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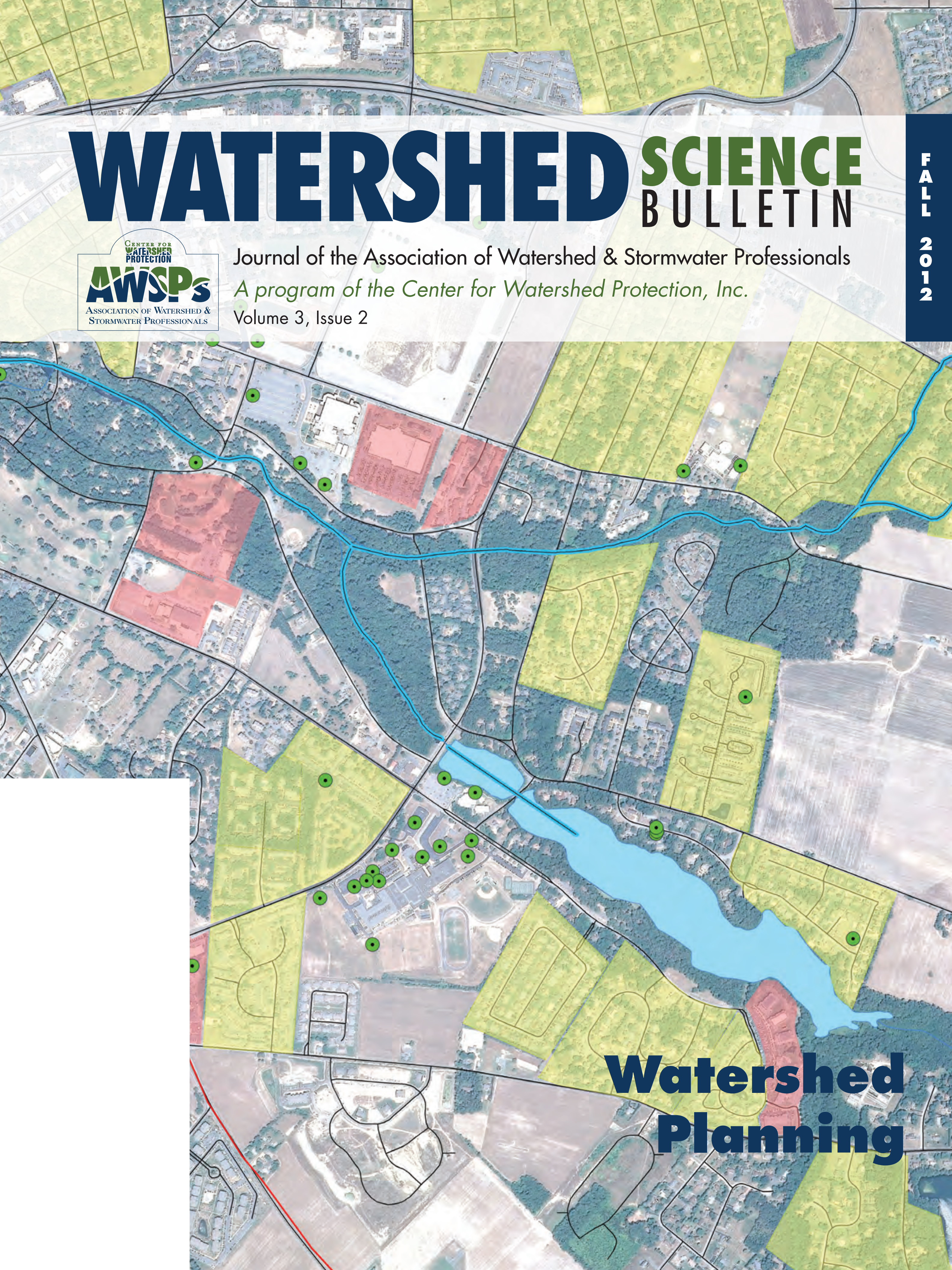

Watershed Planning

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Cover photo courtesy of the Center for Watershed Protection
showing Wicomico River watershed field assessment locations in Salisbury, Maryland.

TABLE OF CONTENTS

FEATUREDCONTENT

BULLETINDEPARTMENTS

From the Editor's Desk

The basic sentiment behind watershed planning *was expressed eloquently by Luna Leopold (e.g., Meine 2004, 214): "the health of our waters is the principal measure of how we live on the land." This sentiment was put into practice in the United States beginning with the passage of the Clean Water Act in 1972. Section 208 of the Clean Water Act called for the development of "area wide management plans" to guide decisions on the degree of land-based pollution control necessary to achieve water quality goals. The total maximum daily load (TMDL) program subsequently provided an important driver for the development of watershed-based plans, but it wasn't until the 1990s that the US Environmental Protection Agency (USEPA) specifically called for states to implement nonpoint source programs on a watershed-by-watershed basis. Today, USEPA's Nonpoint Source Program provides an additional incentive for watershed planning by requiring projects funded by Section 319 grants to have watershed-based plans in effect that meet nine minimum guidance elements.*

With the evolution of this *watershed approach*, the emphasis and responsibility shifted from the federal level to the states, and finally to the local level. While this shift makes logical sense, given that land use is controlled locally, it presents a challenge to track the extent, effectiveness, and lessons learned from watershed planning efforts being implemented by the more than 38,000 local governments in the United States. Our understanding of how well the watershed approach is working to improve the nation's waters is limited by available data on the number of watershed plans developed, the degree to which plan recommendations have been implemented, and the improvements resulting from implementation (e.g., quantified by water quality monitoring).

USEPA's 2011 report *A National Evaluation of the Clean Water Act Section 319 Program* estimates that only about 1% of the nonpoint source–impaired water bodies, or 355 water bodies, have been delisted since 2006, despite the many millions of dollars spent on watershed-based efforts. Some of the major challenges related to successful watershed planning include (1) obtaining funding to develop watershed plans or to implement plan recommendations, (2) finding data on the effectiveness and costs of nonpoint source control technologies and programs, (3) coordinating multiple watershed jurisdictions, (4) gaining public support for watershed restoration projects, and (5) documenting the success of restoration efforts through monitoring. This issue of the *Bulletin* examines the successes and shortcomings of the watershed approach, discusses the challenges faced by today's watershed planners, and highlights effective and innovative approaches to watershed planning.

Lehman and others evaluate the progress of watershed planning in the United States from two different viewpoints: (1) a USEPA review of how well Section 319–funded watershed plans align with federal guidance on plan content and (2) a survey by the Center for Watershed Protection on the status of local watershed plan implementation, challenges, and lessons learned from the implementation of local watershed plans. The paper identifies key findings from each perspective, and provides a discussion of the potential for, and challenges of, leveraging funds through a watershed planning approach that integrates multiple programs and objectives.

Daly and Recktenwald summarize the progress made and lessons learned from one state's watershed planning approach. The North Carolina Ecosystem Enhancement Program is a model for program integration in that it approaches a federal regulatory requirement—mitigation for stream and wetland impacts under Clean Water Act Section 404—from a watershed perspective. This paper details the program's history and demonstrates how the program provides a driver for the development of local watershed plans. The authors also describe two specific examples of implementation success.

Malott and Cook introduce the State of Wisconsin's recently passed phosphorus rule and the related compliance option known as the Watershed Adaptive Management Option. The paper describes how this option may address the key challenges of successful watershed-based water quality management. The crux of this approach is that it provides an incentive for point source dischargers to implement effective (and relatively inexpensive) nonpoint source controls, through which they may restore water quality and achieve permit compliance without the need for costly technology upgrades.

Bannerman describes the results of a long-term monitoring study designed to evaluate the effectiveness of agricultural best management practices implemented in Wisconsin's Bower Creek watershed, as recommended by an earlier comprehensive watershed planning effort. Despite the significant implementation effort, the study showed no substantial improvement in most water quality measures. The authors conclude that the level of implementation was not sufficient to compensate for the changes in farming practices during the study period; they describe how they have adapted their implementation and monitoring approach to better address these changes.

The vignettes in this issue provide further insight into the implementation of a watershed planning approach. The **Ohio Balanced Growth Program** is a voluntary, incentive-based program that uses watersheds as the key organizing feature for land use planning. Although decisions about land use planning are made at the local level, the program provides an opportunity to improve state and local coordination for growth and conservation activities. The benefits of a watershed approach are illustrated by a long-term monitoring program described in the vignette, **Demonstrating the Effects of Best Management Practices on Watershed Water Quality in the Eagle and Joos Valley Creeks, Wisconsin**. Here, a collaboration between the Wisconsin Department of Natural Resources and the US Geological Survey demonstrates improvements in water quality and the achievement of TMDL goals through the installation of watershed management practices. Leaving the conterminous United States, we find that impacts on coral reefs drive watershed planning in the tropical regions of the Caribbean and Pacific islands. The vignette, **Watershed Planning for Coral Reef Watersheds: Experience from the Caribbean and Pacific Regions**, describes approaches for work on island geographies and lessons learned.

This issue also includes our regular feature, Ask the Experts, in which selected professionals in the field of watershed planning share their expertise. Representatives of federal, state, and local organizations provide insight into the origins of watershed planning at USEPA and how it has evolved and adapted to fit local program needs for both urban and agricultural watersheds.

The watershed approach in the United states continues to evolve as USEPA and state and local governments find new ways to apply watershed planning to meet water quality standards and other environmental and sustainability goals. Along with these efforts, the Center for Watershed Protection continues to promote an integrated watershed approach as the key to ensuring a future with fresh clean water and healthy natural resources.

Karen Cappiella and Neely L. Law, PhD,
Editors-in-Chief

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Tracking the Progress of Watershed Planning: Two Views

Stuart Lehman,[a] Karen Cappiella,[b] Julie Schneider,[c] and Laurel Woodworth[d]*

Abstract

This article evaluates watershed planning across the country from two perspectives—a bird's eye view and a ground-level view. The US Environmental Protection Agency (USEPA) provides a bird's eye view of the Clean Water Act Section 319 program based on an internal review of the agency's funding guidelines for the development of watershed plans (the "a–i criteria"). The Center for Watershed Protection provides the ground-level perspective with lessons learned from its recent survey of watershed plans developed for the restoration of water quality in small urban and suburban watersheds in the eastern United States. The major finding from the bird's-eye review of watershed planning is that many watershed plans being developed with USEPA funding are not sufficiently detailed to ensure the attainment of water quality standards. On the other hand, the ground-level review showed that most watershed plans are being used on some level and reported an impressive level of implementation. A summary of watershed planning elements to facilitate implementation is provided.

Introduction

This article evaluates the progress of watershed planning across the country from two perspectives—a bird's-eye view, from the perspective of a federal agency that funds watershed planning projects, and a ground-level view, from the perspective of local organizations and agencies that have developed and implemented watershed plans. The US Environmental Protection Agency (USEPA) provides funding and technical assistance for states and other entities managing water pollution. The Center for Watershed Protection (the Center) is a leading watershed research organization and local assistance provider. In this article, USEPA provides the bird's-eye view with a report on the results of an internal review (USEPA 2011) on how well the agency's guidelines have been followed for the development of watershed plans. The Center provides the ground-level perspective with lessons learned from its recent survey regarding watershed plans developed for the restoration of water quality in small urban and suburban watersheds in the eastern United States.

USEPA defines a *watershed approach* to water resource management as one that is hydrologically defined, involves all stakeholders, and strategically addresses priority water resource goals (USEPA n.d.). A watershed approach addresses all stressors (e.g., atmospheric deposition and stormwater runoff) for a single water body and integrates multiple programs (e.g., stormwater, wastewater, and drinking water), whether regulatory or voluntary. Watershed plans can be created at various scales to address a number of impacts to rivers, streams, lakes, and estuaries. The impacts include those that are physical (e.g., changes in flow regime and temperature), water quality–related (e.g., contamination with metals and nutrients), biological (e.g., a loss of sensitive species), and ecological (e.g., habitat fragmentation and loss). Any of these types of impacts can drive the need for watershed planning. Historically, physical impacts of flooding have been the motivation for hydrologic watershed planning, including the development of flood control reservoirs and levees. Impacts on water quality became an additional driver for watershed work in recent decades with the passage of the Clean Water Act (CWA). Impacts on aquatic biota, such as declining fisheries, are behind multistate watershed initiatives in the Chesapeake Bay, Puget Sound, and Great Lakes, among other locations. Mitigation requirements for impacts to streams and wetlands under Section 404 of the CWA are a major driver for the development of watershed-based plans to identify priority restoration sites to "replace" lost ecological functions.

An integrated approach to watershed management (Figure 1) that addresses all of a watershed's various pollution sources, conservation and restoration programs, and community goals has a better chance of identifying and addressing all of these impacts. Such an approach also promotes efficiency and can help ensure that the watershed plan is funded and implemented. The four-step, cyclical process shown in Figure 1 describes watershed management as an integrative and adaptive course of action that involves a wide variety of state, local, federal, and tribal programs as well as private initiatives (USEPA 1995a,b).

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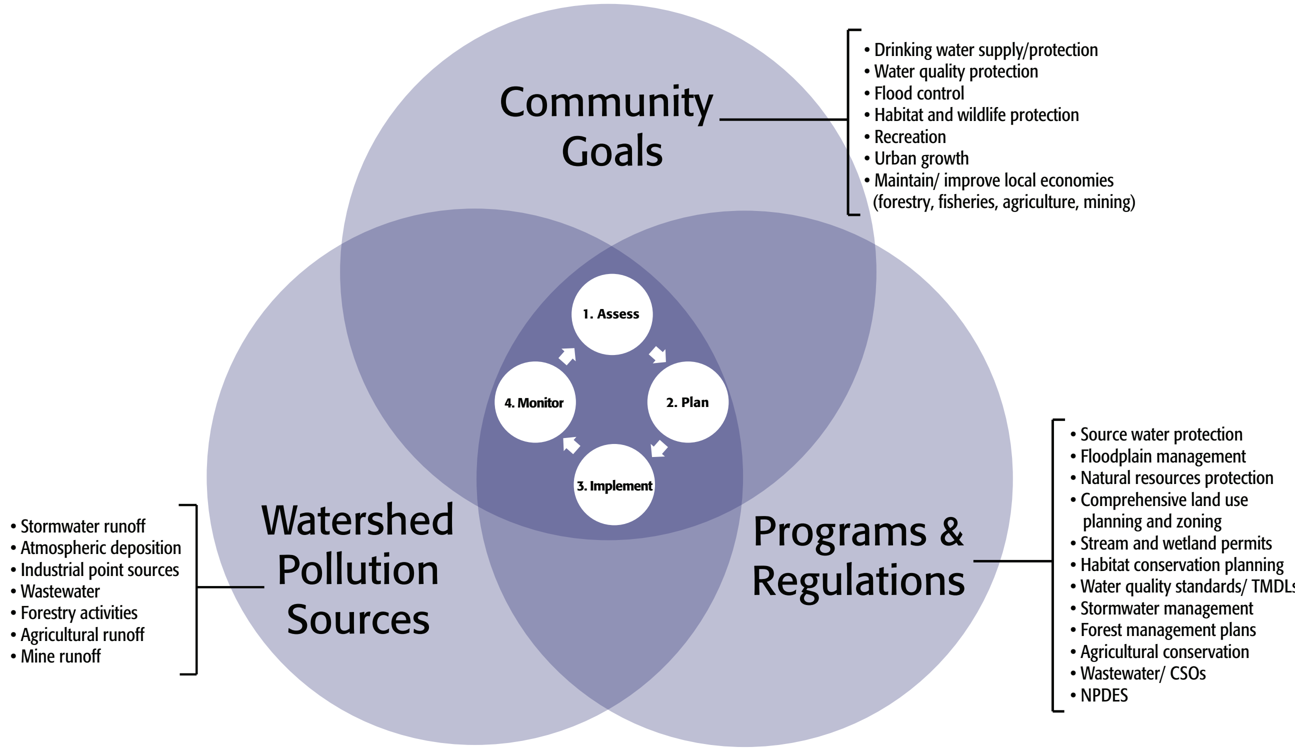

Figure 1. Integrated watershed management. CSO, combined sewer overflow; NPDES, National Pollutant Discharge Elimination System; TMDL, total maximum daily load.

While both USEPA and the Center support an integrated watershed management approach, most of the watershed plans funded or developed by these organizations deal primarily with water quality impacts, specifically nonpoint source pollution (which includes runoff from urban and agricultural areas). The CWA is the primary driver behind the development of USEPA-funded watershed-based plans; therefore, to date, much of the funding and opportunity for the improvement of water resources has been provided through state–federal partnerships to maintain or improve water quality, with limited integration of air quality, flood control, hazardous waste, groundwater, or other programs into the watershed plans. Similarly, the scope and budget for the Center's watershed plans is typically driven by a single entity (e.g., a municipality), often with a single objective, such as meeting the requirements of a stormwater permit. As a result, managing stormwater runoff is a major focus of the Center's watershed assessments and plans, whereas sectors such as agriculture, drinking water, and wastewater receive more limited attention.

To develop a watershed plan that integrates the objectives of multiple programs, collaboration among agencies must occur at the scoping stage for the watershed plan. However, each program often is handled by a separate local government department or state agency, whereas the entity developing the watershed plan has responsibilities and authority within just one of those areas. For example, stormwater, wastewater, and drinking water are typically addressed by separate agencies with different priorities and resources, and each of these agencies may have limited interaction with those that deal with land use planning and natural resources protection. This is a fundamental challenge of watershed planning. Addressing all pollution sources in a watershed plan can also be difficult. For example, developing specific watershed plan recommendations to address agricultural impacts can be limited by landowner privacy concerns. In some instances, close collaboration with key landowners at the early stages of plan development has been successful in overcoming these issues of data and property access.

The approaches of USEPA and the Center differ in that USEPA funding for watershed plan development and implementation by states is directed toward more rural watersheds of a larger size (typically from hydrologic unit code [HUC] 8 scale in the western states to HUC 12 scale in the east), while the Center provides direct support to local governments and watershed groups in smaller (less than 259 km^2, HUC 12 scale or smaller) urban or urbanizing watersheds (Figure 2). Both approaches to watersheds involve working at the local level with landowners, land managers, and watershed groups. Both organizations also recognize the importance

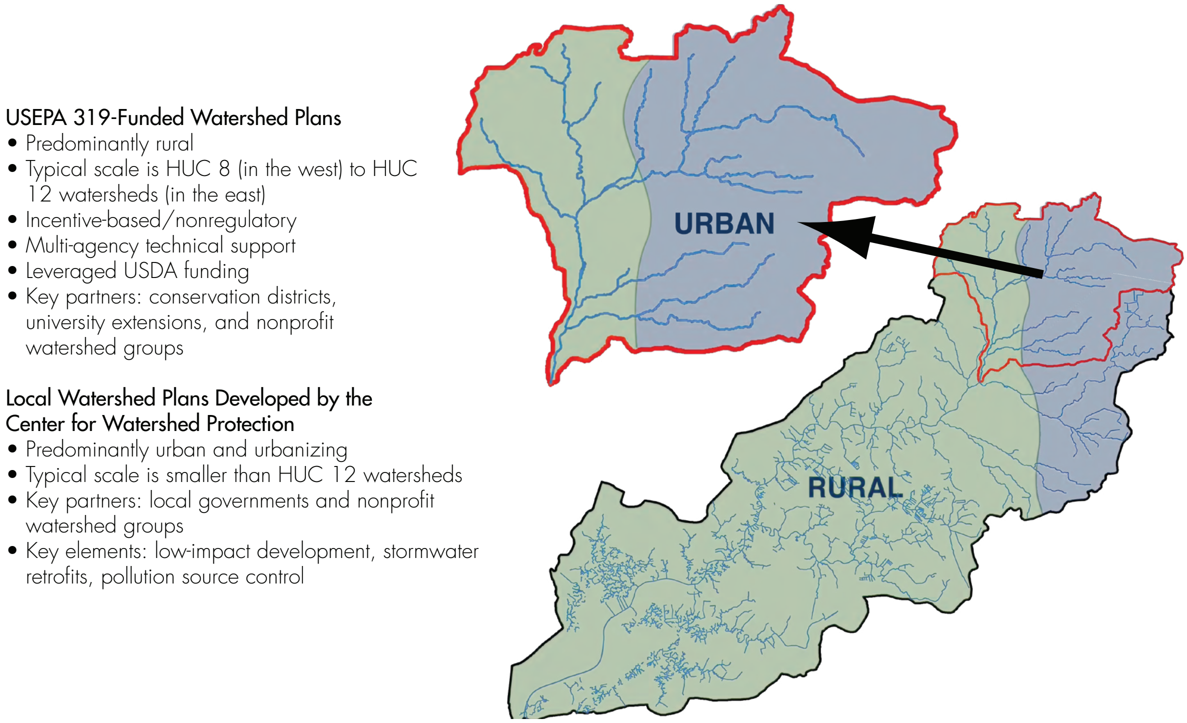

Figure 2. USEPA and Center for Watershed Protection—scale and focus of watershed plans. USEPA 319-funded watershed plans are funded through, and overseen by, the nonpoint source management program established under the Clean Water Act. USDA, US Department of Agriculture.

and value of leveraging resources from private and public sources to implement pollution control practices.

USEPA's Review of CWA Section 319–Funded Watershed Plans

Since the mid-1990s, USEPA has embraced an integrated watershed approach across its CWA programs. The agency has created guidance manuals, provided training, organized conferences, and created tools and online databases that support the alignment of these programs along watershed boundaries. Appendix A provides a summary of USEPA resources for watershed assessment, planning, and implementation. Watershed planning has been an integral part of the CWA since it was first authorized in 1972, beginning with Section 208, which required basin-wide plans for point and nonpoint sources, and with Section 303(d), which called for states to list impaired waters and develop total maximum daily loads (TMDLs; analyses of the level of pollution reduction needed to attain water quality standards). USEPA's funding guidelines suggest that watershed-based plans be developed using information from TMDLs and other water quality assessments and reports that can serve as building blocks for the plan. The CWA also authorizes states to conduct Section 401 certifications of federal permits and licenses that look comprehensively at water quality impacts.

Congress established the Section 319 national program to manage nonpoint sources in the 1987 amendments to the CWA. The program requires states to assess their waters for nonpoint source pollution or water quality threats, develop statewide nonpoint source management programs on a watershed-by-watershed basis, and provide funding for demonstration projects to manage nonpoint source pollution. Section 319 funds for states grew from $38 million in 1990 to about $100 million in 1998. In 1999, Congress doubled that amount to $200 million. This $100 million increase was termed *incremental* 319 funding for the purpose of guidance from USEPA. In 1999, USEPA began requiring that state programs focus their Section 319 watershed project funds on 303(d)-listed waters. Since 2003, the Section 319 funding guidelines for grants have required states to ensure that projects funded with the new incremental federal funds have watershed-based plans in effect that include nine specific elements (USEPA 2003). When these elements are incorporated into a watershed plan, implementation is more likely to lead to the attainment of water quality standards. In In addition to meeting these nonpoint source funding requirements, a plan provides the rationale for restoration work, and the plan itself can be used to inform decision making for a variety of federal, state, and local programs. The nine plan elements ("a–i criteria") to be addressed in a USEPA Section 319–funded watershed plan are listed below.

a. An identification of the causes and sources of pollution by land use subcategory.

b. An estimate of the load reductions expected for the management measures specified.

c. A description of the nonpoint source management measures that will need to be implemented to achieve the load reductions, and an identification of the critical areas in which those measures will be needed.

d. An estimate of the amounts of technical and financial assistance needed to implement the plan.

e. An information and education component that will be used to enhance public understanding of the project and encourage the early and continued participation by members of the public.

f. A schedule for implementing the nonpoint source management measures identified in the plan.

g. A description of interim, measurable milestones for determining whether nonpoint source management measures are being implemented.

h. A set of criteria that can be used to determine whether loading reductions are being achieved over time.

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time.

Methods

In 2006 and 2008, USEPA's Nonpoint Source Control Branch conducted reviews of watershed-based plans (USEPA 2011). For both evaluations, USEPA requested that each regional USEPA office submit the best plan from each of the states in its region. In most cases, the requests were passed on to the state nonpoint source program staff for consideration. The primary purpose of both reviews was to determine how well local subgrantees and states were following USEPA's "a-i criteria" for the supplemental Section 319 funds that were intended for watershed project implementation. In addition, the reviews identified areas for improvement in watershed plans and provided examples of effective and innovative approaches to guide future watershed planning.

Table 1. Summary of 2008 review findings for "a–i criteria."

