United States Environmental Protection Agency New England

Restoring Impaired Waters: Total Maximum Daily Loads (TMDLs) and Municipal Stormwater Programs

EPA 901-F-09-002

April 2009

Executive Summary

Does your NPDES-regulated municipal separate storm sewer system (MS4) discharge to a pollutant-impaired waterbody with an approved Total Maximum Daily Load (TMDL)? If so, you might need to modify your municipal stormwater management program to comply with your state or federal MS4 permit and take actions to help restore that waterbody.

This fact sheet describes how municipal stormwater managers can help implement TMDLs for impaired waters and improve water quality by implementing stormwater management programs required by MS4 permits. This fact sheet also describes how development and land-use changes affect stormwater and water quality and how our regional rainfall pattern can affect the choice and sizing of stormwater best management practices (BMPs). New tools and references are offered to help MS4s implement stormwater source TMDLs by using BMPs, including low impact development (LID) practices.

TMDLs

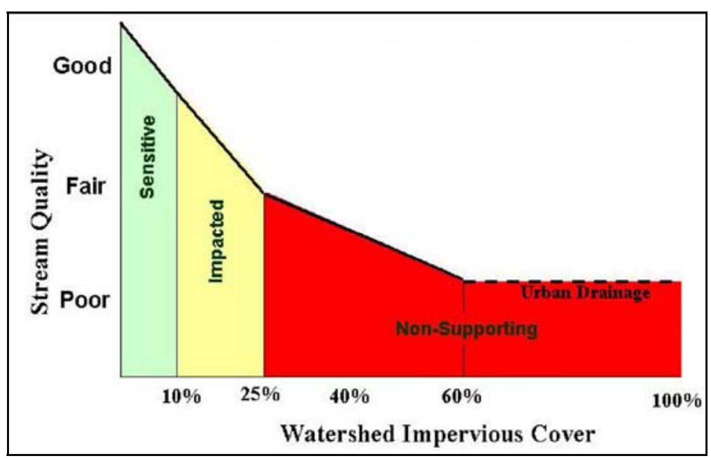
To restore water quality, states are required to develop TMDLs, or maximum pollutant loading targets, for their pollutant-impaired waters (under section 303(d) of the Clean Water Act). Where a TMDL is approved and establishes a pollutant allocation for stormwater discharges to a receiving water, subsequently issued NPDES stormwater permits must include provisions to implement such allocations. Therefore, regulated stormwater dischargers (e.g., an operator of a regulated MS4, industrial facility, or construction site) are responsible for implementing practices to achieve the TMDL.

Land Use and Stormwater—Impacts on Hydrology, Habitat, and Water Quality

In New England, as elsewhere, land development has changed our landscape by developing natural areas into buildings, parking lots, roads, and other impervious surfaces (referred to as **impervious cover**). In undeveloped areas, 80 to 90 percent of precipitation is normally taken up by vegetation or infiltrates into the ground where it contributes to the base flow of nearby streams; this is consistent with the natural hydrologic cycle. When natural land cover is removed and converted to impervious surfaces, the hydrologic cycle is altered, resulting in increased surface runoff and stormwater discharges to nearby lakes, streams, and estuaries. This increase in volume, rate, and frequency of surface flow can erode stream channels and transport additional pollutants to receiving waters. With less precipitation infiltrating into the ground, less water is available to recharge groundwater and to maintain base flows in streams during dry seasons—a situation that can damage aquatic habitat, threaten ecosystems, and deplete water supplies.

Pollutants that accumulate on impervious surfaces during dry weather typically include sediments, nutrients (often bound to sediment particles), and bacteria (often from pet waste). Toxic metals (such as zinc, lead, and copper) are also deposited from the wear of automobile tires and brake pads, fuel combustion, weathering of paints, galvanized gutters and downspouts. These pollutants are quickly washed off and delivered to downstream waters during storm events. Today, polluted stormwater runoff is a major cause of water quality impairment in New England.

