WATERSHED SCIENCE BULLETIN

FALL 2010

AWSPs
Association of Watershed & Stormwater Professionals

Journal of the Association of Watershed & Stormwater Professionals

A program of the Center for Watershed Protection, Inc.

Total Maximum Daily Loads (TMDLs)

Innovations and Implementation

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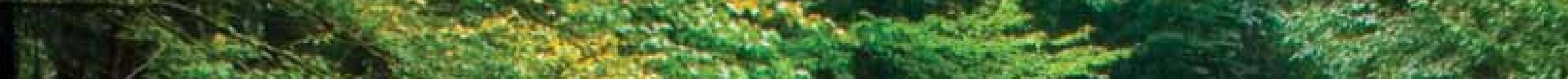

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MISSION: The mission of the *Watershed Science Bulletin* (the *Bulletin*) is to synthesize research and experience from the numerous disciplines that inform watershed management and transmit this valuable information to researchers, regulators, practitioners, managers, and others working to protect and restore watersheds everywhere.

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This photo was taken along Pocono Creek in Monroe County, PA, near Camelback Mountain. Like many streams in Pennsylvania, it is dominated by a forested watershed and provides critical habitat for trout populations. Some tributaries in the Pocono Creek watershed qualify for the highest level of water quality protection under Pennsylvania regulations. Population growth and the resulting urbanization and hydrologic changes are a threat to the health of the watershed.

From the Editor's Desk

Welcome to the inaugural issue of the Watershed Science Bulletin! *This journal has been a long time coming, as we at the Center for Watershed Protection have ruminated for years about reviving our well-received journal Watershed Protection Techniques. We decided to launch a new journal that differs substantially from Techniques by featuring peer-reviewed content from researchers and professionals in the watershed and stormwater discipline, rather than using primarily Center-generated content. We strive to find and feature the best work from our colleagues to appeal to a broad range of people who are working or volunteering to protect and improve our watersheds. The Bulletin also serves the members of the Center's newly formed Association of Watershed and Stormwater Professionals, who look to the Center to help translate the research and require easy access to this information.*

We decided to tackle one of the most difficult topics first, since most watershed and stormwater professionals will have to deal with total maximum daily loads (TMDLs) in some way, shape, or form, given that *at least half* of our country's waters are impaired. We quickly learned that, because TMDLs are so complex and because they address watershed issues, it is nearly impossible for one person to be an "expert" in all things TMDL. So we've pulled together an issue that represents the collective expertise in topics such as modeling, monitoring, best management practice (BMP) design, TMDL policy, watershed planning, stormwater permitting, stakeholder outreach, and more. The Bulletin content is tailored to its unique audience—which includes a range of folks from academics to advocates—and contains both peer-reviewed research papers and case studies as well as short "vignettes" to highlight innovative aspects of some TMDL programs that can be transferred to other communities. Perspectives from professionals having extensive experience with TMDLs provide additional context on both the history and the future of TMDLs.

While not applicable for all TMDLs, we at the Center believe strongly in taking a watershed approach to water resource management issues; therefore, we are always seeking opportunities to use watershed planning to meet TMDL implementation goals in order to reduce costs and duplication of effort and to provide other benefits. In its 2008 draft *Handbook for Developing Watershed TMDLs*, the US Environmental Protection Agency (USEPA) lists such benefits as: the ability to prevent future impairments that necessitate the development of new TMDLs, a quantitative linkage between on-the-ground actions and the attainment of water quality standards, and the provision of a framework for implementing other watershed-based source controls, such as watershed-based permitting and water quality trading.

In developing this issue, we found that many questions related to TMDLs spark healthy (and sometimes heated) debate in the watershed community. Below is a selection of the two most pertinent questions and how they are addressed by the enclosed articles and vignettes.

How can we address the challenges of developing TMDLs for urban watersheds?

