of a federal initiative to protect water quality through voluntary conservation program. The announcement was made by Minnesota Governor Mark Dayton, Secretary of Agriculture Tom Vilsack, and EPA Administrator Lisa Jackson on January of 2012. The program is to be called the "Agricultural Water Quality Certification" and mirrors similar goals and values of MAEAP. The initiative will aid farmers in the implementation of practices and provide an incentive of protection against emerging standards. "Farmers who participate would agree to follow land management practices that slow soil erosion and runoff of fertilizers, pesticides and manure into streams and groundwater. In exchange, they would get financial and technical support and be protected against any new environmental requirements during the life of their agreement, perhaps as long as 10 years. Participating farmers would also be certified through the new Agricultural Water Quality Certification Program, a seal of approval that could be used as a marketing tool for buyers and, eventually, on consumer products."[30] An advisory committee has been selected to develop the program.

Discovery Farms Minnesota
Discovery Farms is a farmer-led program organized and established for the purpose of gathering field-scale information to quantify the impact of a variety of farming enterprises across Minnesota. The mission of the program is to collect water quality information under real-world conditions and provide practical, credible, and site-specific information to support better farm management decisions. They completed the first year of their water quality monitoring program (presented in an April 2012 factsheet[31]). Conclusions: Land management practices affect surface runoff of water, sediment, and nutrients on an annual and seasonal basis. Data from the three sites displayed the importance of the snowmelt period and single storm events in determining total sediment and nutrient losses. Discovery Farms research has shown that several factors are important for reducing risk of nutrient and sediment loss, including:

1. Harvesting Precipitation Water
2. Avoiding Nutrient Application Prior to Anticipated Runoff

Ohio

Ohio Livestock Environmental Assurance Program
The Ohio Livestock Coalition developed a program titled, Ohio Livestock Environmental Assurance Program. LEAP is a voluntary and confidential environmental assurance program for all major livestock species in Ohio. It will help livestock and poultry producers manage environmental challenges that are critically important to the success of the business, and effectively assess how farmstead practices affect water quality. LEAP's primary objective is to "promote sustainability by seeking profitable environmental solutions." LEAP has a Level 1 and 2 consisting of introductions to the program, an on-farm inventory, overview of cost-share programs available and regulations, siting and an environmental plan. In addition, LEAP provides a student education program.[32]

Ohio Clean Lakes Initiative: 4R Certified Nutrient Stewardship Program
Water quality impairments in the Western Lake Erie Basin have prompted partners in the agriculture community to evaluate efforts needed to improve the basin's condition. Recommendations made on

[30] Marcotty, Josephine. A Novel Strategy to Reduce Farm Runoff Will Be Tested Starting in Minnesota. Minnesota Start Tribune: January 16, 2012. http://phys.org/news/2012-01-strategy-farm-runoff-minnesota.html
[31] Discovery Farms Minnesota April 2012 Fact Sheet http://www.mawrc.com/images/DFM-YearInReview_2011.pdf
[32] Ohio Livestock Environmental Assurance Program: www.ohleap.orgwww.ohleap.org

March 15 of this year by Ohio's EPA, Department of Natural Resources and Department of Agriculture leadership outlined the state's plan. Elements of this voluntary program included promotion of 4R Nutrient Stewardship involving the right source, amount, placement and timing of fertilizer applications; additional communication and education efforts to Ohio's farmers about proper application and use; and the development of the Certified Nutrient Stewardship Program.[33]

Ohio River Basin Water Quality Project Pilot Trading Plan

The Ohio River Basin Trading Project is a first-of its-kind interstate multi-credit trading program and represents a comprehensive approach to improving regional water quality and minimizing costs to the public and stakeholders. The project focus is on designing and developing pilot water quality trading markets for nitrogen and phosphorus discharges and greenhouse gas emissions in the states of Indiana, Kentucky and Ohio. For example, a municipality or business that needs to meet water quality standards by reducing phosphorus can work with an agricultural partner upstream and provide financial assistance to farmers for conservation or best management practices to improve water quality in the watershed. They believe this market-based approach will provide businesses and municipalities a more economically viable option to reduce nitrogen and phosphorus loadings.