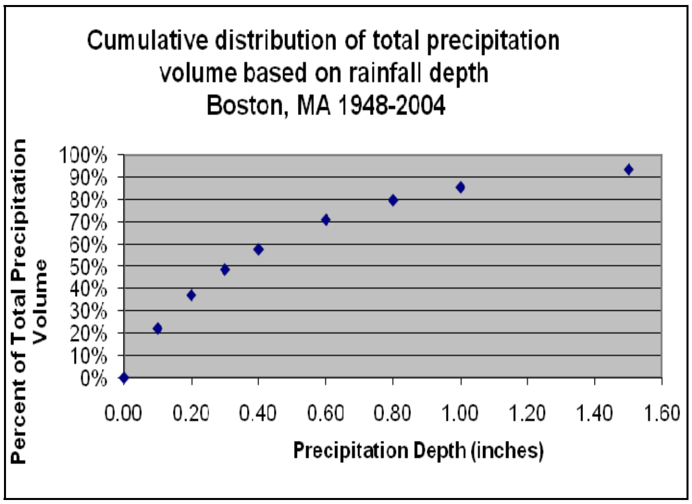
Research has shown that there is a strong correlation between runoff from impervious land cover in a watershed and stream quality. In addition, impervious cover (IC) has been associated with increased pollutant delivery through increased flows. For this reason, an increasing number of TMDLs in the region use a maximum percentage IC value as a surrogate for stormwater pollutant load allocations. The maximum percentage IC value is also used for protecting hydrology and habitat. (See the example on page 3.)



Watershed IC vs. stream quality. (Source: Center for Watershed Protection: Impacts of Impervious Cover on Aquatic Systems)

Regional Rainfall Patterns and BMPs for Water Quality

In New England, rainfall totals average about 43 inches per year (spread over 100 storms). Ninety-three percent of the storms that occur in the region result in one inch or less of rainfall. These one-inch storms produce 80 to 90 percent of the total annual precipitation volume. BMPs designed to capture and treat up to a one-inch storm are therefore capable of addressing a substantial portion of runoff, providing necessary pollutant or impervious cover reductions to support achievement of TMDL wasteload allocations discussed below. Controlling the one-inch storm in New England is essential for protecting water quality and reducing stormwater volume. This can be effectively managed by stormwater BMPs including LID techniques.



Cumulative distribution of total precipitation volume on the basis of rainfall depth- Boston, Massachusetts, 1949–2004. (Source: Tetra Tech for EPA: Stormwater Best Management Practices (BMP) Performance Analysis)

What are LID techniques?

LID practices and infiltration BMPs attempt to preserve predevelopment hydrology through minimizing runoff. MS4s could use LID techniques to manage precipitation from storms less than one inch, which commonly occur in New England. For more information, see fact sheets listed in the resource section and posted at **http://www.epa.gov/region1/npdes/stormwater**

Complying with TMDL Provisions of MS4 Permits

Stormwater permits include requirements with which municipal and other dischargers need to comply to help achieve applicable wasteload allocations established in TMDLs. For municipalities, requirements could include stormwater management program revisions that do the following:

- Develop or enhance local land development regulations to require or **encourage LID practices**
- **Create an inventory**, prioritize and document municipal property and infrastructure suitable for retrofit, and that have been retrofitted with LID BMPs
- **Document** the increase or decrease in **impervious area** within its jurisdiction
- Improve **pollution prevention** and maintenance practices addressing the pollutant(s) of concern
- Include water quality monitoring and **assessment of progress**

Accordingly, MS4s might find it useful to create an inventory of existing structural/nonstructural BMPs and then determine the current stormwater volume, pollutant load, or impervious cover reductions from these practices on the basis of estimated or modeled reduction estimates. It is also helpful to calculate the size of the drainage area served by the BMP.

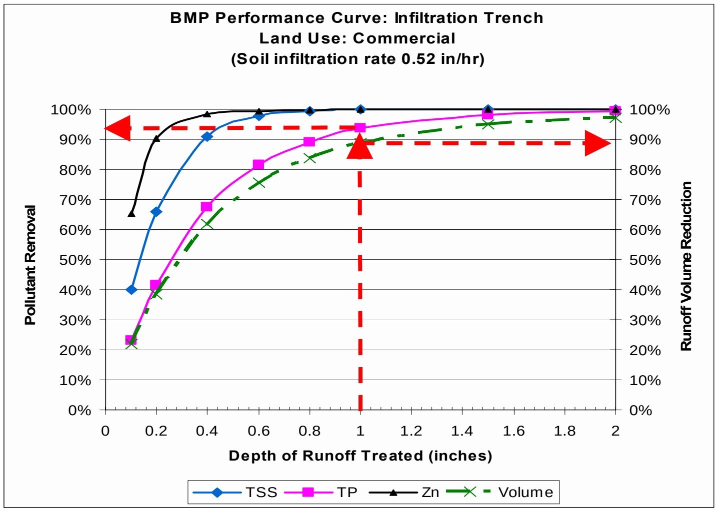
Impervious cover (IC) is a reliable and convenient measurement for municipalities because:

- Research has shown there is a strong correlation between impervious land cover and in-stream water quality
- IC is associated with increased stormwater flows and pollutant loads
- IC can be used for issuing credits for existing or new BMPs installed
- IC can be used to track BMPs and interim progress for NPDES permits

In summary, the information from a BMP inventory and tracking system will help document compliance with the TMDL and satisfy NPDES regulations that require MS4s to assess the effectiveness of the stormwater BMPs used in reducing the stormwater discharge.