Watershed Element	Survey Findings
a: Identify causes and sources that need to be controlled to achieve estimated load reductions	• Sources were identified in most plans, however load estimates from significant source categories (e.g., agriculture or urban land) were sometimes missing. • Sources of pollution often were not quantified at a level useful for watershed restoration (e.g., more specificity was needed regarding locations and types of sources).
b: Estimate load reduction from management measures	• Plans did not provide load reduction estimates. • Load estimates were not linked to overall watershed goals.
c: Identify type and location of management measures to achieve load reduction	• Most plans met this criterion, however some did not explain why certain measures were selected.
d: Provide estimate of costs, funding sources, and partners responsible for implementation	• Most plans met this criterion. • Some plans were missing detailed information.
e: Educate the public and encourage participation	• Most plans included an educational component but did not discuss the potential results of these efforts.
f: Implementation schedule	• Plans often included only a 1-year schedule. • Specific details for implementation were missing (e.g., responsible partner, cost, and timeline).
g: Interim, measurable milestones to assess implementation	• Plans often included only a 1-year schedule. • Specific details for implementation were missing (e.g., responsible partner, cost, and timeline).
h: Establish criteria to determine if goals are achieved	• Plans that did not address element b also did not adequately address element h since these are closely related. • Confusion was evident between elements g (achievement of implementation steps, like the number of best management practices installed per year) and h (expected levels of pollutants of concern at points in time). • Most plans did not identify how progress would be reviewed or who would conduct the review.
i: Establish a monitoring program to assess progress	• Most plans relied on existing state monitoring plans. • The timeline and responsibility for monitoring was lacking in a few plans.

Source: USEPA 2011.

The 2006 review covered 30 plans, and the 2008 review addressed 49 watershed plans. With both evaluations, USEPA developed a scoring system to judge how well the plans addressed the "a–i criteria," with weighting to provide some reflection of the relative importance of each of the nine elements. The agency did not set a pass/fail score for the overall plans; instead, it used the results to identify the relative ranking by which to select model plans. In the 2008 review, USEPA collected additional details about each plan—including watershed size, watershed plan author, pollutant(s) addressed, and models used—to look for trends related to the quality of watershed plans.

In addition to the two watershed plan reviews, USEPA conducted a self-evaluation of its administration of Section 319 funds in 2011, in part to see if the CWA Section 319 national nonpoint source program could be more effective. For this evaluation, USEPA headquarters staff conducted interviews with regional USEPA staff and state nonpoint source program managers. States and regions were given an opportunity to review and provide comments on the assessment. The results of this evaluation are also presented below as they pertain to watershed planning.

Results

The 2006 plan review found that, while some plans were good enough to be shared as examples among state nonpoint source programs, many plans did not adequately address all of the "a–i criteria" and therefore were not likely to lead to the attainment of water quality standards. Plans reviewed in 2008 primarily addressed sediment, bacteria, and nutrients, and many were authored by private consultants or state environmental agencies. The size of the watershed was not correlated with the quality of the plan; however, plans that used models consistently scored higher than plans that relied solely on monitoring data (USEPA 2011). In both the 2006 and 2008 reviews, the elements that scored consistently high were "a" (identify causes and sources of pollution), "c" (describe recommended management measures), "e" (public education), and "i" (monitoring). The elements that were consistently inadequately addressed in both reviews were "b" (expected load reductions) and "h" (criteria for determining if load reductions are met), which is unsurprising given that these two elements go hand in hand. For example, many of the plans did not provide any load reduction estimates, making it difficult to determine whether the proposed measures would meet the defined water quality goals (element "h"). Table 1 provides a summary of the major findings for each individual watershed element from the 2008 review.

Each review called out specific elements of certain plans that USEPA believes provide good examples of addressing one or more of the nine elements, even for plans that had deficiencies overall. Six plans from the 2006 review and four plans from the 2008 review provided the best examples of watershed plans (Table 2).

Table 2. Watershed plans comprehensively addressing "a–i criteria" in USEPA watershed plan reviews.

Watershed Plans from 2006 Review	
Corsica River Watershed, Maryland	The watershed area is approximately 40 square miles. This plan includes a $9 million municipal wastewater treatment plant upgrade and about the same amount in nonpoint source controls. Load reductions are based on the same model being used for the Chesapeake Bay restoration effort. (http://dnrweb.dnr.state.md.us/download/bays/cr_strategy.pdf)
Crab Orchard Creek Watershed, Tennessee	This plan addresses several abandoned mine drainage sites in one watershed. A spreadsheet model is used to estimate alkalinity levels after treatment with limestone, wetland creation, grading, and revegetation. Many of the structures provide neutralization for 30 or more years. (http://www.discoveret.org/chota/COC_Watershed_Plan.pdf)
South Branch Yellow Medicine River Watershed, Minnesota	This plan uses models and literature values to estimate source loadings and load reductions from BMPs. Addresses fecal coliform pollution from livestock, wildlife, pets, and humans in a three-county watershed. (http://www.pca.state.mn.us/publications/wq-iw7-01c.pdf)
Millers Creek Watershed, Michigan	This detailed plan for a partly urban watershed includes the campus of the University of Michigan and reports on various load reduction scenarios for proposed projects and existing treatment systems. (http://www.aamillerscreek.org/Findings.htm)
Flint River Watershed, Alabama	This is a short plan that nevertheless provides a good example of watershed-based planning. The plan provides an example of how the SWAT model can be used to develop pre- and post-BMP implementation scenarios to estimate expected pollution reductions. The plan has a good cost section. (http://www.flintriverconservation.org/FlintRivermgtplan.pdf)
Fort Cobb Watershed, Oklahoma	This plan does an excellent job of evaluating current loads, identifying the primary sources, and establishing an effective management scheme for reaching reduction goals. The planners use the "PRedICT" scenario builder to evaluate treatment effects and implementation costs. (http://www.ok.gov/conservation/documents/Ft.%20Cobb%20Watershed%20Based%20Plan%202009.6.22.pdf)
Watershed Plans from 2008 Review	
Lake Eucha/ Spavinaw River Watershed, Oklahoma	This plan nicely describes the overall goals and how they relate to the needed load reductions and interim water quality measures. The watershed is modeled using the SWAT model, and the plan has a detailed monitoring component. (http://www.environment.ok.gov/documents/CWA/GrantWorkplans/Eucha-Spavinaw%20Watershed%20Riparian%20Protection%20Initiative/EuchaSpavWBPRev2-07.pdf)
Lower Big Blue/Lower Little Blue River Watersheds, Kansas	This plan uses the SWAT model to compare various pollution control scenarios. The plan describes how the model was selected, validated, and run. The plan targets critical areas and provides a breakdown of costs for alternative BMP scenarios. (http://www.kdheks.gov/nps/wraps/Tuttle_Plan&summary.pdf)
Hawksbill and Mill Creek Watersheds, Virginia	For this plan, three specialized stakeholder groups provided detailed planning information and recommendations on identifying sources and selecting BMPs. Targeted locations are identified for maximum load reduction. (http://www.deq.state.va.us/Portals/0/DEQ/Water/TMDL/ImplementationPlans/hksmillip.pdf)
Lower Monocacy River Watershed, Maryland	The plan is an update to an earlier plan so it serves as an example of how an adaptive approach can be applied to planning and improving the pollutant reduction estimates. The plan uses several assessment approaches for various land uses, including a stream corridor assessment and the Impervious Cover Model to assess loads. Costs and benefits are provided, and a cost–benefit analysis is done, which is rarely the case. (http://www.dnr.state.md.us/watersheds/surf/proj/lmon_char.html)

Notes: BMP, best management practice; PRedICT, Pollution Reduction Impact Comparison Tool; SWAT, Soil and Water Assessment Tool.

The USEPA reviews of watershed plans from around the country show that improvements are needed to promote the development of higher-quality watershed plans. Based on these reviews, USEPA (2011) made the following specific recommendations for the states: (1) dedicate sufficient Section 319 funds to watershed plan development to ensure that the "a–i criteria" are adequately addressed and (2) develop watershed plans at a scale that provides the appropriate level of detail (e.g., HUC 12).

The watershed plan evaluation report (USEPA 2011) also includes the following recommendations for USEPA:

- work more closely with the states to increase technical capacity and to ensure that states are investing adequate funding in plan development and implementation;
- distribute the "best" watershed plans to provide examples for plan developers; and
- interview developers of the best watershed plans to gain insight that can be incorporated into watershed planning resources.

A notable finding from USEPA's evaluation of the 319 program in 2011 is that, although CWA Section 319 funding has contributed to more than 355 "success stories" nationwide, largely due to efforts in planning comprehensive watershed projects, this represents only about 1% of the total number of impaired waters (USEPA 2011). Thus, USEPA must find other ways to leverage CWA Section 319 funds and reduce costs related to planning and implementation. The agency is promoting various ways to leverage programs and resources for watersheds. For example, the USEPA Wetlands Program is supporting efforts by the Environmental Law Institute and The Nature Conservancy to help state regulatory agencies and wetland mitigation banks find high-quality sites within watersheds that would serve as cost-effective targets of stream and wetland mitigation funds. USEPA also suggests that states document the need for watershed planning and implementation as part of their annual *needs surveys* to qualify for Clean Water State Revolving Fund (SRF) low-interest loans for pollution control work. The SRF can be applied to efforts to address both point and nonpoint sources and has been successfully used to fund land acquisition in California, source water protection in New York, and stormwater retrofits in Massachusetts, to name a few. Nearly all of the above success stories involve leveraging state and other federal funds and technical assistance (e.g., USDA programs and advisors).

The Center's Review of Small Urban Watershed Plans

The Center has been developing watershed-based plans since its inception in 1992. To date, the organization has developed or contributed to the development of plans for more than 50 watersheds across the country. The Center's approach to watershed planning has evolved over the years, but some constant features have included:

- a focus on small watersheds (e.g., less than 259 km^2) and their subwatersheds (e.g., 26–52 km^2) as the appropriate scale for planning and implementation;
- a focus on urban and urbanizing watersheds;
- a rapid approach to watershed assessment and plan development;
- close coordination with local partners who are committed to watershed restoration; and
- the inclusion of specific recommendations with guidance for their implementation.

The earliest Center guidance on watershed planning, the *Rapid Watershed Planning Handbook* (Center for Watershed Protection 1998), was heavily focused on protecting watersheds from the impacts of land development. This document introduced the "eight tools of watershed protection," which provide a framework for the development of a watershed plan that considers all phases of the land development process, from land use planning through the design and construction phase, and ultimately to building occupancy. More recent Center guidance has focused on restoring small urban watersheds. Planning and assessment techniques for this purpose are documented in the Urban Subwatershed Restoration Manual Series (Schueler and Kitchell 2005; Kitchell and Schueler 2005; Wright et al. 2005; Schueler et al. 2007). Appendix A summarizes the Center's resources for watershed assessment, planning, and implementation.

Methods

The Center recently conducted a follow-up survey on a subset of the numerous watershed plans the organization has developed over the years. The goal was to gain insight that would help inform future watershed plans and planning guidance. More specifically, the survey set out to determine whether the plans are being used, the extent of implementation that has occurred, and key lessons learned in the planning process and in making the plan recommendations a reality. Of the watershed plans completed, the survey targeted 14. The survey included only plans that were at least five years old to allow sufficient time to evaluate implementation progress. In some cases, very old plans (older than ~15 years) were not selected because too little information existed about the plans and the appropriate local contacts. Since the majority of plans were located in Maryland and Virginia, the Center gave plans outside of these states a higher priority to provide better geographic representation.

The Center compiled contact information for each plan and developed a short, 14-question survey (Appendix B). After emailing the survey to each contact, Center staff followed up with emails and phone calls to encourage a higher response rate. We received 11 survey responses, for a 79% response rate, from eight states in the eastern United States (Figure 3).

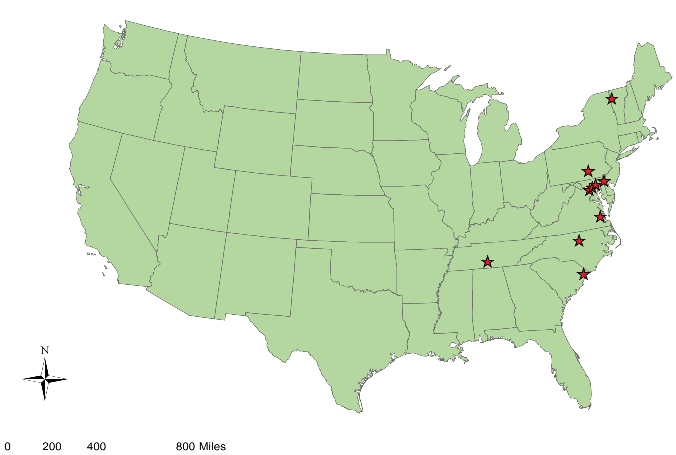

Figure 3. Locations of watersheds for 11 survey respondents. Insert this: 1 mile ≈ 1.6 km.

The watershed plans reviewed were developed between 2001 and 2006 for watersheds ranging in size from 26 to 337 km^2. The watersheds include highly urban areas (e.g., Harrisburg, Pennsylvania), suburban development (Howard County, Maryland), and rural lands (Marshall County, Tennessee), and most of the watersheds have a combination of these land use types. As a result, the plan recommendations included a mix of protection and restoration strategies, with a few plans for the more urban watersheds focusing solely on restoration. The Center conducted a variety of stream and upland field assessments to develop the plan recommendations. Most plans included estimates of pollutant reduction benefits associated with the recommendations, and some plans also included local program and code reviews.

Results

When asked about **drivers for developing a watershed plan** in their communities, more than half of the survey respondents indicated that a primary motive was to create a prioritized list of specific watershed protection and restoration projects for implementation. A second major goal was to address existing or anticipated regulations and policies, such as National Pollutant Discharge Elimination System (NPDES) stormwater permits and TMDLs. In a handful of cases, funding was mentioned as a motive for developing the watershed plan, either because funding was available for the planning effort, or to improve chances of securing project funding in the future. Other drivers included citizen concerns about erosion and flooding, staff interest, and knowledge that watershed planning could help protect water resources from the impacts of urban growth.

Two questions in the survey attempted to gauge **the extent to which each watershed plan has been used by the community**. All plans were reportedly used to some extent. Some plans were used to select, justify, and/or guide the implementation of capital improvement projects. Other Elements of some plans have been incorporated into local government activities, policies, and initiatives, either on an informal basis or by formally incorporating plan elements into the community's comprehensive plan and/or stormwater management ordinance.

When asked to list the **most useful components of the watershed plan**, respondents nearly unanimously asserted that a prioritized list of specific protection and restoration projects is one of the most useful elements of a plan. Several survey respondents explained that ranking and prioritizing recommended projects turns the watershed plan into a realistic

Table 3. Recommendations for watershed planning improvements.

Topic	Recommendation for Improvement
Plan goals and scope	• Carefully consider the goals and planned use of the plan up front so that it can be scoped and budgeted accordingly. For example, will it be an assessment of watershed impairments that identifies specific improvement measures? Will the plan provide a basis for, or can it be integrated with, other initiatives, such as the creation of a TMDL implementation plan? • Ensure that the plan complies with USEPA's "a–i criteria" such that recommended projects are eligible for USEPA Section 319 implementation funding.
Planning process	• Engage local elected and appointed officials during plan development to educate them in watershed planning and increase their investment in the plan's recommendations. • Promote cooperation among the various watershed jurisdictions. • Engage citizens and the development community throughout the process to address concerns and gain support. • Consider how to best communicate the plan to the public once it is complete.
Plan content	• Use design work for specific projects to develop more accurate cost estimates; for planning-level recommendations (e.g., retrofit 20% of impervious cover), use planning-level costs. • Provide cost data for low-impact development practices. • Provide better data on runoff and pollutant reduction benefits of specific recommended stormwater projects. • Do not spend too much time collecting detailed site-level data (e.g., stream cross-sections) that may change by the time projects are implemented in the future.

roadmap for future implementation. Others mentioned that the field work itself was an important component of the process to identify watershed problems and projects and to increase awareness.

The survey asked participants **how the watershed planning process could have been improved.** This question received a variety of responses, but Table 3 highlights a few common themes and important points.

Each of the 11 watershed plans has reportedly been implemented on some level. The survey asked participants to list the specific activities that have been implemented from their watershed plans to date. Table 4 shows the five most commonly implemented types of recommendations, with an estimate of the extent of implementation. Many activities reported in the surveys were not quantified by survey respondents, so the metrics in Table 4 represent only a portion of the implementation resulting from the plans in these watersheds.

Other types of plan recommendations that have been implemented in one or more of the watersheds include greenway establishment, monitoring programs, the protection of priority natural areas, improved stream buffer management, the creation of financial incentive programs for stormwater projects, exclusion fencing for livestock, stormwater program improvements, and pollution prevention programs.

The survey asked participants to identify the **actions implemented that were most successful at meeting watershed goals**. Stormwater retrofits and stream enhancements were the most common responses to this question, and many of these projects also included an educational or public involvement element. Other types of projects that helped meet watershed goals involved changes to local stormwater rules and/or design criteria intended to help reduce the environmental impact of future development.

By far, the most commonly identified **implementation challenge** was a lack of funding. Only one community had a dedicated source of stormwater management funding (initially from development fees, and then through a stormwater utility), but for most other respondents, cost was noted as a significant barrier to implementation. Other commonly cited challenges were either competing interests among the public or lack of public support, and political resistance or apathy. For example, attempts to pass ordinances for

Table 4. Top five activities implemented from watershed plans.

Watershed Management Practice	Implementation Quantified by Survey Respondents
Stormwater management retrofit projects	> 40 individual projects implemented, treating approximately 429 ha
Stream/floodplain stabilization and restoration projects	6,578 m of stream restored
Public outreach, sometimes targeted to specific groups or industries	Not quantified
Changes to stormwater management regulations, ordinances, or design requirements	Not quantified
Vegetative plantings, especially in riparian zones	2,475 trees and other vegetation planted

wider riparian buffers were blocked due to public opposition in two of the watersheds surveyed. A few respondents described the implementation of practices on private property as a challenge due to either restrictions on the use of public funds on private property or a lack of interest from private landowners.

Some survey participants also shared **lessons learned from implementation**:

- Have access to a robust engineering team if the plan calls for structural stormwater retrofits and stream restoration projects.
- Account for the cost of doing preventive maintenance when developing maintenance budgets for stormwater management practices.
- Secure funds for monitoring to enable a demonstration of the project's benefits.

The survey asked participants to describe **how the plan has helped improve conditions in their watersheds**. Although most respondents did not quantify improvements in water quality as a result of the plan, the majority noted other, more qualitative, indicators of improvement. These included the implementation of projects that addressed obvious pollution problems, such as streambank erosion, as well as visual improvements to the stream and riparian zone. Additionally, in all but one watershed, respondents identified benefits resulting from the watershed planning process itself. These included increased awareness of watershed problems, the formation of citizen advocacy groups, staff training opportunities, and knowledge gained to inform future studies and watershed plans.

Two of the watersheds experienced notable improvements. Stormwater retrofits and pollution prevention practices were implemented in Englesby Brook, a 640–ha watershed in an urban section of Burlington, Vermont. These actions, which were recommended in a 2001 watershed plan to address bacteria impairments, have resulted in the reopening of a public beach at the mouth of the stream. In Lewisburg, Tennessee, the 2003 watershed plan developed for the Big Rock Creek watershed contained recommendations for restoring an urban section of the stream that had experienced much erosion, siltation, and habitat alteration. With the use of streambank stabilization and stream restoration techniques, and with better management of buffers along the stream, this section of Big Rock Creek has been "visibly transformed and vastly improved with healthy riparian buffers, improved stream habitat, and increased species diversity" (L. Colley, Duck River Program Manager, The Nature Conservancy, personal communication, 2012).

Discussion

USEPA's review of watershed plans found that many plans do not adequately address the "a–i criteria" and are therefore less likely to lead to the attainment of water quality standards. From the perspective of USEPA, additional resources and assistance appear to be needed for developing watershed plans. Alternatively, the agency's nonpoint source program may need to clarify its guidance or consider ways to leverage more effective or widespread technical assistance to state and local entities. The Center's bottom-up review of watershed plans provided suggestions for improving the success of watershed plans in terms of whether the recommendations are implemented.

Several trends are apparent from the Center's watershed plan survey regarding the elements that are most important for getting from planning to implementation. First, regulatory requirements, such as NPDES and TMDLs, are major drivers for planning and implementation. Second, implementation is more likely to occur when the actions recommended in the plan are explicit and prioritized. Other approaches that survey respondents considered most successful include folding public education and involvement into restoration activities; engaging local elected officials and key stakeholders *early* in the process of recommending changes to stormwater rules, policies, or design criteria; and identifying a steady local source of funding for the implementation of stormwater-related actions outlined in the watershed plan. A lack of funding, followed by a lack of public support, were identified as the most common barriers to plan implementation.

The challenge of limited funding is echoed in (1) USEPA's review of the nonpoint source program, which identified a need to find other ways to leverage CWA Section 319 funds and reduce costs related to planning and implementation, and (2) the summary report from the USEPA watershed plan reviews, which recommends that USEPA work with states to ensure that they dedicate enough resources to fully address the "a–i criteria." Watershed planning offers a process by which one can leverage resources from other CWA programs to meet multiple objectives and make more efficient use of available resources. Most watershed planning efforts do not take full advantage of these potential collaborations. For example, plans that are driven entirely by NPDES permit requirements may fail to consider and address the objectives of other programs, such as TMDLs

Table 5. Integrated watershed planning.

Community or Program Objective	Link to Watershed Plan
NPDES stormwater program	Water quality goals of program; identify priority projects to meet water quality goals; stormwater mitigation fees, capital improvement budgets, or utility can provide source of funding for implementation; departments of transportation in particular may be a good source of funding for mitigation projects within the same watershed that can achieve stormwater objectives.
TMDLs	Water quality goals of TMDL; a single plan may be able to address both the point and nonpoint load allocations and other water quality goals; Section 319 funding is available for the implementation of nonpermitted stormwater sources.
CSO control plans	Stormwater projects that help address TMDLs and provide other community benefits, such as increased tree canopy and improved air quality, can also reduce the frequency of CSOs; because elimination of CSOs is mandated, funding is allocated by local governments to address them.
Drinking water source protection	Assessments conducted for source water protection can be done in conjunction with assessments for TMDL development and other watershed plan efforts; the scale may differ, but the source water area could be dealt with as a single subwatershed in a larger watershed plan.
Land use planning	A watershed plan should consider whether changes to zoning or local codes and ordinances are necessary to achieve watershed plan goals.
Floodplain management	If included in a watershed plan, stormwater management and land use planning are important tools for addressing a community's floodplain management goals.
Endangered Species Act	Habitat conservation plans for listed species may be available for targeting conservation practices in a watershed plan.
Stream and wetland permits	Mitigation for impacts to streams and wetlands under CWA Section 404 requires a watershed approach; therefore, identifying priority sites for mitigation that also address watershed plan goals can leverage implementation funding.
Conservation planning	Green infrastructure plans, wetland conservation plans, forest conservation plans, and other natural resources plans provide a good source of data to include in the watershed plan as a basis for identifying priority conservation projects.
Clean Water SRF program	SRF low-interest loans are available for upgrades to wastewater systems and nonpoint source-related watershed projects placed on state SRF priority lists.
Agricultural programs	Funding is available from various USDA programs for the implementation of agricultural BMPs and wetlands and wildlife conservation projects; these can be critical to meeting the water quality objectives of TMDLs, source water protection, and so on.
Forest conservation	In states with forest conservation requirements, mitigation fees can be used to fund watershed planning projects; USDA Forest Service and State Forestry programs can address priority sources of sediment and habitat degradation.

Notes: BMP, best management practice; USDA, US Department of Agriculture.

or long-term control plans for combined sewer overflows (CSOs), missing opportunities to pool resources from each program to fund implementation in areas of overlapping priority. The key challenge related to integrating multiple programs within a watershed plan is the enormity of the effort involved with coordinating the plan among numerous stakeholder agencies that have limited communication with each other and often different (or competing) objectives, funding directives, and authority. Table 5 illustrates the various community objectives one can address with a watershed plan as well as the potential sources of implementation funding that can be leveraged by tying various program objectives into the watershed plan. This table provides a starting point for watershed plan developers to identify these important linkages at the scoping stage.

Two funding strategies that probably hold the key to sustained funding for watershed plan implementation are water quality trading and stormwater utilities. A water quality trading program allows sources that reduce their pollutant loadings below target levels to sell their surplus reductions or "credits" to other sources that cannot meet their target levels. This approach allows pollution sources that can reduce pollutants at low cost (e.g., agriculture) to sell credits to those facing higher-cost pollution reduction options (e.g., wastewater treatment plants), and improves the ability of communities to meet their water quality goals. In some cases, trading is the only feasible way to meet a TMDL. Most water quality trading programs have focused on nutrients, although one could establish such programs for other pollutants (Center for Watershed Protection and Williamsburg Environmental Group 2010).