Iowa

Iowa Nutrient Reduction Strategy

The Iowa Nutrient Reduction Strategy, unveiled by the State of Iowa on November 18, 2012,[34] is a science and technology-based framework to assess and reduce nutrients to Iowa waters and the Gulf of Mexico. In response to the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force's 2008 Action Plan recommendations, this strategy is designed to direct efforts to reduce nutrients in surface water from both point and non-point sources in a scientific, reasonable and cost effective manner. The strategy identifies five key categories to focus the efforts in addressing non-point sources and identifies multiple action items within each category. The five categories are: Setting Priorities; Documenting Progress; Research and Technology; Strengthen Outreach, Education, Collaboration; and Funding. Working together, the Iowa Department of Agriculture and Land Stewardship, the Iowa Department of Natural Resources, and the Iowa State University College of Agriculture and Life Sciences developed this proposed strategy. The Iowa strategy to address nutrient transport from non-point sources uses a comprehensive, first of its kind, scientific assessment of conservation practices and associated costs to reduce loading of nutrients to Iowa surface waters.

California

Central Coast Agricultural Water Quality Coalition[35]

This Coalition represents farmers and ranchers in the development and implementation of voluntary, cost-effective, producer-directed programs to protect water quality in a seven county region of the Central Coast of California near the Monterey Bay National Marine Sanctuary. The Coalition's agricultural water quality work began in 1999 with the development of a unique partnership with the Monterey Bay National Marine Sanctuary, the California Farm Bureau Federation, commodity groups and individual growers, environmental organizations and governmental agencies. The Coalition launched an Agricultural

[33] Ohio's Ag Water Quality Recommendations 'Officially' Announced, by: Chris Kick, March 15, 2012, http://www.farmanddairy.com/news/ohios-ag-water-quality-recommendations-officially-announced/35585.html

[34] Public Comment Period for the Iowa Nutrient Reduction Strategy ended on January 4, 2013. The full report and additional information can be found at www.nutrientstrategy.iastate.edu

[35] Central Coast Agricultural Water Quality Coalition: http://www.agwaterquality.org/about-us.html

Water Quality Program to demonstrate the compatibility of environmental protection and economic viability in partnership with ranchers and farmers. Watershed Coordinators work to link growers with resources to improve water quality as well as program managers working on specific issues such as Rangeland Water Quality Education and the Co-Management of Water Quality and Food Safety. The Coalition has five full-time staff and a Board of Directors, which is comprised of farmers and ranchers representing each of the seven counties, the five major commodity categories, the California Farm Bureau Federation, and two Ex-Officio Directors representing the two Grower Shipper organizations. The Coalition provides the following services:

- Local knowledge of water quality issues and regulations
- Access to farm water quality educational credit opportunities
- Links to local partners offering water quality improvement programs
- Site visits with growers to review farm water quality management practices
- Sources of technical and financial assistance
- Grower outreach for meetings, field workshops, and conferences

Alberta, Canada

Introductory Guide to Surface Water Quality Monitoring in Agriculture
Alberta Agriculture, Food and Rural Development developed a guide, Introductory Guide to Surface Water Quality Monitoring in Agriculture, which grew out of a 1996 workshop on agricultural surface water quality issues and assessment tools for Alberta conditions. Alberta Agriculture, Food and Rural Development organized this workshop with participants from other government agencies, academic institutions and researchers from the United States Agricultural Research Service. The Alberta Environmentally Sustainable Agriculture Program supported the continued development of the information gathered from the workshop into an extension document designed to create awareness of the fundamentals of developing a water quality monitoring program with the primary focus on streams. This introductory guide provides general information on the fundamentals of water quality monitoring. It is not a comprehensive manual but rather a guide outlining considerations in developing a water quality monitoring program and basic assessment tools. It is intended for people interested in developing water quality assessment programs, such as applied researchers, technical specialists, agricultural fieldmen or watershed coordinators. The guide serves as an initial overview of water quality monitoring program design and tools to evaluate water quality.[36]

Utah

Utah State University Extension: Best Management Practices: Monitoring Guidance
Utah State University Extension Services developed a guidebook titled "Utah State University Best Management Practices: Monitoring Guidance." It provides guidance on appropriate and effective monitoring strategies for specific monitoring objectives. The guidance document targets monitoring for Best Management Practices effectiveness and impacts, and therefore may be useful for anyone who is designing a monitoring program to review before monitoring begins. It is not a "how to" manual, but an organizational approach to answering important questions that must be resolved BEFORE monitoring begins. Best Management Practices Monitoring Guide for Stream Systems provides guidance on