Stormwater discharges from municipal separate storm sewer systems (MS4s) are treated as point sources in the context of a TMDL, yet this approach does not reflect the variety and number of urban pollution sources, the variety of pollutants associated with these sources, and the complex interactions among watershed variables that ultimately determine water quality at the outfall. This also causes difficulty with translating numeric water quality–based wasteload allocations into National Pollutant Discharge Elimination System (NPDES) permit requirements. A second challenge is that many urban streams are impaired by runoff from portions of the watershed that are not regulated under NPDES permits, making it difficult to enforce implementation. Third, the specific causes of impairment in many urban streams are unknown, and the sources of impairment are biological instead of pollutant-specific, making TMDL development more challenging. Fourth, the TMDL and NPDES stormwater programs have very different structures and political boundaries. Lastly, because states are not explicitly required to account for future urban growth in the TMDL (a symptom of the broader disconnect between land use control and environmental mandates such as TMDLs), it is unknown whether communities will be able to meet the required load reductions under their planned growth scenarios.

Papers by **Arnold et al**. and **Hubbart et al.** in this issue describe TMDLs that use impervious cover and flow, respectively, as surrogates for specific pollutants when the sources of impairment are unknown. In both cases, TMDL implementation involves reducing runoff in the watershed to a certain extent and measuring progress toward improvements by evaluating the instream biological community. **Lindow et al.** provide an example of how one community is using its MS4 permit to help meet its TMDL requirements. Owen et al. also discuss the integration of TMDLs and NPDES, focusing on a collective permitting approach to the problem of meeting TMDL goals in a watershed with urban sources of impairment that are primarily unregulated under NPDES. Similarly, **Thermal Load Trading in the Tualatin River Basin: A Watershed-based NPDES Permit** describes an example in which the MS4 permit provides a mechanism to restore riparian areas throughout both the urban and rural areas of a watershed, as the loss of shade in these areas has significantly contributed to the river's impairment.

What basic level of modeling and monitoring is needed to develop and implement a TMDL?

This is one of the top questions asked by state and local governments and consultants who are tasked with developing and/or implementing TMDLs. Additionally, results with high certainty and low cost are key. Uncertainty exists at all levels of TMDL development and implementation as a result of modeling assumptions and parameter limitations as well as gaps in the data on BMP performance, pollutant loads, and the cumulative effects of implementation on stream health. Little consistency can be found in the type or extent of modeling used in the TMDL process. This is evident from a quick glance through USEPA's 2007 report, *TMDLs with Stormwater Sources: A Summary of 17 TMDLs*. The report lists 30 unique models that were used to develop the 17 TMDLs reviewed in the study; 1 TMDL alone used 7 different models.

An adaptive approach to TMDLs (as recommended by the National Research Council's 2001 report *Assessing the TMDL Approach to Water Quality Management*) has been touted as one way to address the uncertainty inherent in TMDLs in a cost-effective and timely manner. In theory, an effective adaptive implementation approach—sometimes called adaptive management (AM)—allows local governments to immediately begin implementing pollutant reduction measures (usually focusing on measures with known benefits, low cost, and/or high public acceptance), even in the face of uncertainty. Concurrent with implementation, additional data are collected to improve understanding about the causes of impairment and the appropriateness of the TMDL targets and to determine whether the TMDL goals are being met. The results are then used to revise the TMDL if needed or to make adjustments to the implementation plan. An AM approach to TMDL implementation in the Lake Tahoe region is described by **Grismer et al.**, while **Lake Clarity Crediting Program for Lake Tahoe: An Adaptive Management Approach for Water Quality Credits** highlights how the data being collected inform how credits are awarded for restoration actions. One critical piece of the AM approach is to clarify up front what additional information will be collected and how it will be collected and used to revise the TMDL process.

While complex models are often used to develop TMDLs, it may not be practical for many local governments to extend the use of these models to support implementation decision-making and tracking because of their cost and complexity. In addition, most models used for TMDL development are not designed to track pollutant reductions associated with the wide range of activities that may be recommended as part of a TMDL (e.g., street sweeping or education programs). **Smith et al.** and **Lindow et al.** describe the use of a simple spreadsheet model for tracking TMDL implementation that is easy and inexpensive for local governments to use; this model also accounts for load reductions associated with nonstructural BMPs. Another modeling approach that supports decision-making for TMDL implementation and emphasizes cost-effectiveness is illustrated in **Optimizing Resources to Achieve Pollutant Reductions in Wisconsin**. This vignette describes the use of an optimization model to identify the optimal combination of load reduction strategies for the Lower Fox River and Green Bay.