Watershed plan recommendations that address stormwater runoff from urban areas are often the most expensive to implement. Communities can pursue regulatory approaches, such as requiring retrofits to be installed as sites are repaved or redeveloped, or incentive-based approaches, such as the District of Columbia's RiverSmart Homes program, which offers incentives to homeowners for reducing stormwater runoff from their properties. Often these incentives come in the form of reduced stormwater utility fees. Stormwater utilities provide a source of funding from monthly or quarterly fees charged to landowners for the amount of stormwater produced on their properties. The fees are typically based on the amount of impervious surface on the property and are administered separately from the general fund to ensure a reliable source of funding for the operation of stormwater programs, the maintenance of stormwater infrastructure, and compliance with stormwater permits (Hirschman and Kosco 2008). The development of a utility requires state enabling legislation and local legal authority (e.g., an ordinance), which can take different forms depending on a state's legal structure. The revenue stream can also be used to issue bonds and provide leverage for grants and loans such as the SRF low-interest loans for water projects.

Respondents in the Center's watershed plan survey identified public support as very important for plan implementation. In the USEPA (2011) review, watershed plan element "e," which requires the inclusion of an educational component in the watershed plan, consistently scored well, indicating that most watershed plans document their educational efforts. However, the USEPA report shows that the information provided for element "e" does not indicate how these public education campaigns were designed to enhance public understanding or involvement, leaving a question about whether the public will actually support implementation. This is an area where the USEPA guidance could be clarified so that watershed plan developers can better make this link. An emerging area of focus in public outreach campaigns that could help enhance this guidance is community-based social marketing (McKenzie-Mohr and Smith 1999), an approach that draws from research in social psychology to design public education programs based on the knowledge level, motivations, and impediments identified in the target audience. Responses from the Center survey that highlight successful measures to gain public support include involving stakeholders, especially elected officials, in the planning process from the start to ensure "ownership" of the plan; selecting projects with high visibility and installing educational signage; and engaging local residents to get involved in project implementation. Survey respondents mentioned that one of the challenges related to gaining public support is that people may not see the value in restoring a resource they do not directly use, such as a small urban stream. Clearly, we need to learn more about how to communicate the value of these resources to local residents in terms that matter to them (e.g., finances and quality of life).

Conclusion

The major finding from the "bird's-eye" review of watershed planning in the United States is that many watershed plans being developed with USEPA funding are not sufficiently detailed to ensure the attainment of water quality standards. Given the findings of the USEPA self-evaluation that only about 1% of the total number of impaired waters have been restored, a primary challenge of the USEPA watershed program will be determining how to bring more resources to bear (both financial and technical) and target pollution abatement across the landscape.

On the other hand, the "ground-level" review showed that most watershed plans are being used on some level and also reported an impressive level of implementation, although data were not sufficient to quantify water quality or other improvements resulting from this implementation. The important plan elements for getting to implementation included funding, public support, a list of specific recommended projects, and a regulatory driver such as NPDES. While the last factor is often instrumental to spur the development of watershed plans, a singular focus on a particular program or regulatory mandate can limit the ability of the planning effort to integrate with other programs and address pollution sources beyond just stormwater.

The obstacle of limited funding and resources for watershed plan development and implementation cannot be addressed with a single solution. Increased integration across programs, although challenging, may be the key to leveraging resources from multiple programs, making the planning process more efficient, and also providing a more comprehensive roadmap for improvement in a watershed. Stormwater utilities and water quality trading—as well as emerging innovative funding mechanisms and programs that require or encourage restoration on private lands—will probably need to be explored as part of the solution as well.

In spite of these challenges, both USEPA and the Center found many cases where multipartner collaborative efforts are starting to show measurable progress in managing watersheds. A watershed plan provides a roadmap for improvement in each watershed, with its unique set of problems and community goals. By documenting the critical decisions, responsibilities, analytical procedures, and funding needs, watershed managers can learn from these efforts and develop ways to disseminate this knowledge more widely across the country.

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Appendix A: Online Resources and Tools for Watershed Plan Development

US Environmental Protection Agency Watershed Planning Resources	Center for Watershed Protection Watershed Planning Resources
General Resources • Watershed Central (online watershed management tools) • Community-Based Watershed Management: Lessons Learned from the National Estuaries Program (document) Assessment • MyEnvironment (online portal for GIS data, permits, and monitoring data) • Healthy Watersheds (website) • Rapid Bioassessment Protocols for Streams and Rivers (document) • Source Water Protection (website) Planning • Handbook for Developing Watershed Plans To Restore and Protect Our Waters • Plan Builder (online tool on Watershed Central website) • Watershed-Based Permitting (website) Implementation • Water Quality Trading Tool Kit for Permit Writers (document) • Sustainable Finance: Watershed Funding (website) Monitoring • Section 319 Monitoring Program Projects (website) Available at: www.epa.gov/owow www.epa.gov/nps and www.epa.gov/safewater/sourcewater	Assessment • Unified Subwatershed and Site Reconnaissance: A User's Manual, Version 2.0 • Unified Stream Assessment: A User's Manual, Version 2.0 Planning • Rapid Watershed Planning Handbook: A Comprehensive Guide to Managing Urbanizing Watersheds • Methods to Develop Restoration Plans for Small Urban Watersheds (document) • An Integrated Framework to Restore Small Urban Watersheds (document) • Using Local Watershed Plans to Protect Wetlands (document) • Urban Watershed Forestry Manual. Part 1: Methods for Increasing Forest Cover in a Watershed (document) • The Watershed Treatment Model Implementation • Urban Stormwater Retrofit Practices, Version 1.0 (document) • Urban Stream Repair Practices (document) • Pollution Source Control Practices (document) • Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments • Better Site Design: A Handbook for Changing Development Rules in Your Community Available at: www.cwp.org and www.awsps.org/publications/owl-intro.html

Appendix B: Survey of Watershed Plans

Watershed Plan:

1. What was the driver/reason for developing a watershed plan in your community?
2. Is the watershed plan used in your community?
3. Has the plan been integrated into other departments of the community? (e.g., comprehensive planning, development codes and ordinances, erosion and sediment control regulations, etc.)
4. Please list the parts of the plan that are most useful to your community in achieving local watershed/stormwater goals.
5. Please list aspects of the watershed plan that could be improved to help achieve local watershed/stormwater goals and the recommended improvements.
6. Please describe how the plan has helped improve watershed conditions. (e.g., reduce pollutants, engage public, increase awareness of issues, etc.)
7. Since the development of this watershed plan, has your community continued to develop additional watershed plans? If so, what, if anything, has changed in the plan?

Watershed Plan Implementation:

1. Have recommendations from this plan been implemented (e.g., stream clean-ups, changes in programs, etc.)?

If Yes,

2. Please list/describe the specific activities and metrics (e.g., # of acres, etc.) that were implemented. (e.g., 5 residential downspouts disconnected, etc.)
3. What was the cost of implementation for each project implemented? (e.g., cost of materials, staff time, construction, etc.) If you are willing to share cost data please email or mail it to us at xxx@cwp.org or Center for Watershed Protection, 8390 Main Street, 2nd Floor, Ellicott City, MD 21043, Attn: x.
4. Of the projects implemented, which are most successful in terms of meeting watershed goals? (e.g., goals can include pollutant removal, increasing community awareness, etc.)
5. Please describe the biggest challenges (e.g., cost, property rights, community support, etc.) and barriers (e.g., poor soils, contractors, etc.) to implementation. What lessons were learned during implementation that you would change next time?

If No,

6. Why have recommendations not been implemented? Please mark the answer below that best describes your answer. ❑ Lack of funding
   ❑ Political resistance
   ❑ Property rights
   ❑ Lack of community support
   ❑ Lack of staff
   ❑ Other: ____________________________

7. Please provide any additional information about the plan in the space provided below.

   ____
   ____
   ____

North Carolina Ecosystem Enhancement Program: Implementation and Lessons Learned from North Carolina's Watershed-Based Approach to Mitigation

Nancy Daly[a]* and Marc Recktenwald[b]

Abstract

North Carolina's Ecosystem Enhancement Program (EEP), formerly known as the Wetland Restoration program, has had a strong commitment to watershed planning throughout its 14-year history. That long-term dedication to watershed planning, the volume of watershed plans developed, and the variety of projects implemented in the context of those plans provides EEP with a unique perspective on the evolution of watershed planning and how it is accomplished.

Introduction: Ecosystem Enhancement Program Background and History

The Clean Water Act's Sections 404 and 401 (33 USC 1344) require "compensatory mitigation" for unavoidable impacts to streams, wetlands, and other waters of the United States. This means that the restoration, creation, or enhancement of streams and wetlands is necessary to compensate for the loss of these resources, where loss is measured in terms of both acres and functions lost. This article describes the Ecosystem Enhancement Program's (EEP's) watershed planning–based approach to compensatory mitigation and provides lessons learned from the development and implementation of watershed plans.

A 1998 memorandum of understanding between the US Army Corps of Engineers (USACE) Wilmington District and the North Carolina Department of Environment and Natural Resources established the Wetland Restoration Program as North Carolina's in-lieu fee (ILF) mitigation program. Through this voluntary ILF program, applicants (e.g., private sector, state agencies, municipalities, schools, and military bases) may make payments to satisfy the Clean Water Act's compensatory mitigation requirement. The mitigation requirement is then transferred to the ILF program, which implements stream and wetland mitigation projects to satisfy the requirements. Like other such programs across the country, North Carolina's ILF program combines multiple mitigation payments to generate larger-scale watershed projects. Enabling legislation also required the Wetland Restoration Program to develop watershed planning documents for all of the state's 17 river basins and directed the initiative to update them at least every five years, concurrent with the North Carolina Division of Water Quality's basin-wide planning cycle. This program became the state's response to the need for a high-quality compensatory mitigation option for private and public entities with Section 404 permits under the Clean Water Act.

In 2000, as the North Carolina Department of Transportation (NCDOT) began to increase its reliance on the Wetland Restoration Program to meet its off-site compensatory mitigation needs, it contracted with the program for the development of watershed plans to identify specific mitigation projects. The increased demand and funding enabled the Wetland Restoration Program to develop local watershed plans (LWPs), a more detailed level of watershed planning that involves a comprehensive assessment of watershed conditions. This approach results in a list of specific projects—prioritized based on their ability to address identified watershed stressors (e.g., sediment loading)—that could be implemented to meet mitigation needs. In addition, LWPs include management recommendations (e.g., best management practices [BMPs] and institutional measures) that could be implemented by watershed stakeholders. This watershed planning approach to mitigation sets the program apart from many other mitigation providers in the state and across the country.

In response to delays of NCDOT transportation projects due to mitigation challenges, NCDOT, the North Carolina Department of Natural Resources, USACE, and other federal and state agencies developed a new program that combined the mitigation requirements of the Wetland Restoration Program's traditional ILF program with all of NCDOT's off-site mitigation needs. In 2003, the North Carolina Department of Environment and Natural Resources entered into a memorandum of agreement with NCDOT and USACE, and EEP was formally established, replacing the Wetland Restoration Program. As outlined in the memorandum of agreement, EEP's purpose is to provide a comprehensive natural resource enhancement program

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that identifies ecosystem needs at the local watershed level and preserves, enhances, and restores ecological functions within the target watersheds while addressing anticipated impacts from NCDOT transportation projects. The identification of mitigation projects in advance of NCDOT's environmental impacts became an innovative element of this new program, highlighting NCDOT's commitment to the environment while advancing transportation projects. In addition to its commitment to provide mitigation for NCDOT impacts, EEP maintained the role, formerly played by the Wetland Restoration Program, of providing ILF compensatory mitigation for private and governmental entities. EEP formally began operations in July 2003.

In July 2010, EEP secured approval of its current operating instrument in compliance with the 2008 federal mitigation rule, Compensatory Mitigation for Losses of Aquatic Resources, 33 CFR Parts 325 and 332; 40 CFR Part 230. While the new instrument replaced the 2003 memorandum of agreement, EEP's mission for ILF customers and NCDOT remains intact, including the program's adherence to the watershed planning approach and to providing NCDOT mitigation in advance of permitted impacts.

The Ecosystem Enhancement Program's Watershed Planning Process

Since its inception, the Wetland Restoration Program emphasized the application of watershed planning principles in the delivery of compensatory mitigation. EEP has continued this practice, generally using two levels of watershed planning. At a macro scale, the program develops plans for the state's 17 river basins; this results in geographic targets that are presented in River Basin Restoration Priorities documents. And, at a smaller scale, the program develops LWPs in strategic areas of the state, resulting in more specific watershed management strategies. As watershed science, policy, tools, and funding levels change, EEP continues to explore ways in which to meet its watershed planning needs. This article describes the two primary levels of watershed planning used by EEP and illuminates lessons learned in the development and implementation of EEP's plans.

River Basin Restoration Priorities are macro-level watershed plans in which EEP identifies priority watersheds across the state that exhibit the best opportunities for functional improvement. EEP develops such a plan for each of the state's 17 river basins by conducting a detailed screening of problems, assets, and opportunities for individual eight-digit catalog units (1,300–5,000 km²) within a river basin (2,500–26,000 km²). Each River Basin Restoration Priorities document identifies priority 14-digit hydrologic unit code (HUC; 25–260 km²) watersheds that exhibit a need for restoration and protection of wetlands, streams, and riparian buffers. This planning process provides broad watershed improvement goals, but does not identify specific mitigation projects. The priority watersheds, referred to as targeted local watersheds, receive priority for EEP local watershed planning and restoration project funds. In addition, EEP encourages other agencies and organizations to focus funding in these watersheds.

EEP develops an LWP—a more comprehensive examination of the factors contributing to the degradation of a targeted local watershed—for an area in which the anticipated mitigation need is high (e.g., where multiple mitigation projects will need to be implemented). EEP selects at least one 14-digit HUC, totaling an area between 25 and 260 km², for an investigation conducted in collaboration with representatives of local governments, nonprofit organizations, and local communities as well as environmental resource professionals. The partnership focuses on opportunities for the protection and improvement of water quality, hydrology, and habitat. EEP carries out LWPs in four phases. Phase 1 provides a preliminary characterization of the watershed based on existing data; Phase 2 incorporates water quality monitoring, field assessments, and data analysis to fill in data gaps identified in Phase 1; Phase 3 identifies priorities for watershed management strategies, including a project atlas with specific project opportunities; and Phase 4 encompasses project implementation work by EEP and watershed stakeholders. As EEP has evolved, the Phase 3 project atlas has become more comprehensive and includes not only stream and wetland mitigation projects for EEP, but also agricultural and stormwater BMPs that may be implemented by diverse watershed stakeholders.

EEP's continued commitment to watershed planning is outlined in the compensation planning framework described in EEP (2010, appendix I).

Overall Results of the Ecosystem Enhancement Program's Watershed Planning Initiatives

The results of EEP's watershed planning–based mitigation approach must be considered in the context of a very dynamic program that has been responsible for the implementation of more than 500 mitigation projects in a compressed period of time. EEP has always worked to maximize the benefits of mitigation investments by relying on watershed planning, but certain conditions have affected the program's ability to implement all projects within designated planning areas. First, the Wetland Restoration Program and EEP have always emphasized project implementation in watershed planning areas, but a requirement to do so was not in place until the establishment of EEP's current operating instrument, developed in compliance with the 2008 federal mitigation rule. Second, in its first few years of existence, EEP was required to provide a substantial amount of mitigation in a very short period of time to ensure that it could be completed prior to NCDOT impacts. Third, LWPs take years to develop and in some cases were not completed in time to be used for the substantial mitigation need for which they were initiated. Fourth, EEP inherited more than 140 NCDOT mitigation projects that were developed without regard to watershed planning. Finally, EEP implemented many projects in its High-Quality Preservation initiative at the program's inception as a bridge for advance mitigation requirements. These projects were developed on the basis of ecoregions (defined by county boundaries with similar geology and ecological characteristics) rather than on a watershed basis.

Since 2000, EEP has completed 30 LWPs, with an additional 5 LWPs in progress and 4 LWPs partially completed and placed on hold because of a decrease in mitigation needs (i.e., a decline in mitigation requests from NCDOT and other ILF applicants). As of June 2011, EEP implemented a total of 583 mitigation projects. Of these projects, 394 (67%) are within targeted local watersheds and 105 (18%) are within LWP areas. In addition, EEP has leveraged $26.8 million in grant funding for project implementation by other entities in LWP areas. The funding sources include federal, state, and local governments as well as private sources. Projects implemented with alternative funding sources complement the effects of restoration conducted for the purposes of compensatory mitigation and move North Carolina toward comprehensive watershed restoration.

Specific Examples of Local Watershed Plan Success

Success is defined differently by different stakeholders and may include quantitative and qualitative measures. For example, indicators of success may include the number of projects implemented, improvement in water quality parameters, the long-term establishment of watershed stakeholder groups, or increased public education and awareness of watershed issues. The two LWPs described below demonstrate both quantitative (number of projects) and qualitative (active stakeholder support) successes.

Muddy Creek Local Watershed Plan

For the Muddy Creek LWP, EEP built on an existing watershed restoration effort. The LWP area is 285 km^2 and encompasses three HUCs (03050101040010, 03050101040020, and part of 03050101030060) in the Catawba River basin (Figure 1). An earlier effort, the Muddy Creek Restoration Partnership (not related to EEP), began in 1998 to address severe sedimentation issues. This partnership included representatives from federal, state, and local government agencies; the private sector; nonprofit environmental organizations; and local citizens. In 2003, the partnership developed a watershed plan that identified priority project areas for the implementation of stream restoration and protection and agricultural BMPs (Equinox Environmental 2003). In 2008, EEP began building on this plan by developing an atlas of potential mitigation projects that would address watershed needs (Equinox Environmental 2008a).

From 2004 to the present, project partners have implemented priority conservation projects with an organized outreach initiative. From 2004 to 2008, a part-time, grant-funded landowner outreach coordinator implemented an education and outreach program to build community support and recruit key landowners. Since then, landowner recruitment efforts have continued through EEP staff and private mitigation bankers.

The partnership developed a monitoring program to collect baseline data and evaluate site-specific and cumulative impacts of on-the-ground restoration. This project effectiveness study (Equinox 2008b), conducted from 2005 to 2007, evaluated the following parameters: bed substrate, bank erosion (through bank erosion hazard index evaluations), habitat quality, fecal coliform bacteria, and benthic community characteristics. Project implementation during this period represented approximately one-half of the implementation that has occurred to date (i.e., 11 km of stream restoration had been completed at the time of the study). Results of the study indicate an improvement in aquatic habitat scores (based on the rating of habitat suitable for benthic macroinvertebrates and fish by the North Carolina Division of Water Quality [2003]) and in the bank erosion hazard index at the reach-specific scale; however, bed substrate and benthic community parameters did not show improvement. The study identified the age of projects (zero to three years) and contributions from the larger watershed as limiting factors to additional reach-scale and watershed-scale improvements (Equinox Environmental 2003, 2008b, 2011).

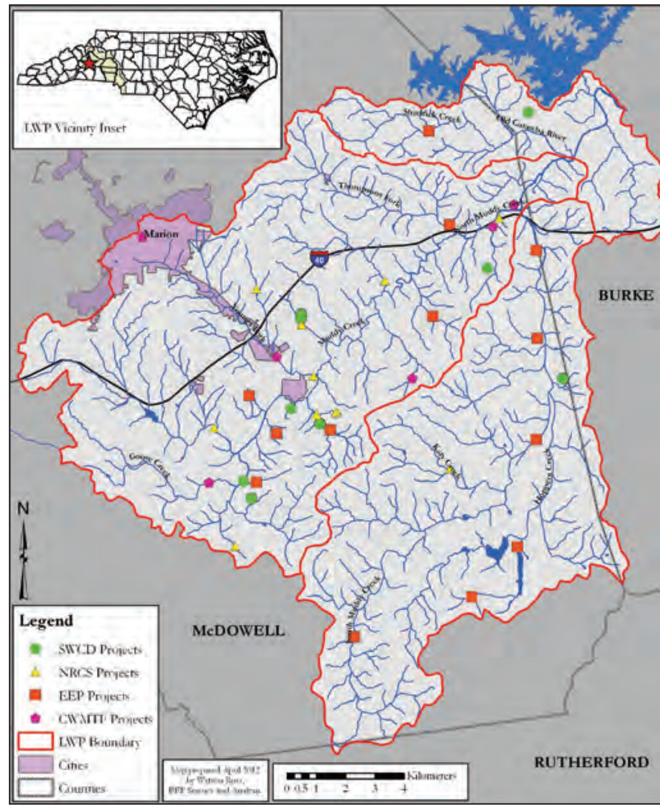

Figure 1. Projects located within the Muddy Creek local watershed plan. CWMTF, North Carolina Clean Water Management Trust Fund; EEP, North Carolina Ecosystem Enhancement Program; NRCS, US Department of Agriculture Natural Resources Conservation Service; SWCD, North Carolina Division of Soil and Water Conservation..

In 2007, the partnership initiated the Corpening–Jacktown watershed improvement initiative to address impacts to an impaired stream draining the City of Marion. The partnership completed a nine-element watershed plan in the Corpening–Jacktown watershed (Equinox Environmental 2011). Nine-element plans meet criteria outlined by the US Environmental Protection Agency (i.e., "a–i criteria") to qualify for Clean Water Act Section 319 funds. These funds are designated to states to implement nonpoint source management programs and may be expended to develop a watershed plan that addresses nonpoint source water quality impairments for a particular watershed (US Environmental Protection Agency 2008, n.d.). The partnership is now seeking sustained funding for a watershed coordinator and project implementation.

To date, EEP has implemented 13 projects in the Muddy Creek LWP area, resulting in approximately 30 km of stream restoration, enhancement, and preservation; more than 8 ha of riparian buffer restoration; and more than 12 ha of wetland restoration, enhancement, and preservation.

Partners leveraged over $2.3 million in grant funding since 1998, with $500,000 of this funding occurring since 2008. Partnership projects include a 46-ha farmland preservation project; two stormwater BMPs (a rain garden and a stormwater wetland); additional planning efforts; and numerous stream restoration, preservation, and agricultural BMPs. Project funding sources include, but are not limited to, the US Department of Agriculture Natural Resources Conservation Service Environmental Quality Incentives Program, North Carolina Agriculture Cost Share Program, North Carolina Clean Water Management Trust Fund, North Carolina Division of Water Resources, US Environmental Protection Agency, and NCDOT. Documentation associated with the Muddy Creek LWP is available from EEP (n.d.[c]).

Little Alamance, Travis, and Tickle Creeks Local Watershed Plan

The Little Alamance, Travis, and Tickle Creeks LWP represents another collaborative effort with state and local partners. The LWP area is 132 km^2 and encompasses two HUCs (03030002040110 and 0303000203001) in the Cape Fear River basin (Figure 2). In 2000, the North Carolina Division of Water Quality listed Little Alamance Creek as impaired because of poor stream biological ratings, which were largely a result of impacts from urban stormwater runoff. Issues included poor water quality, impaired biology, loss of riparian vegetation, bank erosion, and urban runoff. Travis and Tickle Creeks also suffer from poor stream biological conditions. These conditions are primarily a result of poor riparian habitat, impacts from suburban development, and agricultural land use practices (EEP n.d.[a]; Piedmont Triad Council of Governments n.d.). EEP conducted a detailed study of these watersheds from 2006 to 2008 to understand the sources of identified problems and to lay the groundwork for the development of solutions to address the issues. The resulting *Little Alamance, Travis and Tickle Creeks Watersheds Report and Project Atlas* (Piedmont Triad Council of Governments 2008) highlights stressors affecting aquatic ecosystems in the local watershed planning area and provides management strategies to help improve water quality and protect area streams.