[36] Cooke, S.E., S.M. Ahmed and N.D. MacAlpine. Revised 2005, Introductory Guide to Surface Water Quality Monitoring in Agriculture: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/wat2417/$file/final_wq_guide_update2005.pdf?OpenElement

establishing a water quality monitoring program that will demonstrate the effectiveness of Best Management Practices (BMPs) to reduce non-point source pollution in stream systems. [37]

The intent is that the guidance will result in significant time and cost savings in monitoring programs by avoiding collection of inappropriate or unusable data and that appropriate and effective monitoring will advance the management of water quality and watersheds beyond trial and error to a true science based on real understanding of the effectiveness of different practices in different situations. The manual does not provide instructions on how to conduct specific tests or field studies, yet does contain references that do provide this information. This document focuses on the effectiveness of BMPs implemented to reduce or prevent non-point source pollution and may be applied to any water quality monitoring program.

Utah State University Extension: Water Quality Interpretation Tool [38]

Citizen monitoring is a cooperative effort of the Utah Division of Water Quality and USU Water Quality Extension, to acquire better baseline data for Utah's waterways. Monitoring provides an increased understanding of how water bodies function, the changes that occur over time, and how these changes are influenced by land uses and activities upstream. The Utah State University water quality interpretation toolkit was developed to help any Utah citizen evaluate the quality of water for the purposes of drinking, irrigation, livestock, and generally for fish and wildlife.

Bear River Watershed Water Quality Trading

An important element of the USEPA targeted watersheds grant for the Bear River Watershed was to explore the feasibility of water quality pollutant trading as a means of reducing point and non-point source pollution inputs to the watershed in the most cost effective manner. Water quality trading is an innovative approach to try to achieve water quality goals more efficiently and is being tested in places around the United States. Trading is based on the fact that pollutant sources in a watershed can face very different costs to control the same pollutant. Trading programs enable sources facing higher pollution control costs to meet their regulatory obligations by purchasing environmentally equivalent (or superior) pollution reductions from another source at a lower cost, thus achieving the same water quality improvement at lower overall cost.

The water quality trading feasibility study for the Bear River focused on total phosphorus pollution. A total maximum daily load (TMDL) study was completed for several river reaches and a draft TMDL for cutler reservoir was completed. These TMDLs provide a framework within which the trading study was completed. Water quality trading is complicated because the value of phosphorus for a trade is dependent on where the phosphorus enters the river. Phosphorus particles that have washed off a field or been discharged from a pipe may still have quite a journey before they reach a compliance point. Along the way, the phosphorus may settle out of the water, be used by plants, or otherwise be trapped or transformed. Therefore, sources at different locations in a watershed with the same amount of phosphorus loading may contribute very different amounts of phosphorus to a compliance point, depending on the distance from the source to the compliance point.

A water quality model was developed that predicts the fate of phosphorus from any point in the Bear River water quality trading focus area, and determines how much of that phosphorus is likely to make it the compliance point. This is important because only phosphorus at the compliance point is eligible for trade. The purpose of the model is to simulate the physical, chemical, and biological processes that affect pollutant concentrations within the watershed, and to consider the spatial and temporal nature of pollutant loading in order to calculate delivery ratios for different areas of the watershed and different compliance

[37] Utah State University Extension Service, 2012 Best Management Practices Monitoring Guide for Stream Systems, http://extension.usu.edu/waterquality/htm/bmps/bmps

[38] USU Water Quality Interpretation Tool access here: http://extension.usu.edu/waterquality/htm/wqtool

points. These delivery rations are necessary to determine the environmental equivalence of load reductions for potential trades. [39]

[39] You can learn more about the water quality trading project and the model that was developed to support the water quality trading study here: http://bearriverinfo.org/htm/water-quality-trading

Appendix F: TNC Paw Paw Calculator Instructions

These tools are freely available online. However, since they were created to be used by trained staff and partners, the instructions on the sites are minimal. Both tools work best using Firefox. Using Internet Explorer, there are some odd formatting issues noted below.