In urban watersheds where surrogates, such as impervious cover or flow, are used as TMDL targets in lieu of specific pollutants, supporting data are required to establish the links among the surrogate metric, pollutants, and stream conditions. **Hubbart et al.** describe a monitoring approach to collecting data that can be used to support and refine a flow-based TMDL. To make the most of limited resources, this monitoring approach was designed to collect data that are scalable and transferable. **Reducing DDT and Sediment Loads in the Yakima River: A Success Story** also illustrates good use of limited monitoring resources, as the parties involved used sediment as a surrogate for DDT based on an established correlation between the two pollutants and the significantly lower cost of monitoring sediment. This example also shows that we are indeed making progress, as an 80% reduction in daily sediment loads was measured after the first four years, allowing the state department of health to lift the fish consumption advisory. We anticipate having a future issue of the Bulletin dedicated to the ongoing discussion about watershed modeling and monitoring.

We hope you enjoy this issue. Thanks for reading!

–Karen Cappiella, *Editor-in-Chief*

Overview: The ABCs of TMDLs

A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards.

(US Environmental Protection Agency n.d.[b])

TMDL Basics

Section 303(d) of the Clean Water Act (CWA) requires each state, territory, and authorized tribe to develop water quality standards for all water bodies under its jurisdiction. This process includes the identification of designated uses (e.g., fishing, swimming, or water supply) for each water body, the definition of numeric or narrative water quality criteria that correspond to these designated uses, and the establishment of provisions to maintain and protect the uses. These jurisdictions must then monitor their waters to identify water bodies or water body segments that are *impaired*, meaning that they are too polluted or otherwise degraded to meet the water quality standards. The cause(s) of each impairment must also be included in the listing. The CWA requires that these jurisdictions develop total maximum daily loads (TMDLs) for their impaired waters (Figure 1). A TMDL, often described as a *pollution budget*, is "a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards," according to the US Environmental Protection Agency (USEPA n.d.[b]), who administers the TMDL program.

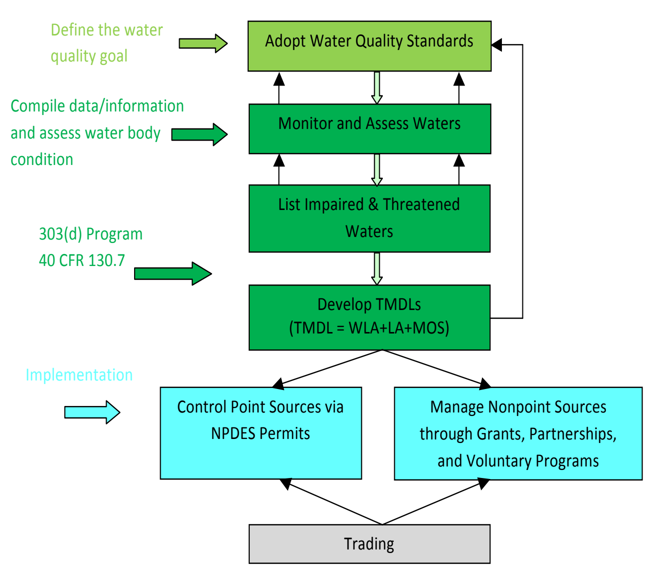

Figure 1. Water quality–based approach of the CWA. (Source: USEPA n.d.[b]) LA, load allocation; MOS, margin of safety; NPDES, National Pollutant Discharge Elimination System; WLA, wasteload allocation.

A TMDL, which also describes how pollutant loads coming from various sources must be reduced to meet the water quality standards, is usually based on modeling, monitoring data, or a combination of both. Each TMDL includes three major components:

1. Wasteload allocations from point sources
2. Load allocations (LAs) from nonpoint sources and natural background conditions
3. A margin of safety (MOS) to account for uncertainty in the various aspects of TMDL development

Typically, a TMDL is developed for a single impaired stream segment. USEPA recently published guidance for the development of watershed TMDLs such that multiple impaired segments within the same watershed can be addressed within a single TMDL. As noted in USEPA (2008, 3), "watershed TMDLs can help states to reduce their per-TMDL costs and address more pollutant–waterbody combinations with the given resources while recognizing a number of environmental and programmatic benefits."