In October 2009, the North Carolina Division of Water Quality awarded the Piedmont Triad Council of Governments a federal 205(j) Water Quality Management Funding grant for the development of the Little Alamance Restoration Alliance. A partnership of citizens, local organizations, municipal staff, and resource professionals, this alliance focuses on improving the water quality of the Little Alamance Creek watershed through educational outreach and water quality awareness. The alliance solicited input on water quality monitoring from

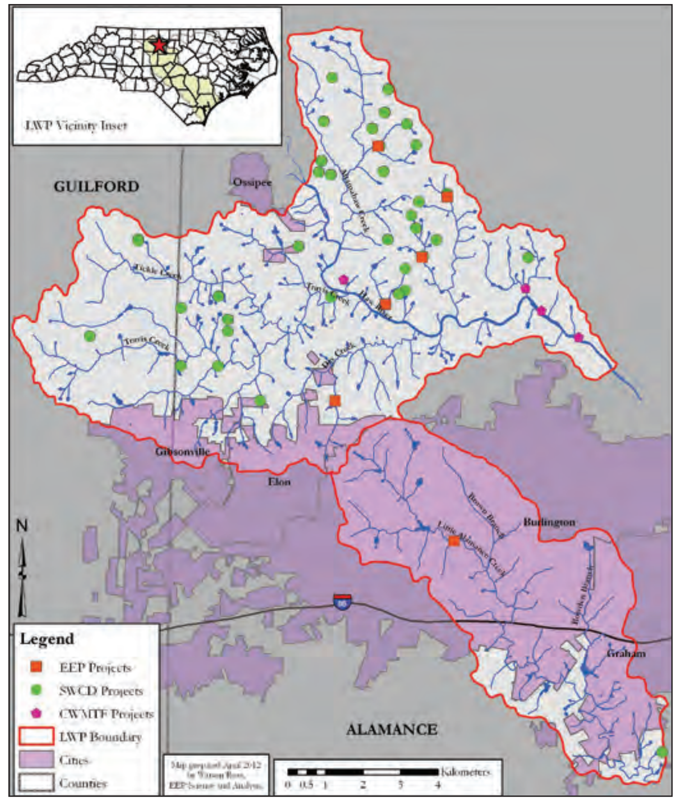

Figure 2. Projects located within the Little Alamance, Travis, and Tickle Creeks local watershed plan. CWMTF, North Carolina Clean Water Management Trust Fund; EEP, North Carolina Ecosystem Enhancement Program; SWCD, North Carolina Division of Soil and Water Conservation.

local citizens and organized the concerted efforts of focus groups. Educational topics included the promotion of stormwater treatment and the establishment of riparian buffers in this highly urbanized watershed (Little Alamance Restoration Alliance n.d.). In addition, the North Carolina Division of Water Quality is currently developing a total maximum daily load within the Little Alamance watershed with a goal of reducing the amount of *effective paved surface* by implementing strategic stormwater BMPs (Piedmont Triad Council of Governments n.d.).

To date, EEP has implemented six projects in these watersheds; these projects have resulted in more than 8 km of stream restoration, enhancement, and preservation and more than 2 ha of wetland enhancement and preservation. In addition, local government and a local land trust have leveraged more than $1,000,000 in grant funds in this LWP area. Included in this amount is funding by the North Carolina Parks and Recreation Trust Fund for the preservation of 77 ha on the Haw River and its tributaries—a priority that was identified in the Little Alamance, Travis, and Tickle Creeks Project Atlas (Piedmont Triad Council of Governments 2008). Documentation associated with the Little Alamance, Travis, and Tickle LWP is available from EEP (n.d.[b]).

Lessons Learned

Many factors, including federal and state regulations, economic fluctuations, and advances in restoration science, influence EEP's watershed planning process. Eleven years after the initiation of its first LWP, EEP can reflect on and share both its successes and its challenges. The key factors that influence LWP success and EEP's lessons learned are discussed below.

Stakeholder Composition

LWPs that have strong local support are more likely to achieve long-term commitments to the implementation of agreed upon recommendations. Federal and state resource agency personnel are part of EEP stakeholder processes and provide valuable support; but without local support, many management recommendations never progress beyond inclusion in the final report. Key local stakeholders in EEP watershed planning processes include the North Carolina Division of Soil and Water Conservation district staff, regional councils of government, and planning representatives from local government. These representatives not only have relationships with landowners within the watershed, they are also familiar with officials in local government who can help foster support for LWP development and implementation. Key outcomes of this support may include endorsement of the watershed management plan, support for the implementation of watershed projects, and funding for a watershed coordinator position.

EEP considers the presence of local watershed champions a key factor in selecting locations for LWP development. This increases the likelihood of an active stakeholder process and helps ensure that local resource concerns are addressed in the watershed management plan. EEP routinely presents the results of watershed planning efforts to local government representatives and elected officials to gain support for watershed plan management recommendations.

Stakeholder-Driven Plans

Given the importance of active stakeholders, EEP believes that building on existing watershed plans is an effective way to increase the long-term success (in both quantitative and qualitative measures) of watershed plans. Rather than asking multiple stakeholders to take part in an EEP planning effort, EEP becomes an active participant of an existing planning team. EEP watershed planners can then offer support in the form of facilitation and coordination, or through financial resources. These efforts are often centered around a specific resource issue, such as threatened or endangered species or nutrient runoff. If a specific resource concern exists, this translates into a greater likelihood of getting key partners to participate in the process, and a greater chance that grant funding opportunities exist and that projects will be implemented. By addressing the specific resource of concern as part of a larger watershed planning effort, greater awareness of watershed resources and a more comprehensive plan for improvement may be developed.

To foster collaboration with ongoing watershed initiatives, EEP developed a process by which entities can submit an existing watershed plan for review and acceptance. EEP's ILF instrument outlines minimum criteria required to meet federal requirements for a watershed approach. By reviewing existing watershed plans, EEP is able to learn about existing planning efforts and determine if they meet federal requirements. For those plans that do not meet all criteria, EEP may offer support for missing elements—such as water quality monitoring, field assessments, or project prioritization—that supplement and benefit local efforts.

By enabling EEP to build on existing local watershed initiatives, this process is more cost-effective than initiating a separate process because funding is focused on supplementing, rather than creating new watershed initiatives and datasets. Watershed partners benefit from this effort by receiving additional resources for watershed assessments and project implementation within the watershed. Once a plan has been adopted, EEP can focus mitigation funding within the planning area. In addition, the LWP provides stakeholders with leveraging opportunities for grant-funded projects.

Feasible Projects

If implementation of watershed improvement projects is a goal, then projects must be technically and economically feasible. Some of EEP's earlier LWPs included long lists of water quality improvement projects that proved to be technically infeasible because of design or construction constraints. In addition, EEP discovered that certain economies of scale exist and that, to be economically feasible, minimum size criteria for stream and wetland projects must be met.

Early on, EEP considered minimum size criteria for project implementation to be approximately 450 m for streams and 2 ha for wetlands. EEP learned that in areas of consistent mitigation need, one large project is more economically efficient than many small projects in meeting the same amount of mitigation need because overall resources spent developing and managing contracts are reduced, the cost of mobilization for multiple sites decreases, and more competitive bids for design and construction are received. Larger sites may also provide more functional benefit (e.g., longer intact riparian corridors that provide habitat and water quality treatment, increased aquatic habitat connectivity, etc.). In areas that do not have consistent mitigation needs, however, the current economic climate makes investing in excess mitigation unlikely to be feasible because of the cost of developing and maintaining projects and uncertainty that future payments to the program will enable this cost to be recaptured in an economically suitable timeframe. In addition, highly urbanized watersheds often necessitate the implementation of smaller projects because of issues such as multiple landowners, utility constraints, and limited stream and wetland project opportunities.

EEP also learned that communication between EEP watershed planners and project implementation managers is a critical component in identifying feasible watershed improvement projects with the best opportunity for implementation. To improve communication and understanding, EEP organized its planners and project managers into regional teams; this greatly improved the watershed planning project atlases. Although EEP has since been reorganized into separate watershed planning and project development units, planners and project managers still serve on teams for plan and project development to continue product improvement.

Project Diversity

Watershed improvement often depends on the implementation of a diverse range of projects and management recommendations. EEP's projects must be implemented in compliance with federal and state requirements for stream and wetland compensatory mitigation. Some of EEP's early LWPs identified projects to address specific mitigation needs, such as wetland requirements, and did not include stream, buffer, and BMP project opportunities. As regulatory mitigation requirements changed, so did the need for a more comprehensive project atlas. In addition, comprehensive watershed plans increase the usefulness of plans for watershed stakeholders. For example, in urban watersheds, while issues such as stormwater runoff may be a primary water quality stressor for the watershed, EEP is currently unable to implement stormwater BMP projects for the purposes of compensatory mitigation because current state and federal regulatory guidelines account for resource loss in acres and feet rather than in functional measurements. In these situations, funding for stormwater BMP projects may be available through grant funding or local governments, and implementing such projects in concert with traditional stream and wetland restoration yields more comprehensive watershed restoration.

It is important to develop comprehensive LWPs that incorporate a diversity of projects and management recommendations, including, but not limited to, wetland and stream restoration and preservation projects, stormwater and agricultural BMPs, and local zoning and ordinance recommendations. In addition, LWPs should include action plans that identify funding resources and entities tasked with the implementation of project recommendations. This helps increase the likelihood that watershed stressors will be addressed through different implementation mechanisms and increases the utility of the plan for stakeholders with different interests in the watershed.

Future of Watershed Planning by the Ecosystem Enhancement Program

EEP's watershed planning process continues to evolve. As demonstrated in the above lessons learned, EEP continues to adapt and tailor its planning process to meet both EEP and stakeholder goals. One key question that remains is, *what watershed scale and concentration of projects is most effective at bringing about measurable water quality improvements?*

EEP is actively trying to address this question. The scale needs to be large enough to support multiple stakeholder interests so that a diversity of projects (e.g., restoration, preservation, BMPs, point source issues, and wildlife habitat) can be implemented, yet not so large that projects are widely distributed and fail to provide a synergistic influence on watershed improvement. EEP is beginning a regional watershed planning initiative that has a much larger geographic range (~1,480 km^2) than traditional LWPs, but with a focus on small priority watersheds and specific functions that can be improved with tailored projects.

After more than a decade of watershed planning and project implementation efforts, EEP is beginning to examine watersheds in which many projects have been implemented and evaluate how these projects have influenced watershed and receiving water quality and living resource conditions. This effort involves studying not only EEP projects, but also projects implemented by other federal, state, and local entities. The results of these inquiries will undoubtedly provide more lessons learned.

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Wisconsin's Watershed Adaptive Management Option: A Novel Approach to Overcoming Barriers to Effective Watershed Management

*Melissa J. Malott[a] * and Daniel T. S. Cook[b]*

Abstract

Nonpoint source nutrient pollution is a significant limiting factor in the success of watershed restoration plans to date. Nonpoint source pollution problems persist in part because of technical, economic, social, and political challenges related to (1) the availability and use of accurate data, (2) the availability of adequate resources, (3) sufficient local community buy-in, and (4) an adequate legal framework. Addressing these challenges can provide the capacity, motivation, and framework for successful water quality management. Under Wisconsin's new phosphorus rule, Clean Water Act permittees may choose a compliance strategy that involves restoring water quality through nonpoint source controls. Permittees who choose this option may avoid high-cost technology upgrades that would not improve water quality. By putting the point source community in the driver's seat for phosphorus pollution, this new rule may put in place the elements critical to successful watershed restoration projects.

Introduction

Since the potential impacts of water pollution first captured national attention in the 1960s, regulations have been relatively effective at reducing many sources of that pollution. For example, significant decreases in phosphorus loading from detergents, and from wastewater treatment plant effluent more generally, were achieved in the states bordering the Great Lakes, with corresponding decreases in nutrient-related water quality issues, such as algal blooms and eutrophication (Litke 1999). Unfortunately, however, water quality and pollution regulations have been less successful with other sources of pollution, including the more dispersed nonpoint sources such as stormwater runoff and agricultural fields.

Because of the general inadequacy of existing water quality regulations to effectively address nonpoint sources, the water quality impacts of those sources have continued to increase relative to others. By 1998, the US Environmental Protection Agency's (USEPA 1998) Clean Water Action Plan found that nonpoint sources were the most significant sources of water pollution nationwide. As a result, some of the early improvements in water quality have since been reversed, and nutrient-related water quality issues have become widespread again. In 2006, the State of Wisconsin reported to USEPA (2006) that 61% of assessed rivers and streams in the state; 72% of lakes, reservoirs, and ponds; and 100% of wetlands were considered threatened or impaired. In more than one-quarter of those water bodies, USEPA (2006) explicitly listed phosphorus levels or eutrophication as causes of impairment.

These impairments have resulted in significant impacts, both to our economy and our way of life. While it is impossible to fully and accurately determine the costs of these impacts because of the inherent complexity and imprecision of environmental economic valuation studies, such studies can prove useful as rough estimates. One recent valuation study examining freshwaters in the United States conservatively estimated the annual cost of eutrophication alone to be at least $2.2 billion (Dodds et al. 2009).

The relative importance of nonpoint sources in contributing to impairment is underscored by a study of 15 priority watershed project plans in Wisconsin, which found that agricultural practices were estimated to contribute 94% of phosphorus loads in those watersheds (65% from croplands and 29% from barnyards and manure spreading; Lohr 2000). Other studies have also consistently demonstrated that nonpoint sources account for the majority of nutrient loading to impaired watersheds (see, e.g., Carpenter et al. 1998). This paper aims to demonstrate how Wisconsin's new phosphorus rule, in part by including elements to address nonpoint sources, pulls together the critical components of a successful water quality restoration strategy.

Historical Barriers and Key Elements for Successful Watershed Restoration

As a result of the increasing portion of total nutrient loads coming from nonpoint sources, the lack of reductions from those sources has become a significant limiting factor in the success of watershed restoration plans to date. A number of factors have contributed to the persistence of these nonpoint

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nutrient discharges; these factors are thus critical to examine and address in designing watershed management programs and policies. Based on historical experience with both successful and unsuccessful programs, these factors can be most easily characterized as technical, economic, social, or political challenges related to:

- the availability and use of accurate data,
- the availability of adequate resources,
- sufficient local community buy-in, and
- an adequate legal framework.

When addressed adequately, these elements together provide the capacity, motivation, and framework for the design and implementation of a successful water quality management program.

The need for accurate data, and proper planning based on those data, generally stems from the overall complexity of the system that leads to water quality issues from excessive nutrient loading. For example, although point sources (such as wastewater treatment plants) have historically been those most easily controlled through regulatory actions, and still account for a significant portion of total nutrient loadings to watersheds, a larger portion now comes from nonpoint sources. Moreover, water quality impacts, such as those from phosphorus loading, are the result not only of the sources of pollutants, but also the transport routes of those pollutants (see, e.g., Sharpley and Tunney 2000). Therefore, corrective actions to reduce watershed nutrient loading must take into account many site-specific factors, which can be elucidated only with accurate data. In particular, best management practices (BMPs) need to be properly planned and implemented, and may have varying degrees of appropriateness and effectiveness in different situations (see, e.g., Chang and Huang 2009; Tuppad et al. 2010).

Overlying these technical factors are economic resource issues that further complicate proper watershed nutrient management. Since many point sources have already been required to install controls to reduce their phosphorus discharges, further reductions from those sources can be difficult and costly—and, in the case of publicly owned treatment works, costs are generally passed on to water utility ratepayers. Additionally, these controls may not guarantee reductions sufficient to significantly affect water quality. Nonpoint nutrient management may offer a way to address watershed nutrient loading that is more cost-effective, at least from a societal perspective; however, such management is largely voluntary (Genskow 2012). Voluntary efforts exist, but the economics of nonpoint nutrient management practices—from the perspective of the individuals who would implement them—means that some of the most effective BMPs for reducing nutrient loading remain relatively unpopular and are not often implemented in reality. For example, vegetation buffer strips can significantly improve water quality, but can also take some agricultural land out of production (Qi and Altinakar 2011). Additionally, manure spreading as a method of waste disposal can easily lead to the loading of fields with excess nutrients, which eventually results in water quality impacts when those nutrients run or leach into surface waters (Sharpley et al. 2001). Manure storage is not economically feasible for many farms, however, and a lack of adequate storage facilities for waste on some farms can exacerbate those impacts by leading to practices such as winter spreading. Unless the economics of nutrient management change, economic incentives may be insufficient to improve nonpoint nutrient management.

Furthermore, recent trends placing increased pressures on both financial and land resources in the farming industry can result in additional hurdles to managing nutrient loading to surface waters. For example, dairies are moving toward the increased use of whole-crop corn silage as a way to maximize available acreage for feed production. This may preclude certain practices—such as the intensified use of grass and/or rotational grazing—that could otherwise provide phosphorus management and economic benefits (Rotz et al. 2002). These financial and resource pressures also make any measures that may take land out of production (e.g., vegetation buffer strips) increasingly difficult to implement. Other external factors, such as fuel costs, may also present barriers to proper nutrient management.

Adequate resources are therefore necessary to counteract local economic forces, to provide the necessary levels of experienced staff, and to help ensure that proper measures are implemented. One example of a watershed in which limited resources have hampered implementation is the Cascade Reservoir in Idaho. Efforts based on the total phosphorus total maximum daily load (TMDL) were initially successful, but rates of improvement have since slowed as a result of repealed funding, as noted by Benham et al. (2006, D17–18): "Availability of funding and BMP monitoring programs have been the key features behind the success of this project. However, recent cuts in funding have negatively affected stakeholder interest and slowed implementation."

Just as important as overcoming technical and economic barriers, local culture and relationships are critical issues in watershed health (Adams 2005); therefore, gaining local community buy-in is crucial. For example, farmers rely on private agronomists for nutrient management planning with the purpose of maximizing yields and profits. Under pressure to keep costs as low as possible, these agronomists may not recommend management practices that could improve water quality if they have any associated costs. When this dynamic is combined with the distrust that can exist at times—for example, between sources of nonpoint pollution and those responsible for ensuring water quality—it can lead to difficulties in designing, implementing, and monitoring improved management practices.

The importance of overcoming any potential distrust of water quality experts, such as watershed management staff, is accentuated by the complexity of proposed nutrient management measures. Proper nutrient management can be difficult to understand and implement (Genskow 2012). Education, implementation assistance, monitoring, and the ability to adapt practices throughout the watershed are therefore critical, and efforts to restore watersheds must involve local experts with relationships in the farming community, such as local conservation staff. These individuals must be recognized and accepted within the community; they also must be familiar with, and advocates of, appropriate practices. In the Central Big Sioux River Watershed Project, for example, some have noted that the owners and operators of feedlots were not provided with the level of personal attention needed to successfully implement BMPs (Strom 2010).

Another part of this significant cultural issue is related to the dynamics of local relationships and land management. For example, differences in land ownership and perceived responsibility for pollution can result in localized political scenarios that create hurdles for the effective implementation of improved management practices. These political scenarios must be taken into account for watershed management plans to be successful (Adams 2005). The importance of these circumstances is further magnified by the variations in nutrient loading potentials that can exist between different areas within a watershed as a result of hydrogeologic and other conditions, regardless of individual practices.

Finally, nonpoint sources remain a significant portion of nutrient loading to waterways because legal frameworks for regulating those sources are generally lacking or insufficient. The lack of effective policies and legal controls on nonpoint sources results in the underregulation or underenforcement of mandated nutrient management efforts, while systematic measures to effect voluntary change at those sources are critically underfunded. The myriad factors that have resulted in this situation are outside the scope of this article; however, the result is that the allocation of watershed management efforts is not efficient or effective. For example, the limitations that result from TMDL allocations determining acceptable pollutant discharges are enforced only on point sources, regardless of the portion of water quality impacts attributable to those sources. In the effort to reduce phosphorus loading in Lake Allegan, Michigan, Benham et al. (2006, D4) noted that, "getting more involvement and participation from nonpoint source groups, without regulations, is a continuing issue. Regulatory action to reduce phosphorus loads from nonpoint sources may be needed to force reductions necessary to meet the TMDL goal." Additionally, while providing local conservation staff to work with farmers may be the most effective means to ensure proper nutrient management, the lack of policies to require this can result in limitations on the oversight and enforcement of any existing regulations, such as nutrient management planning requirements. Without improved legal frameworks to better regulate runoff management, watershed restoration will continue to be difficult and expensive, with the result that watershed health will continue to suffer.

Wisconsin's Watershed Adaptive Management Option (WAMO), codified as Wis. Admin. Code NR 217.18, may address many of these issues. The remainder of this article provides an overview of WAMO, discusses how WAMO operates, and demonstrates why it will be successful in incorporating the elements that are critical to a successful water quality restoration strategy.

In late 2010, Wisconsin passed an innovative rule to address phosphorus pollution in water by creating flexible ways for point sources—holders of Wisconsin Pollutant Discharge Elimination System (WPDES) permits—to meet water quality standards. In developing the rule, the Wisconsin Department of Natural Resources (DNR) convened a diverse stakeholder advisory group to review proposed phosphorus numeric water quality standards as well as the implementing language, which describes the procedures by which permittees may meet the standards. Phosphorus is unlike many other pollutants regulated under the Clean Water Act. Most regulated pollutants come primarily from the regulated community, and water quality standards are usually met when the regulated community controls the discharge of the pollutant at issue. Phosphorus, however, is largely from nonpoint source runoff; in many cases, point source controls within the regulated community will not achieve water quality standards in a water body. Moreover, phosphorus technology controls can be extremely expensive, whereas phosphorus nonpoint controls can be relatively inexpensive and are typically more effective. Wisconsin's regulated community, environmentalists, and Wisconsin DNR staff worked to find a policy solution that would be cost-effective. In short, these groups wanted a rule that would allow permittees to achieve compliance with regulations via traditional methods, like updating pollution control technology, or nontraditional methods, like effectively restoring water quality in their watersheds through nonpoint source pollution controls.

Wisconsin's phosphorus rule is unique: it creates a system by which holders of WPDES permits can opt to avoid expensive technology costs in favor of more affordable solutions to address runoff. Instead of burdening ratepayers or customers with a high-cost technology that would not improve the community's water quality in any significant way, point sources can achieve permit compliance by using nonpoint source controls to ensure that the water body into which they discharge meets water quality standards.

WAMO is a compliance strategy wherein a permittee submits, along with its WPDES permit application or renewal application, a plan that identifies the sources of pollution in the watershed, the pollution reductions in the watershed required to achieve water quality standards, and how the permittee would achieve those reductions. If approved and implemented, a WAMO plan will be modified, or adaptively managed, by the WPDES permittee to achieve water quality standards. In effect, WAMO is a way for permittees to comply with phosphorus standards in a timely and cost-effective manner, taking into consideration the contributions of phosphorus from both point and nonpoint sources in a watershed. Point sources choosing WAMO will fund the reduction of nonpoint source runoff sufficient to restore water quality.

Incidentally, WAMO largely differs from water quality trading in Wisconsin; WAMO has a bottom-line requirement for WPDES permittees that the waters into which they discharge must, at the end of the WAMO plan period, meet water quality standards. To meet that requirement, permittees have the flexibility to find the means to do so. Trading, on the other hand, does not require a particular water body to meet water quality standards; it requires only that permittees offset their pollution by a calculated amount and that they do so within the very strict confines of the established DNR trading program.

Under Wisconsin's phosphorus rule, permittees who choose WAMO must demonstrate the following to receive approval from DNR to take this approach. First, either one-half or more of the phosphorus pollution in a waterway must come from the sum of nonpoint sources and municipal separate storm sewers, or the waterway must not be able to meet phosphorus water quality standards without the implementation of phosphorus nonpoint source controls. Second, water quality–based effluent limits for the permittee must not be achievable without filtration technology or an equivalent treatment technology.

If these conditions exist, permittees may submit a WAMO plan, which must contain the following:

- an analysis of the levels of phosphorus in the permittee's effluent and significant sources of point and nonpoint phosphorus loadings in the watershed;
- the identification of partners to implement the WAMO plan and their level of support for the plan, including the staffing or financial resources they would provide;
- the identification of specific actions that would lead to verifiable reductions in phosphorus pollution, sufficient to meet water quality standards;
- goals and measures for determining whether the actions identified in the plan are effective in achieving water quality standards; and
- an indication of the permittee's ability to fund and implement the plan, either individually or in conjunction with other partners, including contracts with partners.

The process of drafting a WAMO plan with appropriate information gathering, analysis, and coordination is expected to take between two and five years for many WPDES permittees, and can be divided into three phases: engaging with and coordinating stakeholders, collecting and evaluating data about pollution sources and potential controls in the watershed sufficient to achieve water quality standards, and planning the implementation of the watershed restoration project. These three phases are not necessarily chronological. For example, as planning occurs, a permittee may find that planned actions will restore wetlands in addition to reducing nonpoint phosphorus loading; in such a case, groups interested in wetlands restoration may be interested in joining the effort as partners. The subsections below describe these three phases in detail.

Phase I: Stakeholder Engagement

WPDES permittees who choose the WAMO as a permit compliance strategy must engage stakeholders as they develop their plans. Beyond meeting the requirements of the rule, engaging potential partners can build buy-in within the community and bring resources in the form of people or finances. These stakeholders may include federal, state, and local agencies; municipal stormwater utilities or stormwater districts; entities identified under a TMDL for phosphorus in the watershed; university water research departments; farmers and farming organizations; environmental organizations; land trusts; hunting and fishing organizations; community and business organizations; and community foundations.

To maximize stakeholder engagement, permittees should identify ancillary benefits of the WAMO plan, such as a streambank restoration effort that may attract environmental groups, or plans to vegetate buffer lands with biofuels that may draw renewable energy groups. As permittees identify ancillary benefits of the developing plans, they should use education and outreach to further incorporate stakeholders into an identified role in the structure of the plan.

Depending on the role of stakeholders, an organizational structure may be appropriate to bind them to the process in some way. In many watersheds, a memorandum of agreement acts as a contract clarifying the resources each stakeholder brings to the process, stakeholder deliverables, how the project is staffed, and how the project is funded.