1. Paw Paw Sediment Calculator http://35.8.121.111/sedcalc/#

There are instructions on the right-hand "Introduction" box, but here few more suggestions for navigation and use.

a) To select a particular farm field, it's easiest to start by changing the overlay by clicking on the "Base maps" button on the upper left and selecting one of the Aerial overlays.
b) Use the wheel on your mouse to zoom into part of the map.
c) Typical use is the "Compare Two Scenarios" function, so click the tab on the right-hand menu.
d) To select a field, Click the "Activate" button, which will allow you to outline a field on the map with your mouse by clicking the corners of the parcel, double-clicking on the last corner to finish the outline.
e) Under the "Scenario 1" drop down menu, click the current land cover, such as Conventional Tillage. Under "Scenario 2," click a proposed new management regime, such as No-Till. Note that if using Internet Explorer, the formatting of the land cover options can be difficult to read.
f) The 'Optional Parameters' button helps to determine RUSLE factors if those are known. You can also scroll down and hit the 'Calculate' button.
g) Calculation takes approximately 10 seconds. Calculations are displayed in the bottom of the window and indicate change in both tons of erosion and of sediment.

2. Paw Paw Groundwater Recharge Calculator http://35.9.116.206/tnc/map.asp

There are no instructions at this site, though the tool is similar to the sediment tool. Basic Instructions:

a) Use wheel on mouse or zoom arrows to zoom into a part of the watershed.
b) Click on "Create New Parcel" tab on the top center of the window.
c) Use the mouse to outline the borders of a field, clicking on the corners of the parcel, double-clicking on the last corner to finish the outline. Note: If using Internet Explorer, the outline of your field won't be visible until you've double-clicked the last corner. Using Firefox, the outline shows up as it is being drawn.
d) A new window will open and automatically fill in parcel size and soil type.
e) Use drop down menus to fill in current and proposed land use/cover types.
f) Click the "Calculate" button to see the change in modeled groundwater recharge as a result of the land use change.
g) To test various practice scenarios for this same field, change the land use/cover type choices in the drop down menus and hit Calculate again without redrawing the field.

Appendix G: Dissolved Reactive Phosphorus Loads to Lake Erie

Irem Daloglu, Kyung Hwa Cho, and Donald Scavia
Environmental Science and Technology, 46, 10660-10666 (2012), dx.doi.org/10.1021/es302315d

Excerpts

While the Great Lakes Water Quality Agreement focused on total phosphorus (TP) as the water quality parameter by which Lake Erie eutrophication is to be managed, recent research indicates that dissolved reactive phosphorus (DRP) is of great importance because it is highly bioavailable.

…

Moreover, the rate of oxygen depletion in the Central Lake Erie Basin is strongly correlated with DRP load since the mid-1990s.

…

In fact, widespread adoption of no-till and conservation tillage practices corresponds in time with the increased DRP loading after the mid-1990s. In addition to no-till and conservation tillage practices, fertilizer application exceeding crop needs and surface application (broadcasting) of P fertilizer and manure have also lead to an increase in P accumulation in the soil surface layer and to a higher likelihood of P runoff from agricultural fields.

Results

From this analysis, it is clear that fertilizer input influences the magnitude of DRP load but does not appear to be the major factor responsible for the long-term DRP trend.

…

In this scenario, DRP load is lower through the early 2000s, unlike the baseline loads, suggesting that soil stratification and buildup at the soil surface layer is a significant driver in long-term DRP runoff.

…

The frequency of these extreme events during the first three decades was relatively stable in fall and increased in spring (Figure 5a). It is also clear that the frequency increased more dramatically in both spring and fall fertilizer seasons in the past decade, shortening the fertilizer application window and perhaps increasing the potential for enhanced runoff.

…

Moreover, when evaluating the impact of tillage systems on DRP runoff, we need to note that rotational tillage, where the fields are tilled every other year instead of continuous no-till practices, seems to be an increasingly common practice in the study area. More research is needed on the impacts of rotational tillage on DRP runoff.

…

Our model results emphasize the need to focus on agricultural practices and their impact on water quality. For instance, broadcasting fertilizer on bare ground in fall results in unincorporated nutrient accumulation that is vulnerable to runoff until spring. Moreover, according to Kleinman et al., broadcasting P fertilizer onto no-till or conservation tillage fields results in higher DRP runoff. Therefore, to reduce P accumulation in the soil surface layer, incorporation of fertilizer especially under no-till practices is highly encouraged. As promoted by the fertilizer industry and the USDA under the Nutrient Stewardship program, adjustments in agricultural management practices to achieve the right rate, time, and place of fertilizer application can attain reduction in DRP runoff from agricultural landscapes.

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