To help municipalities and others in selecting and sizing stormwater BMPs, EPA New England developed BMP performance curves to estimate pollutant reduction and, for some BMPs, runoff reduction. Pollutant-reduction estimates for phosphorus, total suspended solids, and zinc have been developed for the following BMPs: infiltration trench, infiltration basin, gravel wetland, bioretention area, porous pavement, water quality swales, wet retention pond (wet basins) and extended dry detention (dry basins). Also, for the two infiltration BMPs, EPA developed runoff volume reduction curves to provide an estimate of effective reduction in IC. The report is at

http://www.epa.gov/region1/npdes/stormwater/assets/pdfs/BMP-Performance-Analysis-Report.pdf



BMP optimization curve displaying estimated pollutant and runoff volume reduction for various depths of runoff treatment. (Source: Tetra Tech for EPA: Stormwater Best Management Practices (BMP) Performance Analysis)

Connecting MS4s with their TMDLs in New England

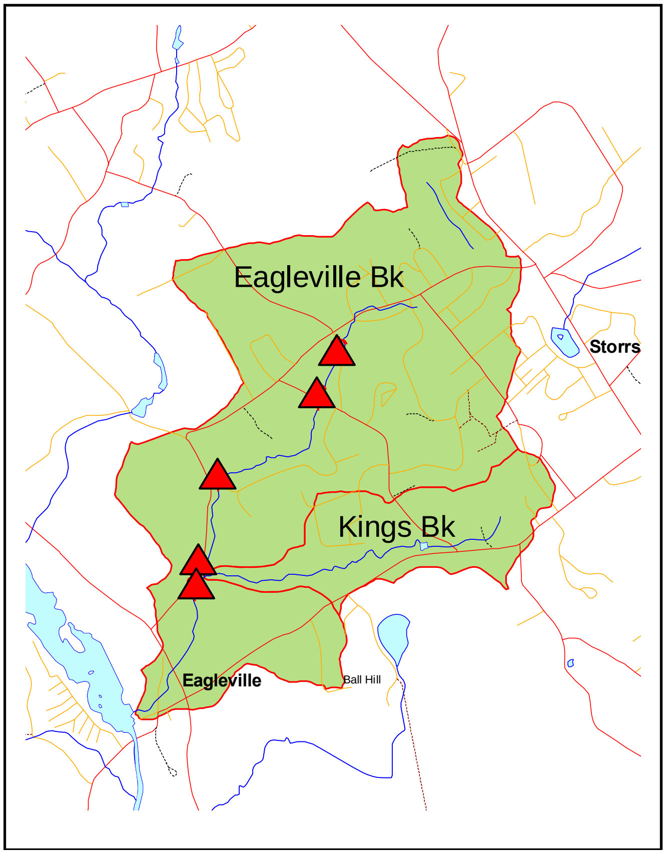
- In Massachusetts and New Hampshire, EPA Region 1 (the NPDES permitting authority) is providing maps of impaired waters for MS4s with lists of approved TMDLs, locations, and aerial extent of directly connected impervious cover (estimated) by subwatershed. These maps will provide tools for a long-term approach to reduce directly connected impervious cover and promote infiltration and evapotranspiration where appropriate. **http://www.epa.gov/region1/npdes/stormwater**
- Maine Department of Environmental Protection and Connecticut Department of Environmental Protection both invite MS4s and other stakeholders to participate in developing and reviewing stormwater TMDLs for impaired waterbodies in their jurisdiction. Outreach includes stakeholder meetings and thorough written responses to public comments.
- In Vermont, MS4s were involved with Vermont Department of Environmental Conservation in the statewide development of TMDLs for stormwater-impaired streams, and they are key partners in developing implementation strategies.
- Rhode Island Department of Environmental Management notifies all affected MS4s when EPA approves a TMDL for an impaired waterbody.