Phase II: Data Gathering

Gathering data is a critical piece of WAMO plan development for two reasons: first, because the phosphorus rule requires certain data, and second, to allow permittees to ascertain significant inputs and major contributors in order to target phosphorus reductions to restore water quality. Additionally, it serves as a reiterative risk and cost assessment tool as permittees gain information about variables and gaps in information. WPDES permittees will need data on physical aspects of the watershed, including phosphorus inputs by sub-basin; landowners; nutrient management plans and records, as available; point source effluent discharge; existing phosphorus runoff controls; potential and expected impacts from climate change; and any nutrient modeling that has been done.

Much of these data will already be available from the county, DNR, the Wisconsin Department of Agriculture, Trade and Consumer Protection, the US Geological Survey, USEPA, universities, point sources, land trusts, and citizen monitoring groups. Existing watershed plans may have information to assist in understanding the history of the watershed, physical aspects, watershed priorities, and various restoration efforts that are in progress or planned. Many agencies have some form of GIS tracking of water quality, like Wisconsin DNR's Pollutant Load Ratio Estimation Tool (or PRESTO) database (Wisconsin DNR n.d.). If information for the watershed is insufficient, DNR may also require additional monitoring.

In many watersheds, a pilot project may be helpful as a small-scale test of what a full-scale watershed project would entail. Pilot projects can help test and establish the organizational structure, communication methods, relationships with the landowner community, pollution control planning and installation efforts, and funding mechanisms.

Phase III: WAMO Planning

Once data are gathered, the WPDES permittee develops the WAMO plan. This planning phase involves (1) choosing a series of phosphorus runoff reduction measures that will result in the achievement of water quality standards and (2) planning efforts to change the behavior of people in the watershed to ensure that the improvement in water quality is permanent. To identify the potential actions to achieve water quality standards, the permittee:

- examines available phosphorus runoff controls;
- uses various models to estimate load reductions expected from each potential strategy, along with their cost and ease of installation or implementation;
- develops monitoring plans;
- compares strategy options to other watershed priorities;
- chooses cost-effective pollution control strategies that will achieve water quality goals and will best address watershed priorities; and
- identifies tiers of less preferred options.

Part of selecting cost-effective phosphorus control strategies is understanding how to get landowners to install or implement and maintain controls. Landowners typically install or implement phosphorus controls either (1) once they understand the environmental and economic impacts of uncontrolled runoff, (2) after they receive financial resources to pay for the controls, or in some cases (3) only if the threat of enforcement looms or commences. While the education of individual landowners may be time-intensive and expensive, it can be much more cost-effective than cost sharing, and both education and cost sharing are generally more affordable than enforcement.

After identifying pollution controls, the permittee creates an implementation plan and timeline that describe the strategy for controlling phosphorus to meet water quality standards, monitoring plans and measurable goals, the roles of partners, and sources of funding. The few, but clear, requirements of WAMO provide permittees certainty in expected outcomes and enormous flexibility in choosing ways to reach those outcomes. Permittees may work through existing governmental structures, contract out much or all of the work, or take on a team of staff to manage it in-house. WAMO's flexibility will give permittees what they need to find the best way to restore the watershed to meet water quality standards. Hypothetically, perhaps in an area where local government may not have the resources or political support for water quality initiatives, a WAMO plan could be implemented entirely through contracts between point sources and farmers; in another area, point sources could provide resources to fund local conservation departments to manage much of the strategy with farmers. The permittee will need to establish some sort of legal framework that binds parties to commit the funding, resources, and policy work to implement the WAMO plan.

The monitoring plan specifically required by the phosphorus rule must indicate collection points and frequencies for water quality monitoring. After the initiation of monitoring, the rule requires permittees to use the monitoring results, combined with modeling, to show water quality improvements and BMP effectiveness as well as the timeline for achieving these improvements with specific milestones.

Funding sources can include funds from the permittee, federal Farm Bill and USEPA grants, state and local nonpoint source control grants, and contributions from nonprofit organizations (e.g., local community foundations, land trusts, hunting and fishing organizations, and other interested organizations). The funding plan should address not only the installation, long-term maintenance, and monitoring of land controls, but also the staff needed to (1) conduct outreach and education, (2) advocate for potentially necessary local-level policy changes, and (3) engage in enforcement activities if necessary.

Once DNR approves a WPDES permittee's WAMO plan, the plan is incorporated into the permit. Concurrent with the implementation of the WAMO plan, the permittee must optimize its facility to reduce phosphorus discharge and meet interim phosphorus effluent limits. Wis. Admin. Code §217.17(3)(b)(1). Further, point sources must submit annual reports to DNR on the execution of the WAMO plan, including progress on measurable goals. Wis. Admin. Code NR 217.18. DNR will track permittee progress based on measurable goals and will encourage or require modifications to the plan where adaptive management may be necessary.

Drivers for the Success of Wisconsin's Watershed Adaptive Management Option

One of the most important drivers for the successful use of WAMO is the constituency of point sources most likely to use it. The WPDES permittees most likely to choose WAMO are wastewater utilities because they are large phosphorus dischargers and would otherwise incur significant costs to meet discharge standards under the phosphorus rule. Having wastewater utilities driving WAMO plans is expected to be effective because:

- existing monitoring responsibilities mean that wastewater utilities understand how to properly obtain, coordinate, and evaluate watershed data;
- their ability to raise rates or to secure grants or loans ensures that they can generate resources for a watershed effort;
- duties to public commissions, ratepayers, and regulators mean that these permittees may have well-established relationships in the community by which to facilitate the recruitment and engagement of stakeholders, encourage community buy-in and the political will for effective policies, generate data, and develop successful runoff control strategies with landowners and farmers; and
- their ability to enter into contracts and pursue contractual or regulatory enforcement allows for a proper legal framework for implementing watershed restoration.

The capacity to generate accurate data, obtain resources, build community buy-in, and establish a political and legal framework means that wastewater utilities can overcome the issues that typically hamper watershed restoration efforts.

Another significant driver for WAMO's success is the permittee's own motivation for its WAMO plan to be successful. The plans and requirements for WAMO are incorporated into DNR-issued point source permits; the permittee's compliance under WAMO hinges on whether the waterway into which it discharges achieves water quality standards for phosphorus by the end of the WAMO plan period. If the waterway does not achieve phosphorus water quality standards, the permittee will need to limit its discharge of phosphorus significantly. For most point sources, meeting the applicable reductions in phosphorus discharge would require the installation of membrane filtration technology, which is very expensive. Thus, because point sources choosing WAMO would be liable for the achievement of water quality standards by the applicable water body, and because the penalty for failing to do so would require the installation of expensive control technology, point sources choosing WAMO will be highly motivated to ensure that phosphorus water quality standards are met.

Another driver behind WAMO is that its environmental, cultural, and economic benefits should generate widespread support. The ancillary benefits of phosphorus runoff controls—such as increased habitat from vegetated buffers or groundwater recharge from runoff-prevention practices that cause infiltration—can have positive impacts on the environment aside from water quality improvement; such impacts can engage the larger environmental community. Furthermore, the data collection and analysis necessary for WAMO plan development may serve to catalyze coordination between public and private entities, building opportunities for involving those interested in better soil science, limnology, local policy, and more.

Conclusions

In conclusion, WAMO incentivizes phosphorus-discharging WPDES permittees to take on the burden of watershed restoration when doing so is preferable to traditional permit compliance strategies. Permittees using WAMO will be motivated to be successful because failure will require them to bear a much larger burden—namely, the achievement of restrictive phosphorus effluent limits, which will require the installation of very expensive technology. In this way, WAMO will overcome the technical, economic, social, and political difficulties that are often the culprits responsible for failed watershed restoration projects.

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Challenges of Achieving Watershed Goals in a Changing Agricultural Environment

Roger T. Bannerman[a]

Abstract

A comprehensive watershed plan, prepared more than 20 years ago for Wisconsin's East River Priority Watershed Project, contained all the key elements for the successful control of nonpoint sources of pollution. These elements included descriptions of the pollutant sources, water quality goals, the identification of best management practices (BMPs) eligible for cost sharing, an implementation plan, and a monitoring plan to evaluate project effectiveness. The Wisconsin Department of Natural Resources selected the Bower Creek subwatershed for implementing the monitoring plan. The watershed project was expected to reduce the phosphorus load in this primarily agricultural drainage area by 70% and the sediment delivery by 50%. After years of monitoring during the pre- and post-BMP periods, the results indicate that implementation of the watershed plan did not achieve any significant reductions in storm loads for phosphorus, sediment, or ammonia nitrogen.

It appears that more or different types of BMPs are needed to achieve storm load reduction goals for the existing agricultural activities. Although many BMPs, such as various barnyard runoff controls and nutrient management plans, were implemented in the subwatershed, they were not enough to compensate for the change in farming practices during the project period. The most important changes in farming practices were a shift toward much larger dairy herds on fewer farms and increased milk production for each animal. These changes led to less conservation-oriented cropping practices and increased manure production. Future efforts at nonpoint source control in this subwatershed should focus on management of the robust network of drain tiles, protection of areas of concentrated flow, and better implementation of nutrient management plans.

Introduction

Nonpoint source contamination is a major contributor to water resource quality problems in Wisconsin. In recognition of the importance of nonpoint sources, the Wisconsin Nonpoint Source Water Pollution Abatement Program (Nonpoint Program) was established in 1978. When first introduced, the Nonpoint Program identified problems in 130 of Wisconsin's 330 watersheds. The 130 watersheds identified as part of the WI Nonpoint Program were called priority watersheds projects. For each watershed, the Nonpoint Program offered funding support for various voluntary best management practices (BMPs). The sizes of the drainage areas generally ranged from 259 to 518 km^2. To help support the appropriate use of the funds, comprehensive watershed plans were prepared by the Wisconsin Department of Natural Resources (WDNR); Wisconsin Department of Agriculture, Trade, and Consumer Protection; and local agencies, such as counties and planning commissions. These plans contained all the key elements to successfully select and implement BMPs for each watershed. With a special focus on the needs of the receiving waters, the key elements included descriptions of the pollutant sources, water quality goals, the identification of BMPs eligible for cost sharing, an implementation plan, and a monitoring plan to evaluate project effectiveness.

The purpose of the Nonpoint Program was to achieve water quality benefits in the receiving waters, rather than to demonstrate BMP effectiveness. To demonstrate the effectiveness of BMPs for improving water quality in Wisconsin's priority watersheds, WDNR and the US Geological Survey (USGS) developed and began a comprehensive, multidisciplinary evaluation monitoring program in water year 1989 (Wierl et al. 1996). This monitoring program, called Whole-Stream Monitoring, included biological and stream habitat monitoring by WDNR and water quality monitoring by USGS. For this extra-intensive evaluation monitoring program, WDNR and USGS chose six subwatersheds from four of the priority watersheds. These subwatersheds were chosen because they had the potential for significant improvement, according to WDNR and County Land Conservation District personnel, and because BMPs were scheduled to be installed within the project time frame. Results from five of these subwatersheds—Brewery and Garfoot creeks in the Black Earth Creek priority watershed (Graczyk et al. 2003), Otter Creek in the Sheboygan River priority watershed (Corsi et al. 2005), and Joos Valley and Eagle creeks

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in the Waumundee River priority watershed (Graczyk et al. 2012)—were published previously.

The sixth subwatershed is within the 383–km2 East River priority watershed (WDNR 1993), which drains directly into the Fox River near the city of Green Bay, Wisconsin. WDNR (1993) classifies Bower Creek, a 110–km2 subwatershed near DePere, Wisconsin, as a warm-water forage stream that has the potential to maintain a forage fish population. WDNR and USGS selected the Bower Creek subwatershed as a whole-stream monitoring site because the fisheries habitat is degraded by sedimentation, and water quality sampling conducted in 1988 found relatively high concentrations of pollutants (phosphorus, biochemical oxygen demand–5, and bacteria; Hughes 1988). The high phosphorus levels are a concern not only to Bower Creek, but to the receiving waters of the East River and Green Bay. Based on calculations done during the preparation of the watershed plan, the Bower Creek subwatershed is the largest contributor of phosphorus and the second-largest contributor of sediment in the East River watershed (WDNR 1993). The BMPs recommended in the East River priority watershed plan were designed to reduce the phosphorus load to Bower Creek by 70% and the sediment load by 50%.

To document the level of phosphorus and sediment reduction achieved in the Bower Creek subwatershed during the East River Priority Watershed Project, WDNR and USGS collected stream flow and water quality data in the pre- and post-BMP period, including both baseflow and storm event samples. Although changes in ammonia nitrogen concentrations and flow were not targeted as goals for the project, we needed the flow data for load calculations and any changes in the ammonia nitrogen concentration might reflect benefits of better manure management. The pre-BMP implementation period was between 1990 and 1994, and the post-BMP implementation period was between 2006 and 2009. Given the high cost of monitoring and the relatively small chance of observing small changes from year to year, we did not sustain the monitoring on an annual basis between the pre- and post-BMP periods. We compared and contrasted pre- and post-BMP concentrations of total suspended solids, total phosphorus, and dissolved ammonia nitrogen in samples collected at baseflow and during storm events.

Physical Setting and Land Use

Bower Creek drains 38.3 km^2 upstream of the stream gaging station; the total length of the stream channel, which is all intermittent channel, is 59.7 km from the station to the stream headwaters. Total land use and land cover for Bower Creek at the beginning of the study is shown in Figure 1. In the Bower Creek subwatershed, cropland (83.1%) dominated the land use and land cover, and woodlots (6%) were the next-greatest land use and land cover. In all, 115 farms were included or partially included in the Bower Creek subwatershed. The average farm size was 48.6 ha, with an average of 33.6 ha in crop production. The subwatershed included 41 barnyards, with an average herd size of 118 animals, of which 97% were dairy cows (Rappold et al. 1997). According to the Brown County Land and Water Conservation Department, the numbers of livestock in the subwatershed and the cropland percentage have not changed substantially throughout the monitoring period, but exact numbers were not available. The soil types in the Bower Creek subwatershed vary spatially and consist mainly of silt loams to silty clay loams. These soils are poorly drained unless a tile system, a network of below-ground pipes that removes excess water from the soil subsurface, is used (Link et al. 1974).

Targeted and Implemented BMPs

Table 1 summarizes targeted and implemented BMPs for the Bower Creek subwatershed. Brown County determined the initial BMP targets based on an assessment of potential water quality influences in Bower Creek (WDNR 1993). The county used inventory data collected between 1988 and 1989 in the Wisconsin Barnyard Runoff model (Baun 1992) and the Wisconsin Nonpoint Source model (Baun and Snowden 1987) to determine the sources of phosphorus and sediment, respectively. The data also included the locations and degrees of streambank erosion. Figure 2 shows the status of animal waste management and streambank protection practices as of 2009.

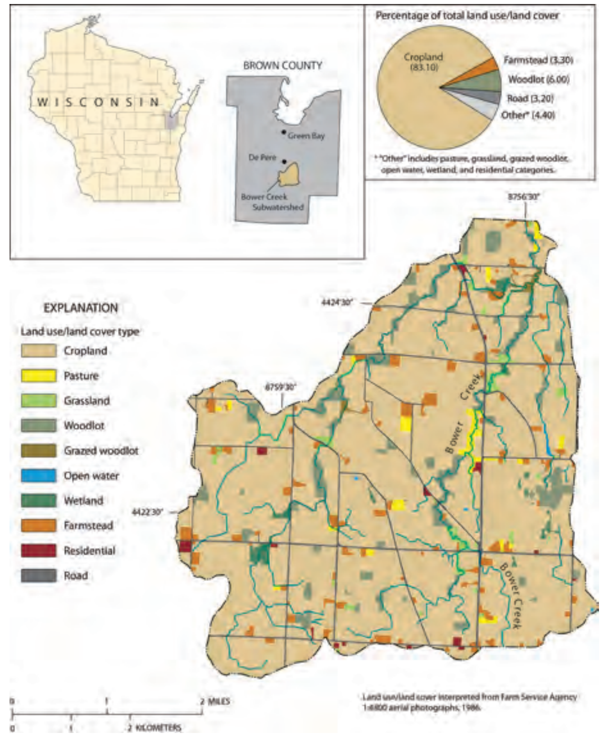

Figure 1. Land use and land cover in the Bower Creek subwatershed, Brown County, Wisconsin.

Table 1. Summary of targeted and implemented rural BMPs in the Bower Creek subwatershed, Brown County, Wisconsin.

Management Practice	Targeted	Implemented
Animal Waste Management		
Manure storage (no. facilities)	9	7 [a]
Barnyard runoff control systems (no. facilities)	32	16
Milkhouse wastewater treatment (no. facilities)	2	2
Streambank Protection		
Stream shaping, seeding, and riprap (m)	707.1	613.6
Fencing (m)	190.5	190.5
Stream crossing (no. crossings)	1	1
Grade stabilization (structures)	0	1
Buffer strips (ha)	0	6.6
Upland Management[b]		
Nutrient management (ha)	1,626.8	784.7
Upland BMPs (ha)	1,813.0	632.9

[a] Seventeen other manure storage facilities were implemented by previous farm programs.
[b] Upland BMPs include a change in crop rotation, reduced tillage, critical area stabilization, grass waterways, and pasture management.

Water Quality before and after Installation of BMPs

The primary objective of this study was to evaluate overall BMP effectiveness at the subwatershed scale. We evaluated changes in water chemistry before and after BMP installation using data from baseflow sampling as well as from storm loads (Corsi et al. 2012). We used land use data to interpret the results of these analyses and to help understand the effects of individual types of BMPs.

Pre- and Post-BMP Implementation Baseflow Concentrations

Baseflow in Bower Creek consists of groundwater contributions, including those from drain tiles. The water quality sample results for baseflow concentrations therefore reflect groundwater discharges, direct surface influences, and instream processes. WDNR and USGS collected fixed-interval water quality samples throughout the pre- and post-BMP implementation periods. We collected a total of 44 samples during baseflow conditions for total suspended solids, 44 for total phosphorus, and 41 for dissolved ammonia nitrogen during the study (Figure 3).

We used statistical analyses (Wilcoxon rank-sum tests) to test for differences between baseflow samples collected during the pre- and post-BMP implementation periods (Helsel and Hirsch 1992). Results indicate a significant reduction at the 95% confidence level between pre- and post-BMP baseflow concentrations for total phosphorus, but not for total suspended solids or dissolved ammonia nitrogen (Table 2). The lack of a significant change in ammonia nitrogen concentrations during baseflow in Bower Creek is similar to results from all but one (Garfoot Creek) of the other whole-stream monitoring sites.

Figure 2. Animal waste management and streambank protection BMPs implemented during the study period in the Bower Creek subwatershed, Brown County, Wisconsin. 1 mile ≈ 1.6 km.

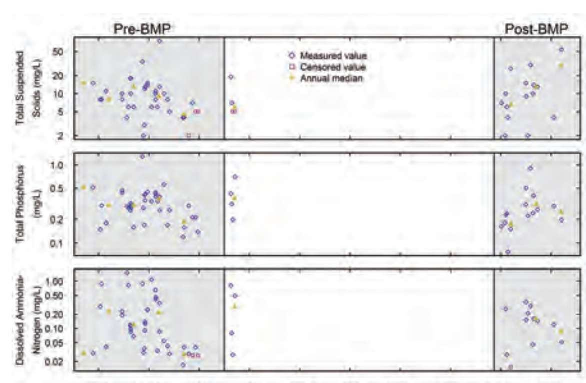

Figure 3. Concentrations and water–year medians of total suspended solids, total phosphorus, and dissolved ammonia nitrogen in baseflow samples throughout the study period at Bower Creek, Brown County, Wisconsin.

Pre- and Post-BMP Implementation Storm Loads

Because much of the annual transport of total suspended solids and nutrients occurs during storms, fixed-interval sampling—particularly at a monthly interval—may not show changes resulting from BMP implementation (Walker 1993). The percentages of the annual total suspended solids, total phosphorus, and ammonia nitrogen loads occurring during storms were about 92%, 79%, and 64%, respectively, for Bower Creek (Corsi et al. 2012). Consequently, we computed mass transport resulting from individual storms and used this in the final storm load analysis. The storm loads also became the basis for judging how well the watershed project achieved the pollutant reduction goals.

For total suspended solids and total phosphorus, median storm loads from rainfall periods decreased. For dissolved ammonia nitrogen, median storm loads increased. Testing the storm load residuals demonstrates that these changes were not statistically significant for any of the constituents at the 95% confidence level (Table 3). Therefore, the differences in pre- and post-BMP conditions are probably not due to the BMPs installed; they are more likely due to natural variability from variable hydrologic or seasonal conditions. The watershed goals of a 70% reduction in phosphorus loads and a 50% reduction in

Table 2. Results of Wilcoxon rank-sum tests for differences between constituent concentrations in baseflow samples from pre- and post-BMP implementation periods at Bower Creek, Brown County, Wisconsin.

Response Variable	No. Samples for pre-/post-BMP Periods	Median Concentration (mg/L)		
		Pre-BMP	Post-BMP	Significance Level
Total suspended solids	29/15	10.0	10.0	0.691
Total phosphorus	29/15	0.340	0.235	0.0258
Dissolved ammonia nitrogen	29/12	0.139	0.149	0.398

Table 3. Median and mean rainfall period storm loads and results of the Wilcoxon rank-sum test comparing storm load residuals for pre- and post-BMP periods at Bower Creek, Wisconsin.

Variable	Median Storm Loads		Mean Storm Loads		Storm Load Residuals
	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP	Significance Level
Total suspended solids (metric tons)	17.2	8.6	137	95.3	0.5508
Total phosphorus (kg)	103.4	83.9	358.3	241.8	0.91
Dissolved ammonia nitrogen (kg)	26.8	65.8	118.4	73.9	0.61

sediment loads were not achieved with the BMPs installed during the course of this study. This unexpected conclusion may be explained by the changing agricultural environment for the Bower Creek subwatershed because changes in agricultural practices may mask the benefits of these BMPs.

Effects of Management Practices on Bower Creek

Landowners implemented many BMPs in the three major categories targeted in the Bower Creek subwatershed (Table 1). In the animal waste category, about 70% of the targeted manure storage and 50% of the barnyard runoff control systems were implemented. Installation of the barnyard runoff control systems provided the extra benefit of controlling most of the animal access to the stream channels since livestock in or adjacent to feedlots previously accessed the Bower Creek stream channel. All targeted streambank fencing, shaping, and seeding listed under the streambank protection category was completed during the project period. A new county ordinance requiring 6.1- to 10.7-m riparian buffer strips resulted in over 6.5 ha of riparian buffer strips. In the upland management category, most of the farms prepared nutrient management plans and they implemented almost 50% of the upland BMPs. A description of the individual BMPs and their potential effects on water quality has previously been published (Graczyk et al. 2003).

Influence of BMPs on Water Quality

Despite the implementation of many BMPs in the Bower Creek subwatershed, the sampling results provide no evidence of substantial improvement in most measures of water quality. Baseflow concentrations were significantly reduced after BMP implementation for total phosphorus, but not for total suspended solids or ammonia nitrogen. Storm loads after the implementation of BMPs did not differ significantly from those observed before implementation began. With such unexpected results, one should always question the sampling approach, but this cost-effective sampling of concentrations pre- and post-BMP implementation has demonstrated improvements for other sites. At the five other streams included as whole-stream monitoring projects, pollutant concentrations during baseflow and storms declined significantly after BMP implementation (Graczyk et al. 2003.; Corsi et al. 2005.; Graczyk et al. 2012). Although not as robust as a paired site design (Clausen and Spooner 1993), the higher cost and difficulty of maintaining a control site over 20 years precludes the use of such an approach in Bower Creek.

Understanding the influences of specific pollutant sources in a watershed is a complex task. Important factors to consider include the land use, topography, condition of the land, proximity to the stream, the likelihood that runoff from a given area will reach the stream under different conditions, the BMPs installed, the effectiveness of the BMPs, human actions that impact drainage, and other factors. Typically, support for watershed managers is not sufficient to enable a detailed inventory of all of these factors, so a substantial amount of uncertainty exists in the evaluation of source influences on water quality. Given these uncertainties, it is difficult to explain why this level of BMP implementation did not do more to improve water quality in Bower Creek. For the purpose of improving BMP implementation efforts in the future, we explore below the potential reasons why we did not observe improvements in baseflow concentrations and storm loads for the Bower Creek subwatershed.

Influence on Baseflow Concentrations

Results from other monitoring projects in Wisconsin agricultural watersheds might help explain the lack of response in the baseflow concentrations of ammonia nitrogen and total suspended solids. Total suspended solid concentrations measured during baseflow conditions dropped significantly during the post-BMP period for three of the other five whole-stream monitoring sites. Those three sites are characterized by pre-BMP concentrations in the baseflow of about 40 mg/L compared to 10 mg/L in Bower Creek (Graczyk et al. 2003; Corsi et al. 2005; Graczyk et al. 2012). Targeted BMPs in those other subwatersheds also included much more streambank fencing and protection than were targeted for Bower Creek. The implementation of streambank protection and fencing in Bower Creek might be expected to have less of an impact on baseflow total suspended solid concentrations because cows in the stream were not a problem in the first place.