TMDL implementation plans are not specifically required under the CWA, although they are often developed by states as part of the TMDL or as a separate document. TMDL implementation plans describe more specifically the actions needed to meet the required point source and nonpoint source reductions. These actions include a wide range of best management practices as well as the enforcement of more stringent permit requirements for industrial and wastewater discharges, which can be met using enhanced treatment technologies. Typically, implementation falls to the counties, cities, and other municipalities located within the TMDL watershed since these entities are primarily responsible for local land use regulation and implementation of National Pollutant Discharge Elimination System (NPDES) permits.

USEPA encourages the use of water quality trading for certain pollutants where it can help achieve CWA goals. In water quality trading, one entity compensates another entity to reduce a defined amount of pollution. Such trading costs less than the implementation of pollution control measures by the original entity itself and provides the same or greater

Responding to the First Impervious Cover–based TMDL in the Nation

Chester L. Arnold,[a] Christopher J. Bellucci,[b] Kelly Collins,[c] and Rich Claytor[d]*

Abstract

In 2007, the Connecticut Department of Environmental Protection promulgated the first total maximum daily load (TMDL) in the country based on impervious cover. This TMDL, developed as a way to deal with streams impaired by poorly understood urbanization-related impacts, is for Eagleville Brook, a small watershed that drains much of the University of Connecticut campus. What is an *impervious cover TMDL*? This article reviews the status and findings of an ongoing project designed to devise an effective and pragmatic response to this new approach. Using the language in the TMDL itself as a starting point, the project team focused on impervious cover disconnection and the related goal of reducing stormwater runoff volume. However, the "bottom line" of improving biota-based indicators of stream health will also require approaches beyond what would result from a strict focus on impervious cover. Based on geospatial data analysis followed by extensive field work, the project team has identified 51 retrofit opportunities, including a "Top Ten" list that attempts to maximize both the environmental and social or educational impacts of the response. Although the watershed plan has not yet been written, considerable progress has been made on campus, including the replacement of conventional parking lots with pervious materials and changes to plans for upcoming construction. The team's preliminary conclusion is that combining the simple framework of impervious cover with the force and accounting rigor of a TMDL can be an effective way to catalyze communities to plan and implement actions to remediate stormwater problems.

Introduction

Watershed professionals have long recognized that impervious cover is a useful indicator of the impact of watershed land use on the health of the receiving water body (Schueler 2003; Brabec et al. 2002). This relationship integrates a complex web of impacts resulting from urbanization. As an indicator, impervious cover has the potential to be widely applied to various land use planning and design scenarios (Arnold and Gibbons 1996)—an approach that has earned both praise and criticism for its simplicity. The total maximum daily load (TMDL) program mandated by the Clean Water Act, on the other hand, can be said to take quite the opposite approach. It is very site-specific and can be implemented with confidence only when scientific understanding of a particular water body and the fate and transport of specific pollutants within that system is sufficiently comprehensive. This approach, too, has both fans and detractors.

Can these two approaches be wedded successfully? The ongoing Eagleville Brook Impervious Cover TMDL Project, a partnership of the Connecticut Department of Environmental Protection (CTDEP), the University of Connecticut, and the Town of Mansfield, aims to answer this question. This article summarizes the project's progress to date, focusing on project approach and methods rather than technical results.

The Genesis of the Impervious Cover TMDL

Connecticut is an urbanizing state. During the 21-year period from 1985 to 2006, the state added approximately 616 km^2 of land comprising the *development footprint*, as determined by remote sensing land cover data. This represents almost 5% of the entire area of the state (Center for Land Use Education and Research [CLEAR], University of Connecticut n.d.). As might be expected, urbanization is a major cause of water quality impairment in the state. Of the 105 impaired stream segments listed by CTDEP in 2006 as *not meeting water quality standards*, CTDEP attributed this status to urbanization for at least 58%; for another 40%, the agency attributed it to unknown causes (Bellucci 2007).

Under Section 303(d) of the federal Clean Water Act, Connecticut is required to develop TMDLs for these 105 stream segments. But as a practical matter, how does one apply the data-intensive TMDL program to so many water bodies, most of which are suffering from what has been called *urban stream syndrome*, a complex and synergistic combination of hydrologic alteration and multiple pollutant stressors (Walsh et al. 2005)? As Bellucci (2007) notes:

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