Collaborative Restoration Example: Eagleville Brook, Connecticut—An Impervious Cover TMDL

Watershed Overview

The Eagleville Brook watershed drains a portion of the University of Connecticut (UConn) campus in Mansfield, Connecticut. It has a 2.4-square-mile drainage area and is a tributary to Eagleville Pond, an impoundment of the Willimantic River. Biological monitoring showed that the aquatic life use goals were not being met in Eagleville Brook. All sites were identified as impaired, and a TMDL was developed with a goal of reducing the effects of stormwater on Eagleville Brook's aquatic life.

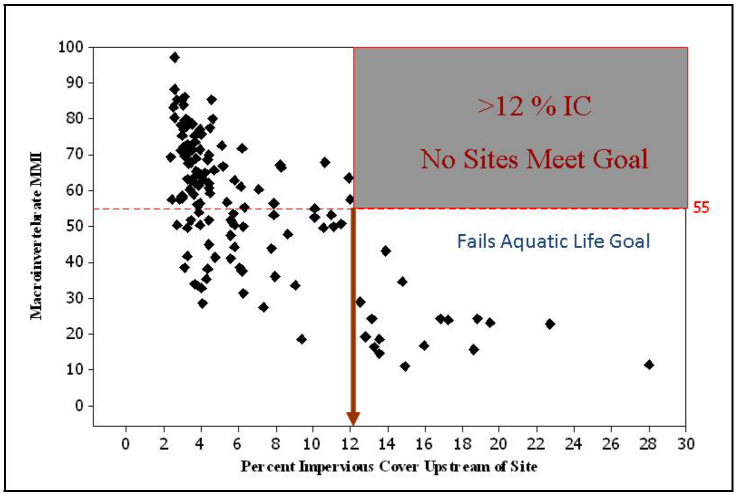
Because the cause of the impairment in Eagleville Brook was unknown at the beginning of the investigation, a stressor identification (SI) analysis was completed to determine the most probable cause(s) of the impairment. The SI determined that a complex array of pollutants transported by stormwater was the most probable cause of impairment in Eagleville Brook.



Map showing the location of fish and macroinvertebrate sampling sites along Eagleville Brook. (Source: Connecticut Department of Environmental Protection: TMDL Analysis for Eagleville Brook, Mansfield, Connecticut)

TMDL Development

On the basis of the strong correlation between watershed impervious cover and stream water quality, Connecticut Department of Environmental Protection (CT DEP) developed the Eagleville Brook TMDL using IC as a surrogate parameter for the mix of pollutants conveyed by stormwater. The TMDL was established as percent of IC (% IC) in the watershed as a whole that must be achieved to meet the aquatic life criteria and attain the designated aquatic life uses. The wasteload allocation target was set at 11% IC (with a 1% IC explicit margin of safety), and EPA approved the TMDL in February 2007. For more details, see **http://www.ct.gov/dep/tmdl**.



Connecticut IC model: macroinvertebrate MMI (multimetric index—a measure of macroinvertebrate community health) vs. % IC. (Source: CT DEP: TMDL Analysis for Eagleville Brook, Mansfield, Connecticut)

TMDL Implementation

Implementing this IC-based TMDL involves a collaborative effort among UConn, CT DEP, and the town of Mansfield. The goal of reducing stormwater effects on Eagleville Brook's aquatic life involves an adaptive management strategy that will strive to

- Reduce IC where practical
- Disconnect IC from the surface waterbody
- Minimize additional disturbance to maintain existing natural buffering capacity
- Install engineered BMPs to reduce the effect of IC on receiving water hydrology and water quality

Following are implementation actions that are underway and planned for the future in the Eagleville Brook watershed:

- Create a site-level map to locate directly connected impervious areas
- Hold technical meetings among project partners to discuss the range of opportunities for reducing the effective IC of the watershed and tie this work into other initiatives and activities already underway on campus
- Conduct a field survey and analysis to develop specific stormwater practices and retrofit recommendations, ranked for efficiency
- Prepare schematic designs and cost estimates for selected high-priority stormwater practices
- Develop a final water quality management plan, addressing both existing and new development
- Design a series of educational programs for the town land use commission that address general planning and design approaches to stormwater control with specifics for Eagleville Brook

Assessing Effectiveness

CT DEP will assess compliance with the TMDL by directly measuring the aquatic life, according to its rotating basin monitoring strategy. Benthic macroinvertebrate samples will provide the primary aquatic health measure, with additional fish collection data provided by the Connecticut Inland Fisheries Division. An interim measure to assess progress could involve tracking the IC elimination/disconnection or equivalent IC reduction in the watershed during BMP implementation.