All but one of the other whole-stream monitoring sites showed no significant change in ammonia nitrogen concentration during baseflow. It is not clear why the commonly used BMPs, such as nutrient management, do not control this dissolved pollutant during baseflow. In contrast to total suspended solids, the main source of ammonia nitrogen is most likely groundwater during baseflow. A large number of drain tiles have been installed in the Bower Creek subwatershed; this could be an important system for delivering total phosphorus and ammonia nitrogen to Bower Creek during nonevent periods. Results from drain tile monitoring for the Discovery Farms program in Wisconsin indicated that drain tiles can flow all year long and contribute substantial amounts of total phosphorus and ammonia nitrogen to receiving streams (Cooley et al. 2010). BMP implementation in the Bower Creek subwatershed did not focus on the reduction of nonevent flows from drain tiles.

The results from the other whole-stream monitoring sites do not help explain why a significant reduction in total phosphorus baseflow concentrations was observed for Bower Creek. Out of the other five sites, only Joos Valley and Eagle Creek subwatersheds had significant reductions in baseflow total phosphorus concentrations (Corsi et al. 2012). One factor might have been the unusually high total phosphorus concentrations during baseflow. Results from the five other whole-stream monitoring sites indicate that median total phosphorus baseflow concentrations during the pre-BMP period at those sites ranged from 0.07 to 0.15 mg/L, compared with a much higher median of 0.34 mg/L at Bower Creek (Graczyk et al. 2003; Corsi et al. 2005; Graczyk et al. 2012). Another possible factor needing more evaluation is that the nutrient management practices, such as proper manure application rates, may have a greater impact on the amount of total phosphorus reaching the groundwater or drain tiles than on the amount of ammonia nitrogen. The post-BMP median baseflow concentration of 0.235 mg/L at Bower Creek is still much higher than the 0.075 mg/L targeted for streams of this size (Robertson et al. 2006).

Influence on Storm Loads

Unlike baseflow concentrations, storm loads are more a consequence of sources activated by runoff events. These sources include upland areas, barnyards, woodlots, eroding streambanks, and drain tiles. Results from monitoring small watersheds in the Southeastern Wisconsin Till Plains ecoregion indicate that Bower Creek had the second-largest annual median total suspended solids (out of 14 sites) and total phosphorus (out of 12 sites) unit area loads at 48.9 ton/km^2 and 120 kg/km^2, respectively (Corsi et al. 1997). As mentioned above, storm loads accounted for 92% of total suspended solid loads in Bower Creek, 79% of total phosphorus loads, and 64% of ammonia nitrogen loads throughout the study period (Corsi et al. 2012). Such high storm loads would seem to make it easier to observe some reduction as a result of BMPs, but it also means that targeting the sources with the largest storm loads is more important. All of the above sources must be considered when evaluating the potential reasons why the management practices did not significantly reduce the storm loads in the Bower Creek subwatershed.

Two main factors may explain why storm loads were not reduced: (1) milk production has become more intensive in the watershed and (2) the existing BMPs did not address all of the sources. In the approximate time frame of the monitoring activities (1981 to 2008), the number of cows in Brown County increased only slightly, but average milk production grew from 5,987.4 to 10,115.1 kg/cow/year. Because milk production increased so substantially, manure production also increased (US Department of Agriculture, Natural Resources Conservation Service 2009); therefore, field applications of manure must have increased through the study period. In the same time frame, the number of herds in Brown County declined from 1,348 to 239, indicating that manure was concentrated on fewer farms. According to Brown County records, these county-wide trends also apply specifically to Bower Creek. Dairy farming in Brown County is following the national trend of creating ever-larger dairy herds, with thousands of dairy cows potentially concentrated on one farm. In addition, changes in cropping practices have resulted in less erosion protection and less ground cover over the winter. The altered cropping practices include (1) more land in soybeans, corn, and wheat; (2) less land in hay and other cover crops; (3) less conservation tillage; (4) oats eliminated as a crop; and (5) more land in corn silage. Between 1981 and 2008, the land used for growing soybeans in Brown County increased from 80.9 to 9,665 ha, and the land used for growing hay declined from 74,000 to 61,000 acres. With these increases in manure production and changes in cropping practices, one may have expected storm loads to increase during the monitoring period; instead, storm loads did not change significantly over the study period. It appears that the potential increase in pollutant storm loads due to the transition to less protective cropping practices and a higher concentration of cows might have been offset by the implementation of BMPs targeted in the watershed plan.

Determining whether the implemented BMPs actually prevented a degradation of water quality as a result of these changes would require additional data. But similar sets of BMPs implemented in other whole-stream monitoring sites have produced measurable reductions in phosphorus and sediment storm loads (Corsi et al. 2005; Graczyk et al. 2012). It is reasonable to speculate that a measurable reduction would have been observed in Bower Creek without the changes in the agricultural environment.

Given the water quality results obtained in this study, it appears that more and different types of BMPs are needed to achieve the storm load reduction goals in the watershed plan. Many of the future BMPs will have to be adjusted to target the existing agricultural activities. Previous management efforts in Bower Creek achieved a relatively high level of implementation of animal waste management BMPs, but 50% of the targeted barnyard runoff control measures were not implemented. In addition, substantial targeted areas remain for future implementation of upland management BMPs (Table 1). Soil test phosphorus values (50 to more than 100 ppm) for a number of fields in the Bower Creek subwatershed pose an increased likelihood for phosphorus loading contributions to Bower Creek from upland erosion (Kelling et al. 2003). Many farms have nutrient management plans in place, but some have not been fully implemented because of concentrated flow areas—such as dead furrows (plowed trenches meant to help drain fields more efficiently) and fields without grassed waterways—that have not yet been addressed (Figure 4). Brown County staff feels that it may be beneficial to review how well these nutrient management plans are being implemented.

Figure 4. Example of a dead furrow in the Bower Creek subwatershed, Brown County, Wisconsin.

An additional upland pollutant source that probably needs more consideration and management is the robust network of drain tiles within the subwatershed. This drainage system enhances the efficiency of runoff and allows farmers to work in fields earlier in the growing season than without the drain tiles; however, their use also results in an efficient system that transports pollutants directly to the stream. Previous monitoring of agricultural drain tiles through Wisconsin's Discovery Farms program in Kewaunee County determined that 34% of the annual total phosphorus load and 25% of the sediment load from the monitored fields was delivered through the drain tiles (Cooley et al. 2010). Ammonia nitrogen loads are significant during periods of frozen ground, because it is too cold in the spring for nitrification to occur (Cooley et al. 2010). This indicates that substantial reductions in storm loads may be possible in Bower Creek with management of drain tile discharges. The other whole-stream monitoring sites might also benefit from better management of drain tile discharges, but information on drain tile coverage and extent is not available for the other sites. Future work at Bower Creek will explore means of reducing the concentrations of ammonia nitrogen and phosphorus in drain tile effluents; the successful reduction of pollutants will probably depend on a combination of better implementation of nutrient management plans and the installation of end-of-the-pipe controls, such as flow control valves, on the drain tiles with larger flows. Flow control valves on the drain tiles would restrict discharges in the spring when flows are high; the valves could be opened to lower the groundwater levels when the growing season begins.

Summary and Conclusions

As part of Wisconsin's Nonpoint Program, state and local agencies prepared a comprehensive watershed plan for the East River priority watershed near the city of Green Bay. Based on inventories and the results of runoff models, pollutant reduction goals were selected for each of the subwatersheds. To evaluate the effectiveness of the targeted BMPs to achieve the pollutant reduction goals, WDNR selected Bower Creek subwatershed for a comprehensive monitoring program. For this subwatershed, the total phosphorus and sediment reduction goals were 70% and 50%, respectively. WDNR and USGS collected flow measurements and water quality samples in the pre-BMP period (1990 to1994) and the post-BMP period (2006 to 2009). Despite the implementation of many of the BMPs targeted in the watershed plan, such as barnyard runoff controls and streambank fencing, the monitoring results did not show any significant reduction in the storm loads of total phosphorus, sediment, or ammonia nitrogen. Since the storm loads represent a large percentage of the annual load of each pollutant, the pollutant reduction goals were not achieved after almost 20 years of BMP implementation. WDNR and USGS evaluated changes in baseflow concentrations, but found a significant reduction only in total phosphorus concentrations. Implementation of all targeted BMPs could have helped achieve a significant reduction; however, the changing agricultural environment in the subwatershed might have played a larger role in the failure to achieve the reduction goals because such changes could require the use of different BMPs.

A concentration of approximately the same number of dairy cows on fewer farms and a large increase in the milk production by each cow has changed the agricultural environment in the Bower Creek subwatershed. Not only is the spreading of manure more concentrated, but the amount of manure each cow produces is greatly increased.

In addition, farms in this subwatershed shifted toward cropping practices that provide less protection from erosion. It is possible that these changes somewhat offset the effects of implementing the targeted BMPs in the original watershed plan.

Reasonable goals were selected in the East River Priority Watershed Project based on agricultural practices in the early 1990s. To meet the challenges of a changing agricultural environment, an updated watershed plan would have to keep some focus on existing targeted BMPs, such as upland practices, but increase the emphasis on nutrient management and recommendations for controlling pollutants in drain tile effluent. Improved implementation of nutrient management plans would have to put special emphasis on controlling unaddressed areas of concentrated flow, such as dead furrows. Reducing the pollutant concentrations discharged from drain tiles would help reduce loads to the stream for storms and baseflow.

Acknowledgments

Support for this study included contributions from WDNR and USGS. The author especially thanks Steve Corsi, Judy Horwatich, and Troy Rutter at USGS who performed the extensive field work, reduced the data into usable formats, helped with data interpretation, and provided review comments. The author also thanks Bill Hafs, Jon Bechle, and other staff at the Brown County Land and Water Conservation Department who provided land use data, communication with land owners, and input on the interpretation of final results. In addition, the author thanks David Graczyk, John Walker, David Housner, Daniel Olson, and other colleagues at USGS and WDNR for their work throughout the project.

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Ohio Balanced Growth Program

Through the Ohio Balanced Growth Program, the State of Ohio and participating local governments are working together to achieve healthy watersheds, economies, and communities. The program, which uses watersheds as the key organizing feature for land use planning, follows a voluntary, incentive-based strategy to protect and restore Lake Erie, the Ohio River, and Ohio's watersheds as a way to ensure long-term economic competitiveness, ecological health, and quality of life (Figure 1).

The Ohio Lake Erie Commission led the initial development of the Balanced Growth Program, which was piloted in the Lake Erie watershed in 2004–2008. In 2009, the Ohio Water Resources Council expanded the program statewide. The goal of the program is to link land use planning to the health of watersheds and major water bodies. As of May 2012, a total of 16 watersheds in both the Lake Erie and Ohio River drainage areas, covering 5,760 km^2, were participating in the program, with each of 131 local communities supporting a watershed balanced growth plan for its watershed (see Table 1). The state endorsed six new plans in 2012 alone.

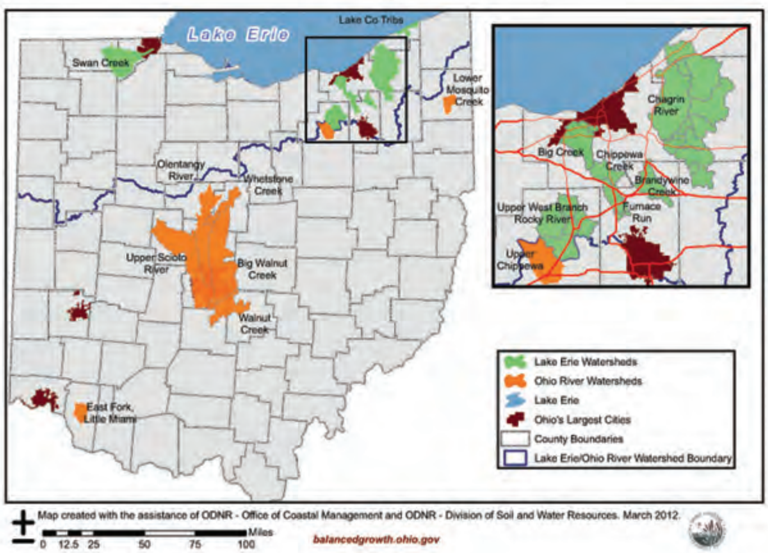

Figure 1. Balanced growth planning partnership watersheds. ODNR, Ohio Department of Natural Resources; 1 mile ≈ 1.6 km.

The Balanced Growth Program works through the establishment of local watershed planning partnerships (WPPs) and endorsement from the State. Partners in each WPP include local government representatives who receive input from regional planning organizations, nongovernmental organizations, county metroparks, federal parks staff, business organizations (such as homebuilders associations), local farm bureaus, interested local citizens, district state agency staff, and others. The WPP works toward the development and implementation of a watershed balanced growth plan, which among other elements must contain maps of priority development areas (PDAs), priority conservation areas (PCAs), and priority agricultural areas (PAAs) based on specific measurable criteria; these maps will support watershed-based land use planning and project implementation. A watershed balanced growth plan is a framework for coordinated, local decision making about how growth and conservation should be promoted by local and state policies and investments in the context of watersheds. The local role is to work toward the development, adoption, and implementation of the plan; the State's role is to support the local government effort and be responsive to the resulting State-endorsed plan. Once the State has endorsed a plan, the local community is eligible for state incentives to assist with plan implementation, including both financial and technical support. For example, 26 state programs include special consideration for Balanced Growth participating communities in the form of grants, loans, tax credits, technical assistance, and regulatory programs. (A Balanced Growth participating community is one that has passed a resolution of support for a watershed balanced growth plan that has been endorsed by the State.)

Activities within the program fall into two broad categories: local activities geared toward planning and implementation, and state activities in support of the program. A summary of the status of Balanced Growth activities follows.

Local Implementation Activities in Endorsed Watersheds. Of the 16 watershed balanced growth plans prepared by WPPs, 11 are in the implementation phase of the process following endorsement by the State. Ongoing implementation includes (1) activities funded by grants from the Lake Erie Protection Fund in the Swan Creek watershed (title: Swan Creek Urban BMP Inventory & Assessment; awardee: Toledo Metropolitan Area Council of Governments), (2) efforts in the Big Creek watershed (title: Big Creek Watershed Stormwater Retrofit Ranking; awardee: Friends of Big Creek), and (3) work in the Chagrin River watershed (title: Great Lakes Mall Green Infrastructure Program; awardee: City of Mentor). Friends of Big Creek has also used other funding to facilitate

Table 1. Balanced Growth Program participating watersheds.

Drainage	Watershed	Area (km²)	Final Support Communities[a]	Total Population
Lake Erie	Chippewa Creek	44	3	18,993
	Swan Creek	528	20	112,538
	UWB Rocky River	181	8	98,169
	Chagrin River	691	28	269,879
	ELCCT	78	7	20,641
	Furnace Run	52	6	8,483
	Big Creek	101	5	168,928
	Brandywine Creek	67		21,688
	Subtotal	1,742	77	719,319
Ohio River	Olentangy River	963	27	277,439
	Upper Chippewa Creek	114	9	12,046
	Lower Mosquito Creek	106	9	46,699
	Middle East Fork	145	9	19,181
	Upper Scioto River	1,165		414,867
	Walnut Creek	388		45,019
	Big Walnut Creek	974		477,203
	Whetstone Creek	163		12,497
	Subtotal	4,018	54	1,304,951
Total		**5,760**	**131**	**2,024,270**

Notes: ELCCT, Eastern Lake County Coastal Tributaries; UWB, Upper West Branch.
[a] Empty cells indicate that watershed balanced growth plans are under development, with final support communities to be determined at a later date.

the purchase of property along the creek corridor identified in their plan as PCA, and the Clean Ohio Revitalization Fund has provided funds to clean up a PDA in Toledo's Swan Creek watershed.

Local Watershed Planning Projects in Progress. Five WPPs are currently in the planning process: Brandywine Creek in the Lake Erie watershed, and Upper Scioto River, Big Walnut Creek, Walnut Creek, and Whetstone Brook in the Ohio River watershed. A sixth new WPP forming in the Upper Cuyahoga River (Lake Erie) watershed—which is dominated by the City of Akron in population and area—will be led by staff from the Northeast Ohio Four County Regional Planning and Development Organization. Once this WPP has formed, Balanced Growth Program staff will meet with the group to help kick off their process. The Cuyahoga River Community Planning Organization will also assist the group. The addition of this partnership will bring the total number of WPPs in the Lake Erie watershed to 9 and the total across the state to 17.

The Walnut Creek watershed's balanced growth plan is in the late stages of development; a draft has been provided for state staff review. This WPP is led by the Mid-Ohio Regional Planning Commission. The Big Walnut Creek plan will be next, and then the Upper Scioto River plan. Currently, a series of public meetings are being held to support plan development. The Mid-Ohio Regional Planning Commission, which is administering the WPPs, will be seeking formal resolutions of support for these plans from the local communities through 2012.

State Assistance Work Group/State Activities. The updated *Ohio Balanced Growth Strategy*, adopted by the Ohio Lake Erie Commission on December 21, 2011, was adopted by the Ohio Water Resources Council at its meeting on February 21, 2012. This version of the strategy expands the program statewide, incorporating the previous planning framework and strategy into one document, and updates the state action items for implementation of the program. One of the key action items in the strategy is for the participating state agencies to continue to augment state incentives. The final document is available on the Balanced Growth Program's website.

Balanced Growth Best Local Land Use Practices. In place since 2006, the Ohio Balanced Growth Program's Best Local Land Use Practices Program provides education, technical assistance, and resources to local communities, encouraging them to adopt recommended zoning and land use practices. Training sessions on these practices have reached more than 1,600 individuals since program inception.

Participants have been able to see and appreciate direct local benefits, such as improvements in stormwater/ flood management, protection of areas suitable for conservation,…

The recently updated *Best Practices* document (2012) provides guidance on the best local land use practices for (1) minimizing the impacts of development on water quality wherever the expansion of developed areas occurs and (2) reducing impacts to water quality in redevelopment situations. The document includes a set of example zoning ordinances and resolutions recommended for voluntary adoption by local communities, a set of guidance documents for the best practices, and training opportunities for local elected officials and staff. Guidance documents address comprehensive planning; conservation development; compact development; stream, wetland, and floodplain protection, stormwater management and erosion and sediment control; source water protection; agricultural lands protection, tree and woodland protection, scenic protection; historic preservation; steep slopes protection; transfer of development rights; brownfields redevelopment; and access management. Supplementary marketing materials are also under development.

In conjunction with Ohio State Extension, the Best Local Land Use Practices Program will hold a statewide conference in January or February 2013 in Columbus. The conference will focus on changing trends in growth and development, tools and practices that are available to local governments and regional planning groups to address those trends, and resources available to help with implementation. The conference program target officials from local government agencies (township, municipality, and county), professional planners (e.g., local government planners and consultants), and the development community. This conference will be followed by a series of technical workshops through April 2013 to provide more detailed information for local officials and professionals who are in a position to implement the recommended practices.

Interest in the Ohio Balanced Growth Program is growing. The WPPs report that this program has brought to the table conservation and development groups that do not usually communicate with each other on planning issues. In addition, local officials have been able to coordinate more closely with the state to address local land use. The program has been very successful in encouraging the majority of the local governments in the Balanced Growth watersheds to participate in watershed planning and to consider the PCAs, PDAs, and PAAs in their own local land use plans. Participants have been able to see and appreciate direct local benefits, such as improvements in stormwater/flood management, protection of areas suitable for conservation, encouragement of low-impact development, enhancement of redevelopment opportunities, and encouragement of more efficient infrastructure development.

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For More Information

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Demonstrating the Effects of Best Management Practices on Watershed Water Quality in the Eagle and Joos Valley Creeks, Wisconsin

The Eagle and Joos Valley creeks are part of the larger Waumandee Creek watershed in Buffalo County, Wisconsin (Figure 1). Joos Valley Creek joins Eagle Creek, which drains 80.6 km^2, about halfway along its route to the Mississippi River. Eagle Creek then joins the larger Waumandee Creek before flowing into the Mississippi River at Fountain City Bay.

Work on the Eagle and Joos Valley creeks began in 1985 with the development of the *Waumandee Creek Priority Watershed Plan*. Wisconsin's Priority Watershed Program planning process inventoried types of land uses, identified water quality issues, and recommended best management practices (BMPs) to control pollutants causing degradation of water quality in the creeks. The plan, completed in 1990, identified several nonpoint sources of pollution that were degrading water quality. In some areas along the waterways, the streambanks were trampled by grazing cows. Streambanks had little overhanging vegetation, and a large amount of sediment was washed off the landscape. The streams were not able to support the coldwater fisheries that were once present in the creeks.

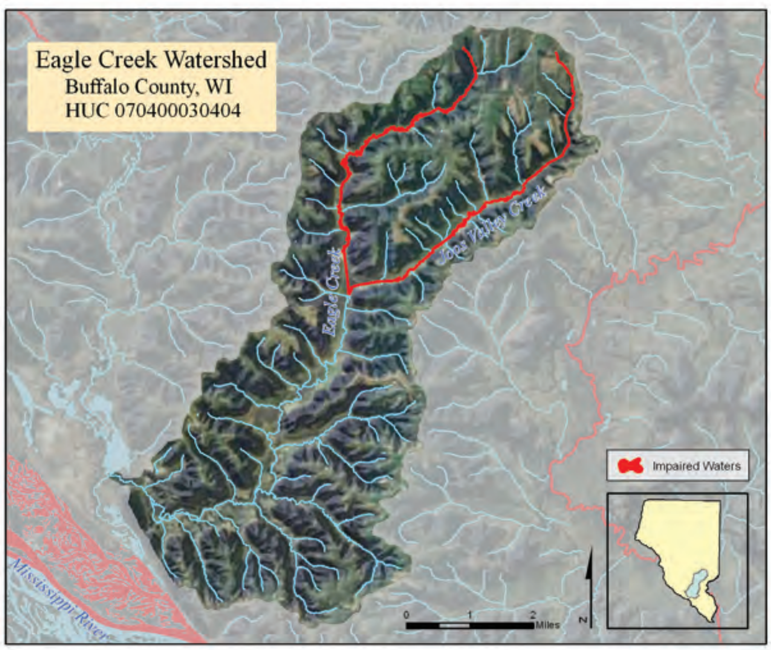

Figure 1. Eagle Creek watershed. 1 mile ≈ 1.6 km.

Both creeks were included in the state's 1998 impaired waters list which, in accordance with Section 303(d) of the federal Clean Water Act, identifies waters not meeting water quality goals. This listing required the state to analyze the effects of sediment loads on the attainment of water quality standards in the two creeks. The analysis led the state to develop a total maximum daily load (TMDL), approved in 2003, that identified pollutant sources causing the water quality impairment and included a goal for a 58% reduction in average annual sediment load based on 1990 conditions. Because sediment contains phosphorus, efforts to control sediment also end up controlling significant amounts of phosphorus, a nutrient that causes algal blooms.

Tom Schultz, Buffalo County conservation technician, is an expert on efforts to improve water quality in the Eagle and Joos Valley creeks, having worked in these watersheds and in the larger Waumandee Creek watershed for 26 years. Schultz notes that he did not have to sell the concept of reducing sediment and phosphorus loads in the creeks and stabilizing the streambanks to restore local trout populations: "I had local farmers very interested in making improvements on their farms—the landowners here are conservation-minded. About 40% of the landowners now are absentee owners who live in Portage, Milwaukee, or Madison, but they want to do the right thing for the land."[1]

A 17-year-long collaboration between the Wisconsin Department of Natural Resources and the US Geological Survey attempted to quantify how water quality changed in the Eagle and Joos Valley creeks following the installation of watershed BMPs. The study monitored the amount of suspended solids, ammonia nitrogen, and phosphorus in the Eagle and Joos Valley creeks before the watershed BMPs were installed, during the installation phase, and for seven years after the majority of the BMPs had been installed. The study found substantial reductions in pollutant loads in these creeks. A comparison between pre- and post-BMP monitoring data for Eagle Creek showed reductions of 89% for suspended solids, 77% for

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[1] Julia Riley, Improving Watershed Water Quality: Eagle and Joos Valley Creeks Demonstrate the Effects of Best Management Practices (Madison, WI: Wisconsin Department of Natural Resources, 2011), 1.

total phosphorus, and 66% for ammonia nitrogen. Similarly, in Joos Valley Creek, the study found reductions of 84% for suspended solids, 67% for total phosphorus, and 60% for ammonia nitrogen.

The improvements to the watersheds are attributable to significant cooperation and partnership among local landowners and volunteers and financial support from the state and from private organizations. One of the first projects was the installation of electrical fencing above streambanks and stream crossings to prevent cows from entering the creeks. As Schultz stated, "… 90% of the dairy farms in these watersheds kept their cows on pasture. There were areas alongside the creeks that were torn up and trampled and looked more like a cobbled moonscape devoid of vegetation instead of pasture."[2] The Priority Watershed Program paid for 70% of the fencing cost. Contributions from the Fountain City and Alma rod and gun clubs helped reduce the landowner's share of the fencing cost to 10% for famers who needed additional financial assistance; although four or five farmers still could not afford it.

With the creeks protected from trampling, 30 to 40 areas in the watersheds were targeted for stream restoration. Lunker structures—which combine streambank protection to curb bank erosion with fish cover—were installed with the help of volunteers from the rod and gun clubs to improve fisheries. Box elders were removed, and the area was planted with herbaceous vegetation to stabilize the soil; mowing prevents the return of box elders. The streambanks were also regraded to slopes of approximately 6:1.

Earthen erosion control structure dams with underdrain piping were installed to remove the 3- to 6-m deep gullies that had formed as a result of soil erosion during rainfall events. The smaller dams on the tops of the ridges cost about $5,000 per installation; the larger (4.5- to 6.1-m) dams cost up to $12,000 per installation. Funds from the state's Priority Watershed Program provided a 70% cost share with landowners, who saw the benefit of removing these gullies and were supportive of the dam installations. The dam structures have effectively reduced soil erosion throughout the watersheds. Permanent pools of water have formed behind the larger dams, and the underdrains control the amount of water discharged from the 15.2- to 20.3-cm drain pipes onto grassed swales. The dams also provide flood control, as demonstrated in summer 2010, when a rainfall of more than 23 cm occurred over a 24-hour period. According to Schultz, "there was water running over the emergency spillways in the erosion control dams, but they held back a considerable amount of water and helped prevent flooding downstream. I had people calling me telling me how the installation of all those dams helped prevent a larger flooding event, how well the dams had worked, and that it was a good thing we'd put those in."[3]

[2] Ibid., 2.

The water quality monitoring data support Schultz's assessment of the BMPs installed in the watersheds as the "right things" to do (Table 1). Wisconsin's Priority Watershed Program provided more than $392,000 for cost sharing on BMP installation. A special grant from the US Environmental Protection Agency provided an additional $52,000 for riprapping, streambank shaping and seeding, and barnyard runoff control systems. A series of BMPs implemented in the Eagle Creek and Joos Valley Creek watersheds successfully reduced the amount of suspended solids, and the TMDL sediment reduction goal has been exceeded. Both Eagle Creek and Joos Valley Creek were delisted from the state's 2012 impaired waters list—a cause for celebration!

Although the BMPs installed in the Eagle Creek and Joos Valley Creek watersheds clearly have improved water quality, an unanticipated change in land use, related to economic and generational shifts, also occurred. As many of the watersheds' dairy farmers retired, younger family members were not interested in continuing dairy farming. The cows were sold off and about 40% of the farms are now used for hunting and recreation by absentee owners. Those lands are often leased to local farmers, predominantly for corn production. Some of the smaller farms in Buffalo County are converting to less labor-intensive poultry farming. A few dairy farms still have pasture cows, but the number of cows in the watersheds has substantially decreased. Cows that once roamed woodland pastures on the steeper portions of the watersheds created soil erosion due to the compaction and disturbance of the more erodible soils. Woodland pastures have now been virtually abandoned, and this has been extremely beneficial to water quality. The voluntary removal of a significant number of cows from the landscape may also be an important unintended contributor to water quality improvement. The long-term US Geological Survey study supports historical observations that BMPs can and *do* make a difference in water quality. Those monitoring results support the sense locally that the "right" changes have been made. Wisconsin's Priority Watershed Program has ended, but the state's investment in the installation of watershed BMPs continues to pay off. With time, these changes will

[3] Ibid., 2–3.

Table 1. Summary of implemented rural BMPs in the Eagle Creek and Joos Valley Creek watersheds, Buffalo County, Wisconsin.

Best Management Practices	Units	Eagle Creek	Joos Valley Creek
Animal Waste Management			
Manure storage	No. facilities	3	0
Barnyard runoff control systems	No. facilities	8	2
Streambank Protection			
Streambank protection	m	1,394	2,066
Stream fencing	m	591	518
Stream shaping and seeding	m	145	560
Stream crossing	No. crossings	2	1
Upland Management			
Nutrient management	km^2	1.9	0
Grade stabilization	No. erosion control structures	9	1

bring a healthy trout population back to Eagle and Joos Valley creeks.

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For More Information

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Contributors

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Watershed Planning for Coral Reef Watersheds: Experience from the Caribbean and Pacific Regions

Threats to coral reef health are both global and local. Globally, corals are threatened by rising ocean temperatures, sea levels, storm activity, and ocean acidity. These threats alone can severely compromise coral health, but they are compounded by localized land-based sources of pollution (LBSP) and overfishing of key reef-managing species. Pollutants, such as nutrients, bacteria, and sediment, become major stressors and threats to coral health when they collect in the near-shore environment (Figure 1). These local threats can reduce the resiliency of coral reef ecosystems in confronting the broader, global impacts. Bryant and colleagues estimate that up to 22% of the world's coral reefs are threatened by soil erosion and other LBSP, and up to 50% are threatened on islands with wide-scale land clearing.

Figure 1. Example of a sediment plume entering Coral Bay. Photo courtesy of: Coral Bay Community Council.

For these reasons, the National Oceanic and Atmospheric Administration's (NOAA) Coral Reef Conservation Program (CRCP) has put renewed emphasis on building local capacity to protect coral reefs though watershed-based management approaches.

Watershed planning is a powerful tool to help understand and act on local LBSP; however, watersheds in coral jurisdictions face some unique challenges. For example, the amount, intensity, and variability of rainfall make the management of runoff very challenging. According to Giambelluca and colleagues, some areas on the same island may receive no more than 25 cm of rainfall per year, while others receive well over 250 cm. The variability of island geology also presents a challenge. Areas of volcanic origin tend to have steep slopes and small drainage areas that result in high-energy systems with elevated erosion potential. Limestone areas are characterized by the rapid movement of pollutants into sole-source drinking water supplies and, ultimately, coral lagoons.

Island land management practices often exacerbate LBSP. Practices such as burning vegetation to abet hunting, the proliferation of poorly constructed dirt roads, insufficient erosion control during construction activities, and inadequate treatment of stormwater and wastewater (including the widespread use of cesspools) lead to increased loads of sediment and other pollutants. Watershed planning, however, needs to be sensitive to the isolation and institutional capacity of coral jurisdictions, which often have limited access to the technical resources and materials that are readily available on the mainland.

The bottom line for coral watersheds is that there is a direct and palpable link between the land and the water resource. While this relationship is certainly not unique to islands, the window of opportunity to "get it right" with coral watersheds is present and compelling. The presence of coral can be an important part of the identity—not to mention economy—of many of these islands. Fortunately, watershed planning in coral watersheds is evolving and has strong support from environmental agencies at all levels of government, as well as through partnerships with the nongovernmental sector.

As a way to focus funding and implementation, priority coral watersheds are designated through a consensus process between local and federal resource managers based on relative coral health and other factors (e.g., the presence of a Marine Protected Area). Watershed planning also works in conjunction with other planning efforts, such as local action strategies that address marine and land-based resource protection issues, the Nature Conservancy's conservation area planning process, and planning for Marine Protected Areas.

With support from NOAA, the US Department of Agriculture, the US Environmental Protection Agency, and local jurisdictions, the Center for Watershed Protection (the Center) and the Horsley Witten Group (HW) have been involved with assessment and planning in a number of priority island watersheds over the last few years. These efforts, which have involved many dedicated local agencies and individuals as well as allied partners from universities and nonprofits, have led to a number of ongoing watershed planning and implementation initiatives, such as those described below.

Nonprofits Championing Implementation in US Virgin Islands Watersheds. With support from federal and territorial agencies, nonprofits have played a major role in the management of a number of priority watersheds. The 2008 *Coral Bay Watershed Management Plan* on St. John, developed by the Center, has led to more than $1 million in implementation funds to hire watershed staff, stabilize dirt roads, and install stormwater retrofits through the Coral Bay Community Council. In 2011, HW completed a plan for the 31 km^2 rural watershed draining to the St. Croix East End Marine Park (the first marine protected area in the US Virgin Islands). The St. Croix Environmental Association secured funding from the US Department of Agriculture to advance engineering designs for stream restoration, rain garden installation, and unpaved road drainage planning projects.

Figure 2. Island agencies, NOAA, HW, and the Center construct Saipan's first rain garden.

Building Stormwater Program Capacity in the Commonwealth of the Northern Mariana Islands (CNMI). In 2006, the US Environmental Protection Agency and the CNMI Division of Environmental Quality hired HW to develop the *CNMI and Guam Stormwater Management Manual*, which established specific criteria for best management practices (BMPs) in limestone and volcanic soils using updated rainfall statistics. Subsequently, HW developed a contractor certification program for erosion and sediment control (the Republic of Palau soon followed suit with a stormwater manual and erosion and sediment control training program). In 2009, a pollution prevention workshop conducted by CRCP, HW, the Center, and local agency staff led to an inventory of pollution sources, storm drain stenciling, and the ultimate launch of the Blue Starfish program to encourage local businesses to minimize stormwater pollution in Garapan. In addition, island agencies, with assistance from NOAA, HW, and the Center, installed the island's first rain garden early in 2012 (Figure 2).

Promoting Green Infrastructure in American Samoan Watersheds. The Center and HW are developing engineering designs and implementation strategies for stormwater retrofits to support the 2012 *Faga'alu Watershed Plan*, which was completed by local villagers, the American Samoa Environmental Protection Agency, and NOAA. Other exemplary efforts—such as long-term sediment monitoring by San Diego State University, construction by the American Samoa Environmental Protection Agency of the Pacific's first Leadership in Energy and Environmental Design–certified building (with green roof, permeable pavement, and bioretention facilities), and preliminary work on updating the island's stormwater standards—indicate a real commitment to protecting local water resources. Based on these efforts, NOAA has designated the Faga'alu watershed as a coral priority for restoration funding over the next several years.

Convening Pacific Island Watershed Practitioners in Hawaii. In 2010, the first Pacific Island Watershed Institute was held on Oahu. The conference included participants from the Hawaiian Islands, Guam, CNMI, American Samoa, Palau, and the Federated States of Micronesia. The training utilized local watershed planning and restoration activities conducted by Hui o Ko`olaupoko and the Mālama Maunalua watershed organizations. Each island developed a list of watershed-related priorities for building local watershed capacity or implementing existing watershed plans. NOAA subsequently funded implementation for some of these priority projects, including demonstration rain gardens and the expansion of island stormwater BMP design guidance.

Focusing Federal Dollars on the Coordinated Restoration of Guánica Bay, Puerto Rico. The Center developed the 2008 *Guánica Bay Watershed Management Plan* for the 391 km^2 urban and agricultural watershed located in the southwestern corner of Puerto Rico. Historically, the area was associated with some of the most pristine reefs on the island; now these reefs are impacted by pollutants, such as nitrogen, sediment, bacteria, polycyclic aromatic hydrocarbons, DDT, and polychlorinated biphenyls, along with other critical issues (e.g., upland erosion in the coffee-growing regions, instream channel erosion, loss of historic Guánica Lagoon, and sewage treatment). NOAA and the National Fish and Wildlife Foundation have provided funding toward the implementation of the plan's recommendations for the past two years. Current efforts, facilitated by Ridge to Reefs, include implementing BMPs for coffee growers, conducting an agricultural use assessment study, developing plans for a wetland treatment system at the wastewater treatment plant, constructing retrofit and stream restoration projects within the watershed, and establishing a local nonprofit organization to orchestrate some of these activities.

Watershed planning for coral reef protection is a key component to overall coral reef protection strategies.

Protecting Aquifers and Surface Water Quality in Guam. Priority surface waters, such as the Piti Bomb Holes Marine Preserve, are an important resource for Guam, with unique natural features as well as a high level of human use. Guam's sole-source drinking water aquifer sits below highly permeable limestone and is subject to contamination threats from stormwater injection through ponding basins as well as potential overuse, particularly in light of significant military base expansion plans. Over the past several years, CRCP, the Center, and HW have conducted a series of watershed planning, site design, and stormwater training activities for island agencies and private sector stakeholders. A two-day field reconnaissance of the Piti and Asan watersheds conducted in 2009 has led to the finalization this year of a watershed management plan by Guam's Coastal Management Program. In addition, the Center and HW developed an addendum to the *CNMI and Guam Stormwater Manual* that contains detailed specifications for four innovative island stormwater BMPs: island bioretention, permeable pavement, rainwater harvesting, and multicell ponding basins.

Watershed planning for coral reef protection is a key component to overall coral reef protection strategies. This work has shed light on a few guiding principles for watershed planning in coral jurisdictions. It is important to adapt watershed planning elements and procedures to work on islands. As watershed planning and modeling become more sophisticated for mainland watersheds, one should keep in mind that islands may have to ramp up to these more sophisticated approaches, focusing initially on elements that have a high probability of being implemented. NOAA, island jurisdictions, and stakeholders could collaborate on a "short list" of essential watershed planning elements. Watershed planning should make appropriate use of outside expertise, balancing this with local knowledge and traditions that will be meaningful and motivating for island residents. Island-based universities are also playing an important role in developing and disseminating local approaches. As with other efforts, much of this work is about building relationships and trust, and interim achievements should be fully celebrated.

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Contributors

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HAVE A QUESTION YOU'D LIKE US TO ASK OUR EXPERTS? *The upcoming Spring 2013 issue will focus on green infrastructure and will support national and local efforts to help fill gaps in our knowledge about the performance and cost-effectiveness of green infrastructure in site- and landscape-scale applications, approaches taken to implement green infrastructure within a community, and how green infrastructure, in its many forms, fits into programs to protect and restore watersheds. AWSPs members and Bulletin subscribers may email their questions to bulletin@awsps.org. The Bulletin features interviews with experts in the watershed and stormwater professions to discuss the topic of each issue. In this issue, four professionals provide insight into the origins of watershed planning and how it has evolved and adapted to fit local program needs for both urban and agricultural watersheds. Here is what our experts had to say…*

Dov Weitman

Chief, US Environmental Protection Agency, Nonpoint Source Control Program (Retired)

Dov Weitman received a BA in mathematics from Yeshiva University in 1973 and a JD from Harvard Law School in 1976. After two years in private legal practice, Dov joined the US Environmental Protection Agency (USEPA) in 1978 and worked as a lawyer for 11 years. In that capacity, Dov focused on developing regulations for USEPA's water quality and hazardous waste programs and defending those regulations in federal courts. Beginning in 1989 and continuing until his retirement on January 1, 2012, Dov served as chief of USEPA's Nonpoint Source Control Program, managing a highly diverse management program that encompassed agriculture, urban runoff, hydrologic and habitat modification, forestry, grazing, stream restoration activities, and the protection of healthy watersheds. For more information about some these programs, please see the Resources list.

Q: How have you been involved in watershed planning?

A: I worked at USEPA for 33 years beginning in 1978. At first, I used my background in law for rulemaking and litigation in point source programs, wetlands, and hazardous waste. Beginning in 1989, I served as chief of the Nonpoint Source Control Program for 22 years until my retirement in 2011. In this capacity, I led USEPA's national efforts to promote watershed planning at the state and local levels.

Watershed planning is an essential part of the Nonpoint Source Control Program. In fact, the Clean Water Act (CWA) of 1987, which created the Nonpoint Source Control Program, explicitly directed states to implement their nonpoint source control programs, "to the maximum extent practicable . . . on a watershed basis." In the program's initial years, states were not provided enough money to work holistically at the watershed scale. In its first ten years, USEPA received modest funds, ranging from $40 to $100 million in appropriated funds, and distributed it to states for pilot projects that focused on demonstrating remediation technologies and approaches; but planning was, in most cases, minimal and only project-related. In 1999, Congress increased funding to $200 million and beginning in 2002, USEPA required states to develop watershed-based plans prior to implementing projects. USEPA defined nine elements ("a– i criteria") for watershed plans to address before implementation.

Q: Can you tell us more about the "a–i criteria"?

A: The "a–i criteria" came about as a way to combine better watershed planning with a water quality improvement outcome that supported the total maximum daily loads (TMDLs) that states developed for their nonpoint source–impaired waters. The idea was that TMDLs defined estimates of load reductions to achieve water quality standards, while watershed planning provided the steps to identify and quantify actions to achieve those load reductions. I credit my boss, Chuck Sutfin, the division director who managed both the TMDL and Nonpoint Source Control Programs, with establishing the basic framework for the watershed planning "a–i criteria" as a means to achieve water quality standards. The first three criteria are to understand the pollutant problems in a watershed and identify their sources, estimate the load reductions from management practices, and describe the best management practices that could reduce pollutants. Using a quantitative modeling approach, you determine what nonpoint source pollutant reductions you need to meet the TMDL. The next six components are aimed at how to implement the overall watershed project, including the identification of available resources, a plan for public outreach, and an indication of how progress will be monitored over time. USEPA initially released guidelines for this approach in 2002 and 2003; then in 2004, the agency rewrote the entire Nonpoint Source Control Program guidelines with a watershed planning approach as the central feature. However, USEPA is currently in the process of revising the guidelines again.

A fair complaint when these requirements were established was that most states did not have adequate tools to implement this approach. USEPA recognized the need for training and has created guidance documents and provided live training and web-based resources to help states develop their technical capacity to do the analytical work; USEPA also trains people on the ground to work with community members and find solutions. Funding is always an obstacle, and states need to supplement 319 funds with their own funds, cost sharing by fund recipients, and other funding sources, such as the US Department of Agriculture's (USDA) Environmental Quality Incentives Program (EQIP).

Q: Ideally, the watershed approach addresses multiple stressors (e.g., wastewater, agriculture, and atmospheric pollutants) and integrates multiple programs (e.g., wetlands, land use planning, and stormwater). Is this approach used? Why or why not? How can we improve the watershed approach?

A: Acknowledging all stressors in a watershed is a first step in planning but, because of resource constraints, states typically focus their implementation of watershed plans on their highest-priority pollutants and stressors and their sources. For example, a state might first focus on animal waste in a watershed where that is the dominant source of pollutants, while deferring projects addressing streambank erosion until funds become available to address that source as well.

We can improve the watershed approach by increasing technical capacity through collaboration. For example, partnering with universities, local governments, and/or consulting firms often results in stronger watershed plans. It is also important for project planners to spend time in the field to better inform the models used to develop watershed plans.

Q: How can watershed planning be used to inform the decision-making process (policy and regulatory)? For example, how can watershed plans be integrated into city, county, state, or federal budgets? How can watershed plans help shape regulations?

A: First, develop a watershed plan that provides a real feel for what it will take to meet water quality goals and the implementation issues or barriers. During this process, staff leading the watershed planning effort should meet with the people who will do the implementation.

Public willingness to help or not help has a big impact on success. Through the watershed planning process, you may learn, for example, that you need more funds to involve the stakeholders in the process. Or you may learn that you need to use a regulatory approach to implement the plan. State policy direction can be informed by learning whether well-designed watershed plans are adequate to achieve implementation targets that can solve the water quality problem or whether other steps need to be taken to promote implementation. In addition, a watershed plan estimates the funds needed to solve a watershed problem. This information can be disseminated to the public and political decision makers to increase the likelihood that the project will have adequate financial support as well as other needed human and capital resources.

Overall, watershed planning should provide a factual basis on which to make intelligent decisions about how to spend federal, state, or local funds to make progress toward water quality goals. Leveraging federal and state funds with local resources is important and is needed.

Q: What do you think are the best opportunities for funding watershed planning and implementation?

A: In addition to CWA Section 319 funding, an agricultural watershed can use funds from USDA programs—such as EQIP, the Conservation Reserve Program, or the Conservation Reserve Enhancement Program that provide cost sharing, allow valuable land to be set aside for conservation, and/or protect riparian areas. However, if urban runoff pollution is the watershed's main source of impairment, then different funds, such as state or municipal funds, can supplement Section 319 funding. Urban areas often have regulations to address new development, and local governments can raise funds through programs such as state revolving funds or locally developed stormwater fees.

Q: What innovations in technology or funding for watershed protection and restoration have you seen or do you see on the horizon?

A: In urban areas, the last decade has seen the emergence of low impact development (LID) and stormwater retrofits that use land in both developed and developing areas to capture, store, treat, and filter the stormwater runoff. I think LID is the wave of the future and will, over time, achieve great success in helping to protect and restore urban water quality. On a broader geographic scale, green infrastructure will be used in conjunction with LID to protect and restore watersheds. Green infrastructure is broad-based and includes constructed wetlands, the protection and restoration of green space, and so forth to improve stormwater management and to achieve a myriad of broader societal goals. Looking at the long term, I have a lot of confidence and enthusiasm for where we are headed in urban areas.

In rural areas, the work is more complicated and can be more difficult. We should continue to push the envelope in nutrient management planning and soil conservation planning, and we need to have mechanisms in place to ensure that these plans are implemented. We may find that regulatory or strong incentive-based approaches are needed to ensure the development and implementation of these plans.

Finally, riparian protection and restoration in urban and rural areas is beginning to occur and will show progress in the future.

Q: Based on your experience with watershed plans and watershed planning, what research, innovations, or other work (e.g., coordination of programs) is still needed for effective watershed planning?

A: Watershed planning needs to be easier. In other words, we need user-friendly modeling platforms and databases that are easy to access, understand, and use for widespread watershed planning at every level. It is critical that we continue to pursue the use of high-quality data in our watershed planning. For example, new technologies—such as geographic information systems (GIS), remote sensing, and modeling—should be incorporated into the process. USEPA has done extensive training and resource development, but more is needed to reach local governments and communities and to support them in determining their watershed impairments, possible pollution causes, and what to do to begin fixing the impairments.

Q: Anything else you want to tell us?

A: The money available is not adequate to do the job. States will need to use available resources for watershed planning and increase the use of the regulatory component to drive consistent long-term improvements. Otherwise, experience to date (including many billions of dollars expended by USDA, USEPA, states, local communities, and the private sector) indicates that it is unlikely that significant reductions in overall water quality impairments nationwide will be achieved unless significant funding increases or regulatory approaches are made available.

Resources

Handbook for Developing Watershed Plans To Restore and Protect Our Waters
http://water.epa.gov/polwaste/nps/handbook_index.cfm

Healthy Watersheds
http://water.epa.gov/polwaste/nps/watershed/index.cfm

Low Impact Development (LID)
http://www.epa.gov/nps/lid

Polluted Runoff (Nonpoint Source Pollution)
http://www.epa.gov/owow_keep/NPS/index.html

Section 319 Nonpoint Source Success Stories
http://water.epa.gov/polwaste/nps/success319/

USEPA Management Measures for Nonpoint Source Pollution
http://www.epa.gov/owow/NPS/MMGI/index.html

Watershed Central
http://www.epa.gov/watershedcentral

Stephen Stanley

Aquatic Ecologist, Washington State Department of Ecology

Stephen Stanley earned a BS in aquatic biology and BA in environmental studies from the University of California, Santa Barbara, and has more than 30 years of experience in wetland and watershed assessment, management, and regulation. In his work as a consultant, educator, and regulator in the state of Washington, Stephen has conducted and reviewed wetland delineations and assessments and has developed wetland enhancement and restoration plans, including a watershed-based restoration plan for the Snohomish Estuary. At the Washington State Department of Ecology (WDOE), Stephen manages the Puget Sound Characterization Project. He developed guidance for characterizing and analyzing watershed processes in western Washington and assisted in the development of wetland assessment models for the Columbia basin. Also, for the past ten years, he has co-taught the fall quarter of the wetland certificate program at the University of Washington.

Q: How have you been involved in watershed planning?

A: I work with local governments and state and federal agencies that manage and regulate development in freshwater and nearshore watersheds. This includes planning under the state's Growth Management and Shoreline Management acts. Currently, WDOE is developing a watershed-based approach to help guide local planning decisions on the best locations for new development and priority areas for protection and restoration. This approach is being used in a Puget Sound pilot project for freshwater watersheds in Washington known as the Puget Sound Characterization Project.

Q: Ideally, the watershed approach addresses multiple stressors (e.g., wastewater, agriculture, and atmospheric pollutants) and integrates multiple programs (e.g., wetlands, land use planning, and stormwater). Is this approach used? Why or why not? How can we improve the watershed approach?

A: We address the multiple stressors in a watershed using coarse-scale models and local-level data collection efforts to help inform planning decisions. For example, the Puget Sound Characterization Project consists of three distinct assessments: water flow, water quality, and habitat. For the water flow assessment, our watershed approach is based on the assumption that broader-scale processes drive the formation and maintenance of habitat structure, which subsequently supports habitat functions. An assessment of these watershed processes is essential to developing a planning approach that comprehensively protects and restores watershed ecosystems by understanding the root causes of watershed problems. Generally, the watershed unit assessments are rated using an importance model that includes physical indicators for water delivery, movement, or loss. The watershed unit is also assessed by a degradation or stressor model. The combination of the results from these two models helps in the development of land use guidance for the best locations on the landscape to protect, restore, conserve, and develop land.