Biological Indicators

Measuring in-stream metrics of biotic integrity is an effective way for state agencies to document whether aquatic life uses and state water quality standards are attained. Benthic macroinvertebrates (organisms that attach to rocks on stream bottoms) are fixed in place, integrate all the effects of excessive stormwater runoff, and provide a direct measure of environmental response to stormwater management remediation efforts. Research has shown a direct relationship between the biological condition of the waters receiving stormwater runoff and the amount of impervious land cover in the watershed.

Additional Resources

This fact sheet is one of a series of four prepared by EPA New England. The others are listed below and are on the EPA New England website:
http://www.epa.gov/region1/npdes/stormwater

- *Funding Stormwater Programs*
- *Incorporating Low Impact Development into Municipal Stormwater Programs*
- *Managing Stormwater with Low Impact Development Practices: Addressing Barriers to LID*

For other EPA and non-EPA websites, see the following:

EPA New England's link to state 303(d) lists of impaired waters
http://www.epa.gov/region1/eco/tmdl/impairedh2o.html

EPA New England's link to EPA's TMDL approvals, and state TMDLs
http://www.epa.gov/region1/eco/tmdl/approved.html

Center for Watershed Protection website
http://www.cwp.org
See: Watershed Protection Research Monograph No. 1, *Impacts of Impervious Cover on Aquatic Systems*, March 2003.

EPA Region 1 TMDL website at
http://www.epa.gov/region1/eco/tmdl/regionalpgrfs.html.

EPA Headquarter's TMDL and Stormwater website
http://www.epa.gov/owow/tmdl/stormwater

Direct links to Impervious Cover (IC) support manuals:

Stormwater TMDL Implementation Support Manual
http://www.epa.gov/region1/eco/tmdl/assets/pdfs/Stormwater-TMDL-Implementation-Support-Manual.pdf

Pilot TMDL Applications Using the Impervious Cover Method
http://www.epa.gov/region1/eco/tmdl/assets/pdfs/ensr_pilot/ENSR_PilotTMDLsusingICM.pdf

Stormwater Best Management Practices (BMP) Performance Analysis, December 2008
http://www.epa.gov/ne/topics/water/stormwater.html or direct link at
http://www.epa.gov/region1/npdes/stormwater/assets/pdfs/BMP-Performance-Analysis-Report.pdf

Contacts

EPA New England - Ray Cody

Cody.ray@epa.gov

617-918-1366

The following Nonpoint Education for Municipal Officials or *NEMO* programs provide education and assistance to municipal officials on stormwater management.

Connecticut

http://www.nemo.uconn.edu

John Rozum
Connecticut NEMO Director

E-mail: john.rozum@uconn.edu
Phone: 860-345-5225

Maine

http://www.mainenemo.org

LaMarr Clannon
Maine NEMO Coordinator

E-mail: lcannon@maine.rr.com
Phone: 207-771-9020

New Hampshire

http://www.extension.unh.edu/CommDev/NROC/CANROC.cfm

Julia Peterson
Extension Specialist

E-mail: julia.peterson@unh.edu
Phone: 603-749-1565
Amanda J. Lindley Stone
Natural Resources Outreach Coalition Coordinator

E-mail: amanda.stone@unh.edu
Phone: 603-364-5324

Rhode Island

http://www.uri.edu/ce/wq/NEMO

Lorraine B. Joubert
Water Resource Specialist

E-mail: ljoubert@uri.edu
Phone: 401-874-2138

Lisa DeProspo Philo
Communications Specialist

E-mail: lphilo@uri.edu
Phone: 401-874-5687

Vermont

http://www.uvm.edu/~seagrant/education/default.html

Emma Melvin
Water Quality Educator

E-mail: emelvin@uvm.edu
Phone: 802-859-3086 x340

NOTE: This document is not law or regulation; it provides recommendations and explanations that MS4s can consider in determining how to comply with requirements of the Clean Water Act and NPDES permit requirements.

General Disclaimer: References in this fact sheet to any non-federal product, service, or enterprise do not constitute an endorsement or recommendation by the EPA.
Information Disclaimer: The information provided in this fact sheet is only intended to be general summary information to the public. It is not intended to take the place of written laws, regulations, permits, or EPA policies.

Website Endorsement Disclaimer: This fact sheet provides links to non-EPA websites which contain additional information that may be useful or interesting and are consistent with the intended purpose of this fact sheet. References in these websites to any specific commercial product, process, service, manufacturer, or company does not constitute its endorsement or recommendation by the EPA. The EPA is not responsible for the contents of non-EPA websites, and cannot attest to the accuracy of these websites.