Our approach is designed to integrate abiotic and biotic data from multiple models, programs (the Shorelines and Environmental Assistance Program and Water Quality Program at WDOE), and agencies (the Washington Department of Fish and Wildlife and the Washington State Department of Natural Resources). These broad-scale assessments use relatively basic data and information in comparison to site- or reach-scale assessments that require much more detailed data and analysis to understand processes and functions at the finer scale. This approach identifies the best locations for future development and restoration or protection actions at a watershed scale, instead of mitigating for impacts on an individual project basis. If it works, it may help inform similar approaches at the national level. Our next task is to use this pilot to develop a web-based decision support tool for local implementation.

Q: What are the key factor(s) in a watershed plan that make it more likely to be used and implemented instead of sitting on a shelf gathering dust? Are there general standards or rules of thumb that you believe watershed plans should follow (e.g., USEPA's "a–i criteria," recommended watershed scale)?

A: I have seen watershed planning come full circle from being in favor during the 1970s, to not being used, and now reconsidered because research has demonstrated its importance. The key factors to ensuring its implementation are to (1) work closely with local government planners when putting together the methods and the guidance for interpreting and applying assessment results and (2) implement pilot projects at the local level to address issues uncovered during the watershed's characterization assessment. We are attempting to do this by forming a technical team of watershed experts to work with local governments on watershed issues and by developing subarea plans (Birch Bay and Gorst watersheds) in conjunction with local governments. Another key aspect is that stakeholders will not support the plan if they do not understand why they need to undertake the actions identified, so training, education, and outreach are essential to making this happen.

Q: Could you provide an example of a watershed plan you were involved with that you consider a "success story"? What made it a success?

A: One success story is Birch Bay in Whatcom County in northeastern Puget Sound. We conducted the watershed assessment and provided the information to the local government. The local government staff interpreted the information and developed a management plan with minimal involvement from us; in other words, we did not dictate the outcome. This allowed the local government to find the best way to work with landowners and to apply the watershed assessment results in the most effective manner. This was also a success because the local government had the technical expertise (e.g., GIS and modeling) and the willingness to do the work and implement the plan. The Birch Bay watershed-based subarea plan is the basis for the following two credit systems: (1) a point-based permit application system and (2) a buffer reduction in-lieu fee. Under the permit point system, an applicant receives points for approved LID practices. An expedited permit is issued when enough permit points are credited. The in-lieu fee system allows buffer reductions in degraded watershed units. A fee is paid for the buffer reduction, and the funds are used for buffer restoration in watershed units of higher ecological value.

Q: What do you think are the best opportunities for funding watershed planning and implementation?

A: USEPA's National Estuary Protection (NEP) Program has been a key source of Puget Sound funding for efforts such as the Puget Sound Characterization Program; the NEP has also funded watershed technical teams and the development of a watershed-based grant program for pilot program implementation. The best opportunities for using this or similar funds is when we have all jurisdictions, cities and counties, participate in the development of a comprehensive and coordinated watershed plan.

Q: What innovations in technology or funding for watershed protection and restoration have you seen or do you see on the horizon?

A: The development of ecosystem services markets applied to local watersheds has great promise. If we can identify ways to provide incentives to residents within a watershed to undertake actions that protect, restore, and sustain processes and functions in that watershed, we can reduce the reliance on state and federal funding sources. These funding sources are not long-term and typically, when the funding expires, so does the program. Then, we start the work all over again a decade later. Because the ecosystem services market is so new, it will require considerable time and effort to understand how it can be successfully incorporated into the existing planning and permitting system.

We have several grantees looking at ecosystem services economics to establish reasonable values for natural areas and propose a feasible market mechanism. These market mechanisms will then be tested in several pilot projects in Puget Sound.

Q: Overall, how well is the watershed-based approach working to protect/restore water resources?

A: It is too early to say how well the watershed-based approach is working in our state. We are just developing the guidance and web support for implementing the characterization results. It will take time for local governments to apply the watershed framework we developed. Also, it will take time to gather data showing whether we improved watershed conditions (e.g., whether we solved the key watershed problem[s]) through the implementation of these watershed-based plans.

Q: Based on your experience with watershed plans and watershed planning, what research, innovations, or other work (e.g., coordination of programs) is still needed for effective watershed planning?

A: Currently, the approach to watershed planning is a patchwork quilt of policies, assessments, recommendations, and land use actions that are reach- or site-specific and are not coordinated with watershed stakeholders.

I believe that the key to success is, first, to set up a framework to assess and solve watershed issues at multiple scales appropriate for local government and resource agency use. Second, we need a comprehensive monitoring program to evaluate whether key environmental indicators, such as flow regimes, are within or returning to the normal range of variation. This feedback loop to test how the watershed's environmental indicators change over time using monitoring data is essential to correct and modify the models, assessments, and land use measures used in the watershed framework.

Resources

Puget Sound Watershed Characterization Project
http://www.ecy.wa.gov/services/gis/data/pugetsound/characterization.htm

Washington State Department of Ecology "Mitigation That Works" Landscape Planning
http://www.ecy.wa.gov/mitigation/landscapeplan.html

Patrick J. Sutter

County Conservationist, Dane County, Wisconsin, Land and Water Resources Department, Land Conservation Division

Pat Sutter graduated from the University of Wisconsin, Madison, in 1982 with a BS in agricultural education. He has been a soil and water conservationist for Dane County, Wisconsin, Land and Water Resources Department since 1984, serving the Conservation Division. Since his promotion in 2006 to the position of county conservationist, Pat has managed both agricultural and urban staff serving all of Dane County. He managed the Black Earth Creek and Dunlap Creek priority watershed projects from 1987 to 2004. Over the years, he has worked on various local, state, and federal conservation initiatives to implement conservation practices. Most recently, Pat has supervised the implementation of the Lake Mendota Priority Watershed Project (located north of Madison). One of the main goals of all three watershed projects was the management of sediment and nutrient runoff into the county's lakes and streams. A key to the success of these projects was the development of close working relationships with landowners, nonprofits, municipalities, and partner agencies. As a result of these efforts, tons of sediment and nutrients have been prevented from entering the county's water resources.

Q: How have you been involved in watershed planning?

A: I work in watersheds throughout Dane County, Wisconsin. Our work is focused in watersheds that vary in their scope, size, priority pollutant(s), available funding, geography, stakeholders, collaborators, etc. Most watershed plans focus on sediment, phosphorus, and/or nitrogen and are tailored to prioritized needs for the different areas in the county. For example, trout waters on the 303(d) list are the focus in the western part of the county, whereas in other areas, agricultural runoff is the focus, and in Madison, the lakes are our primary focus. One thing we know is that getting partners identified up front is essential. Difficulties arise when partners in the watershed planning process come into the process late. We work with a wide variety of groups and stakeholders for each watershed project. Our watershed planning focuses on both rural and urban water quality issues but also considers the "whole-farm planning" approach, which includes all other resources, such as wildlife, woodland, pastures, wetlands, streams, etc.

Q: Ideally, the watershed approach addresses multiple stressors (e.g., wastewater, agriculture, and atmospheric pollutants) and integrates multiple programs (e.g., wetlands, land use planning, and stormwater). Is this approach used? Why or why not? How can we improve the watershed approach?

A: The watershed approach allows us to make measurable progress and clean up our water resources. Using this approach, we can understand the different types of pollution impacting the watershed and where they are coming from, and we can plan to reduce the pollution using several different methods.

In the past, we tended to focus primarily on cropland, but we have learned, over time, that we may have missed the other big producers of sediment or phosphorus coming off the pastures where manure has built nutrient levels to an extreme. We improved our watershed approach to identify these areas and now work with stakeholders, especially the farmers, in the beginning of the planning process. For us, getting the involvement up front of farmers or other stakeholders—such as local leaders and townships—is essential. Input from these experts into the initial watershed planning project is a major element of our work. We also know that we are not experts on everything, so we bring others to the table to help support the watershed plan.

To improve our planning process, we are using improved science and tools, such as SNAP-Plus, that help us identify the fields that are likely to contribute the most pollution. We have learned, through improved science and technology, that small fields can be big pollution sources for sediment, nitrogen, and/or phosphorus. We need models that are field-tested and proven to work. We get support from partner agencies such as the University of Wisconsin, Madison, for the improved technology and resources.

Q: What are the key factor(s) in a watershed plan that make it more likely to be used and implemented instead of sitting on a shelf gathering dust? Are there general standards or rules of thumb that you believe watershed plans should follow (e.g., USEPA's "a–i criteria," recommended watershed scale)?

A: I think we first need to be confident, ourselves, that the watershed plan will do what it was designed for, and that is to improve water quality in that specific region. If we have confidence in the plan, it is much more likely to be used and not shelved. I think another key factor is to work with landowners and farm producers to change their management tendencies. We need to encourage them to think "outside of the box" when it comes to conservation planning. Through increased education and outreach, we have seen positive changes in management and have built our credibility with our landowners and farmers. We need experienced staff that are skilled and can convince people to contribute to the watershed plan and its implementation.

Another key factor is to not promise too much in your watershed plan and to stick with what you can deliver. This builds credibility with landowners. We want the farmers and other landowners to feel like this is their plan, and we ask for their input to ensure that the plan has actions that they can, and will, complete. Once we have built a credible program and have trained staff, we have people knocking on our door to work with us. If you have a plan that was built with stakeholders who see you as credible, then the plan will not sit on the shelf. Finally, policymakers or decision makers should be confident in the plan's content and confident that, if implemented, it will be a success.

Q: Could you provide an example of a watershed plan you were involved with that you consider a "success story"? What made it a success?

A: When I worked "in the field" I managed the Black Earth Creek Watershed Project where we got all but two of the targeted farmers in the 100-square-mile watershed to participate in the watershed project and conservation planning effort. This project worked because I was directed to spend the majority of my time in the watershed. We began working with a few farmers who we felt confident would work with us and show other farmers some successful projects. Then, I got call after call from people who needed and wanted our help. I was able to spend the time needed in the watershed to make the project successful. A local group of stakeholders formed during this project, called the Black Earth Creek Watershed Association, and it is still functioning after 25 years. To me, that is one sign of a successful plan.

Q: How can watershed planning be used to inform the decision-making process (policy and regulatory)? For example, how can watershed plans be integrated into city, county, state, or federal budgets? How can watershed plans help shape regulations?

A: Look back at watershed plans that were successful and those that were not as successful to determine what works and what does not work. Then, share this information with policymakers so they have that documentation to form or change the policy. In a recent example, the Pleasant Valley Watershed Project, we used SNAP-Plus to inventory 85% of the cropland/pastureland in the 22-square-mile watershed. This information helped us target those farms producing the highest nutrient loads. We found out that 20% of the land produced 50% of the nutrient load in that watershed. By focusing our resources on that 20%, we saved staff time and used our incentive monies in the most efficient way. When the project is over, we will use these results to support our arguments to policymakers for the need for water quality improvements.

Q: Tell us about how your organization works with farmers and also is part of the regulatory agency for the farmers?

A: We have developed a good working relationship with farmers by keeping our agriculture planners on the conservation side of the job. We have separate urban planners who address enforcement. This helps to alleviate concerns about the regulatory nature of my organization. We use step enforcement, where we try to fix the situation with the farmer's cooperation. In my 28 years on the job, only one farmer has ever seen a judge.

Q: Overall, how well is the watershed-based approach working to protect/restore water resources?

A: If done right, the watershed-based approach works well. For example, in Black Earth Creek, the US Geological Survey documented water quality improvements due to conservation practices in a ten-year study.

You have to implement the plan. If you only implement half the plan it is only half of a success. Also, I think if you have enough time to get the planning right, do the research, work with the community, bring in experts, and manage expectations, there is more chance for success. Finally, in watershed planning, the inputs are always changing. For example, in the Lake Mendota watershed, we are not seeing the phosphorus levels in the lake drop as we would like, but you need to recognize how nutrient inputs have changed. For example, the herd size in the watershed has nearly doubled over the last 20 years, the area experiences more intense storms, and the crops planted have changed.

Q: Based on your experience with watershed plans and watershed planning, what research, innovations, or other work (e.g., coordination of programs) is still needed for effective watershed planning?

A: We need current research and modeling available so that we can "show the facts" to farmers, stakeholders, policymakers, and others who are involved in the watershed plan. We need to defensibly show that we were objective in the management options suggested and that there will be improvements if we follow the recommendations.

In our area, we need research that quantifies the winter manure application in order to determine if an ordinance would impact water quality. Currently, the research load findings are mixed. We know that the state has a phosphorus index of six but we need a couple more years of research to determine if that is a high number or if it should vary among watersheds. We also need to know how to verify that nutrient management plans are implemented correctly. For example, perhaps a soil test could be part of the nutrient management plan to track the change over time on a farm-by-farm basis.

Q: Anything else you want to tell us?

A: We are fortunate to have a staff that enables us to do a variety of work. Across the board, better statewide watershed planning needs to have consistent resources available. It is extremely important to have "boots on the ground" for conservation practices to be consistently successful. We have Land Conservation Committees that prioritize activities based on what we need to do, how much funding we need, and what regulations we need to meet our goals. Policymakers and county board supervisors support this type of effort.

Resources

Dane County Land and Water Resources Department
http://www.countyofdane.com/lwrd/

Dane County Land and Water Resources Department, Land Conservation Division
http://www.countyofdane.com/lwrd/landconservation/

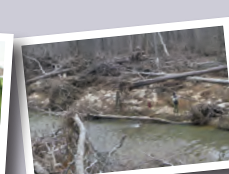
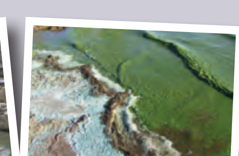
SNAP-Plus Nutrient Management Software
http://www.snapplus.net/

AWSPs Photolog Contest

The Association of Watershed and Stormwater Professionals (AWSPs) is accepting photo entries for our next photolog contest. The winning photo will be featured on the AWSPs website and in the Spring 2013 issue of the *Bulletin*.

The photolog contest features the watersheds in which we work, live, and play. The photos can feature any number of subjects, including:

- streams, forests, or other natural features;
- stormwater best management practices;
- restoration projects; or
- anything that captures the essence of a watershed.

To submit your photolog, provide one original digital photograph with a 250-word description to photocontest@awsps.org. All photologs must be submitted by **Friday, November 2nd, 2012,** by 5 p.m. For complete contest rules, see http://www.awsps.org/photolog.html.

Tom R. Schueler

Executive Director, Chesapeake Stormwater Network

Tom Schueler has more than 30 years of experience in practical aspects of stormwater practices for the protection and restoration of urban watersheds. The founder of the Center for Watershed Protection (the Center), Tom currently directs the Chesapeake Stormwater Network, a nonprofit organization devoted to the implementation of more sustainable stormwater practices across the Chesapeake Bay watershed. As director of the Chesapeake Bay Stormwater Training Partnership, he oversees the development and dissemination of webcasts, workshops, and online training modules that train engineers in the implementation of new practices. He also serves as the stormwater technical coordinator for USEPA's Chesapeake Bay Program. In all of his work, Tom actively promotes better stormwater regulations and permits in communities across the Bay.

Q: How have you been involved in watershed planning?

A: In my career, I have worked at three different scales of watershed planning. At the scale of large urban watersheds, I worked for the Metropolitan Washington Council of Governments Department of Environmental Programs on the Anacostia River watershed plan. This was the first urban watershed restoration effort in the country. It involved multiple jurisdictions, and the result was a comprehensive watershed plan that is still being implemented today. Second, at the Center, I advocated for strong planning efforts geared toward small (~10-square-mile) watersheds, incorporating GIS mapping, desktop assessment, and field assessments. Now, as the Chesapeake Stormwater Network's executive director and the USEPA Chesapeake Bay Program's stormwater coordinator, I work on a watershed that is 64,000 square miles, spans seven states, has multiple stakeholders, and must meet cutting-edge regulatory thresholds, such as watershed implementation plans and the Chesapeake Bay TMDL.

Q: Ideally, the watershed approach addresses multiple stressors (e.g., wastewater, agriculture, and atmospheric pollutants) and integrates multiple programs (e.g., wetlands, land use planning, and stormwater). Is this approach used? Why or why not? How can we improve the watershed approach?

A: At the Center, we spearheaded the notion that watershed restoration and protection plans should include many different stressors and sectors. There is always the challenge of having too many objectives, so a smaller watershed scale with fewer objectives is ideal. For small urban watersheds, tools like the Impervious Cover Model (ICM) are useful for watershed practitioners because they can aggregate multiple stressors in a single planning tool. With larger watersheds, the ICM breaks down and more comprehensive tools are needed. The Chesapeake Bay watershed is large and has numerical TMDLs that have a large impact on watershed planning with good and bad impacts. The good impacts include a more quantitative and accountable watershed implementation approach, but the bad impacts include a narrow planning focus with few objectives (e.g., nutrients and bacteria) that leave out other worthwhile objectives, such as wetland protection or green space

Q: What are the key factor(s) in a watershed plan that make it more likely to be used and implemented instead of sitting on a shelf gathering dust? Are there general standards or rules of thumb that you believe watershed plans should follow (e.g., USEPA's "a–i criteria," recommended watershed scale)?

A: A few rules of thumb for watershed planning are found in *Methods to Develop Restoration Plans for Small Urban Watersheds*, which is part of the Urban Subwatershed Restoration Manual Series that I oversaw when I was at the Center. This type of watershed planning is most practical for small urban watersheds. However, watershed protection plans are not as successful as they could be due to the difficulty of changing land use patterns to protect sensitive aquatic resources. There is never the political will to make hard land use decisions that hold up over time.

Also, check out "Eleven Reasons Why Watershed Plans End Up on the Shelf" (in the Schueler [2000] document listed below), which explores common watershed plan pitfalls such as "the document was too long or complex" and "the plan had no regulatory meaning." I still frequently see plans that have these common pitfalls.

Q: Could you provide an example of a watershed plan you were involved with that you consider a "success story"? What made it a success?

A: A series of watershed plans that the Center developed with James City County, Virginia, were good examples. This was the first time that a lot of field work was used with Center methods such as the unified stream assessment, unified subwatershed and site reconnaissance, urban stormwater retrofit practices (retrofit reconnaissance investigation), and forested wetlands assessment. There was also the now-famous watershed camp where we compiled information in an informal setting at the end of the day. A few plan accomplishments included: (1) the identification of specific conservation areas for protection, (2) the discovery of endangered plants and birds during the field work, (3) the conservation of a 300-foot buffer for the Powhatan Creek mainstem, and (4) strong stakeholder involvement that influenced the county council to pass the controversial plan by a narrow vote. The county continues to implement the plan's recommendations today.

Q: How can watershed planning be used to inform the decision-making process (policy and regulatory)? For example, how can watershed plans be integrated into city, county, state, or federal budgets? How can watershed plans help shape regulations?

A: Watershed plans can create a dialogue about changes needed in local development codes, stormwater ordinances, and land conservation policies, but this rarely happens. Watershed plans are just the beginning of the recommendations, and more work is needed to get the recommendations implemented. For example, one way to use policy to improve plan implementation is to incorporate the watershed plans in the municipal separate storm sewer system permits. This can provide a long-term way to stay on top of the plan (i.e., to implement the plan).

Q: What innovations in technology or funding for watershed protection and restoration have you seen or do you see on the horizon?

A: As we shift towards watershed plan implementation, real innovation is needed to improve the local watershed delivery capacity (i.e., innovations in local management capability and/or capacity). We have most, if not all, of the tools needed to solve the problems, but we lack the internal capabilities to cost-effectively deliver these tools through public and/or private partnerships.

Q: Based on your experience with watershed plans and watershed planning, what research, innovations, or other work (e.g., coordination of programs) is still needed for effective watershed planning?

A: While an enormous amount of good work has been done in watershed planning, we need to collectively get together to learn from each other, network, and share results. Watershed planners also need to play a more prominent role in the legislative and political world. Watershed planning is a bit of an orphan in several disciplines, such as hydrology, water quality, forestry, wetlands, GIS, and many others.

Q: Anything else you want to tell us?

A: Historically, watershed planning has cycled up and down in popularity. We seem to be in a waning cycle now. I think this is partly due to the recent decline in local and state resources for environmental planning, but it also may be attributable to the fact that watershed planning has not always delivered on its grand promises. We need to continually evolve our planning methods to ensure that we can truly achieve tangible watershed results.

Resources

Schueler, T. R. 2000. Crafting better watershed protection plans. Watershed Protection Techniques 2(2): 162–170. Available online at: http://www.cwp.org/.

Watershed Superstar

The Association of Watershed and Stormwater Professionals (AWSPs) sponsors a Watershed Superstar contest as a way to highlight the achievements of watershed professionals. AWSPs solicited nominations in the Spring 2012 issue of the *Watershed Science Bulletin*. A panel of three watershed professionals from the Center for Watershed Protection, Inc., judged applicants based on their accomplishments as well as the unique qualities that make up a Watershed Superstar, including ambition, innovation, collaboration, and dedication.

The *Bulletin* received many applications for Watershed Superstar. Each applicant has made a significant and positive impact on his or her local watershed, and some have done so at national and international levels! The dedication and commitment shown by these applicants demonstrates what can be done to protect and restore our watersheds—one project, one mile at a time. Congratulations to everyone for their contributions.

The Watershed Superstar for Fall 2012

Rachel Zuercher,

Nonpoint Source Pollution Coordinator
Commonwealth of the Northern Mariana Islands,
Coastal Resources Management Office

*Nominated by:Katherine Chaston,
National Oceanic and Atmospheric Administration,
Coral Reef Conservation Program, & Anne Kitchell,
Horsley Witten Group*

Before East Coast superstars are out of bed in the morning, Rachel has already spent a full day implementing watershed goodness in one of the most humid and remote locations one could imagine—the Commonwealth of the Northern Mariana Islands. On the cusp of the deepest trench in the world, Rachel has spawned stormwater miracles that protect our precious coral resources, ignite similar actions throughout the Pacific, instill confidence in funders, and inspire even the most seasoned watershed veterans. With the gumption of a former Peace Corps volunteer, Rachel has been a central force in reinvigorating the island's watershed working group; setting the groundwork for the Saipan Lagoon Aquatic Ecosystem Restoration Study; and overseeing Lao Lao Bay road stabilization, stream repair, and stormwater management activities (a huge multi-agency initiative at the federal and commonwealth levels). She was the driving force behind the installation of the island's first permeable pavement parking lot and is the main reason why Garapan now has a rain garden demo to showcase. On the mainland—where funding, materials, and know-how are in relative abundance—we can't truly comprehend the resourcefulness, creativity, and dedication required to accomplish such feats in a watershed where none of those luxuries exist … especially when austerity measures mean you get paid for only four days a week! Rachel is all heart and damn good with a shovel. What else is there, really?

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Enjoy reading the *Watershed Science Bulletin*? Consider joining the Association of Watershed and Stormwater Professionals (AWSPs).

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- 50% discount on publications
- subscription to the quarterly e-newsletter, *Runoff Rundown*
- significant discounts on Career Center postings
- exclusive discounts for industry conferences
- full access to the Online Watershed Library
- free members-only access to the Center's Lunch & Learn series
- exclusive discounts on industry software packages

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Sponsors of the *Watershed Science Bulletin* benefit from the Center for Watershed Protection's status among top decision makers in the watershed and stormwater business. For additional information about sponsorship within the journal, please visit www.awsps.org/media-kit.

Future Bulletin Issues

Spring 2013
Green Infrastructure

Fall 2013
Economics and Financing

The article submission deadline for the Fall 2013 issue is **Friday, April 5, 2013**. For submission requirements, visit www.awsps.org/publications/watershed-science-bulletin.html .

Upcoming Events

- October 24, 2012, 12–2 p.m., Webcast: Leaving You Out in the Rain—Design & Implementation of Monitoring Projects (www.cwp.org/our-work/training/webcasts)
- December 12, 2012, 12–2 p.m., Webcast: Customizing Your Stormwater BMP Design for Specific Pollutants (www.cwp.org/our-work/training/webcasts)

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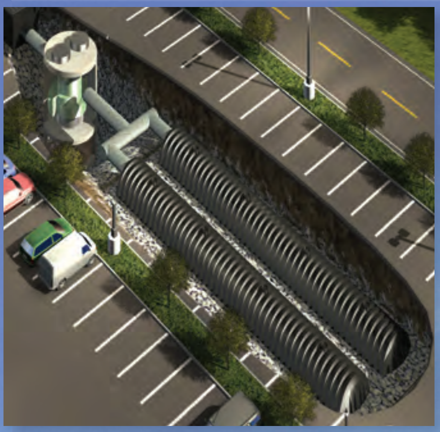

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