United States Environmental Protection Agency

EPA 832F12016

Green infrastructure can help restore water quality and habitat in urbanizing watersheds.

Total Maximum Daily Loads

This factsheet is the fifth in a series of six on integrating green infrastructure concepts into permitting, enforcement, and water quality standards actions.

Integrating Green Infrastructure Concepts into Permitting, Enforcement, and Water Quality Standards Actions

This factsheet is the fifth in a series of six factsheets in the U.S. EPA Green Infrastructure Permitting and Enforcement Series (http://water.epa.gov/infrastructure/greeninfrastructure/gi_regulatory.cfm#permittingseries). This series describes how EPA and state permitting and enforcement professionals can incorporate green infrastructure practices and approaches into National Pollutant Discharge Elimination System (NPDES) wet weather programs, including stormwater permits, Total Maximum Daily Loads (TMDLs), combined sewer overflow (CSO) long-term control plans (LTCPs), and enforcement actions. This series builds upon EPA's continued investment in green infrastructure and low impact development. Existing EPA authority, guidance, and agreements enable EPA Regions and state agencies to work with permittees to include green infrastructure measures as part of control programs.

For additional resources on green infrastructure, go to the EPA Green Infrastructure Web page: http://water.epa.gov/infrastructure/greeninfrastructure/index.cfm.

Key green infrastructure guidance issued to date can be found at: http://water.epa.gov/infrastructure/greeninfrastructure/gi_policy.cfm.

This vegetated swale retains and treats stormwater from the street and sidewalk, reducing the discharge of pathogens, sediments, metals, and other contaminants into receiving waters.

Introduction

Throughout the U.S., there are many waters listed for water quality impairments associated with combined sewer overflows (CSOs), storm sewer overflows (SSOs), and urban and suburban stormwater discharges. In addition to delivering pollutant loadings to receiving waters, the volume and energy of stormwater discharges can cause physical changes to water bodies. Green infrastructure practices can be implemented to reduce pollutant loadings and the volume of wet weather discharges, and help restore and protect water quality.

The purpose of this factsheet is to describe how Total Maximum Daily Loads (TMDLs) and TMDL implementation plans (IPs) can address the hydrological factors that contribute to impairments by including green infrastructure. This factsheet also summarizes two case studies to demonstrate the principles discussed.

Implementing TMDLs with Green Infrastructure

Section 303(d) of the Clean Water Act requires States (and authorized Tribes) to establish a list of waters for which technology-based effluent limits are not sufficient to implement water quality standards. After establishing the 303(d) list, States are required to create a TMDL for each impaired water body that calculates the maximum amount of pollutants the water body can receive and still meet water quality standards. Once these pollutant "budgets" or allocations are calculated, they can then be translated into management actions that are implemented through permitting and/or non-regulatory programs.

Currently there are thousands of 303(d)-listed waters in the U.S. for stormwater-source pollutants such as pathogens, nutrients, sediments, and metals. In addition, many listed waters have degraded habitat and/or impaired biological communities that are related to changes in natural hydrology that have occurred as development has taken place. Urban and suburban development often is associated with greater areas of impervious surfaces, resulting in increased stormwater volumes and velocities, which are highly erosive and degrade stream and lake habitats. As land use increasingly becomes more urbanized, water body impairments from stormwater sources likely will increase, requiring additional TMDLs.

The following sections discuss how green infrastructure concepts and practices can be integrated into TMDLs and TMDL IPs to help restore impaired waters.

Future Growth

EPA's regulations at 40 CFR §130.2(i) and §130.7 define a TMDL as the sum of wasteload allocations (WLAs) for point sources plus load allocations (LAs) for nonpoint sources plus a margin of safety (MOS) to account for uncertainty. Mathematically, a TMDL can be expressed as follows:

$$\text{TMDL} = \sum(\text{WLA}) + \sum(\text{LA}) + \text{MOS}$$

WLAs are loads allotted to existing and future point sources, and LAs are loads allotted to existing and future nonpoint sources plus loads from natural background. "Future growth allowances" in TMDLs account for anticipated new or increased pollutant loadings. For instance, in areas where land use changes are anticipated, TMDLs can include a reserve for increased loadings of pollutants caused by land use changes or future population growth. This reserve can be expressed as a distinct element in the mathematical expression above, or included in the WLAs or LAs. For example, if the population being served by a municipal wastewater treatment plant is expected to grow, the volume of the discharge from the wastewater treatment plant (WWTP) would also be expected to grow. In a case like this, the TMDL might include a "future growth allocation" for the WWTP discharge reflecting any additional pollutant loadings expected as a result of population growth.

A "future growth allocation" can also be included in the TMDL for stormwater discharges if significant land use changes are expected to occur in the drainage area. For example, if open space and farmland are predicted to be converted to residential and industrial land uses, there will be more imperviousness in the drainage area. The volume of stormwater and the pollutant loadings for many constituents will likely increase when the development occurs. In situations such as this, the TMDL may include a "future growth allocation" reflecting the expected increases in pollutant loadings from stormwater discharges.

A "future growth allocation" for stormwater will typically reflect at least two factors:

1. The anticipated extent of new development (future growth), i.e., how much land area will convert from open space or agricultural uses to more intensive land uses.
2. The anticipated design of the new development areas, i.e., will conventional development practices be implemented, or will green infrastructure practices be widely implemented? The future growth allocation typically can be lower if green infrastructure practices will be systematically implemented.

In determining a "future growth allocation" for stormwater in a TMDL, population projections and land use plans can be used to estimate the future growth, and pollutant loadings associated with the future development can be estimated using various modeling tools. Typically, when green infrastructure practices are implemented, the "future growth allocation" for stormwater can be lower. If the "future growth allocation" for stormwater can be reduced by planning for green infrastructure practices, this may create more flexibility with regard to other allocations in the TMDL while still meeting overall pollutant reduction targets.

Implementation Plan

TMDL IPs describe the management actions that can be adopted to reduce pollutant loadings to meet the water quality targets identified in the TMDL. Although there are no federal requirements that IPs be approved by EPA or included in a TMDL, many States do develop IPs and/or include some implementation information in the TMDL. An IP can specifically discuss how green infrastructure



Effective green infrastructure approaches like rain gardens and swales help protect our waterways for safe recreational uses.

practices can help restore and protect water bodies, and can identify regulatory, permitting, or non-regulatory actions or programs to stimulate green infrastructure implementation. For example, a TMDL's implementation plan might discuss which stormwater management practices could be, or are expected to be, implemented to meet the WLA(s) or LA(s) in the TMDL.

A TMDL implementation plan could potentially also identify the long-term stormwater management controls needed to restore and protect impaired waters. These controls could be built into stormwater permits for construction sites and MS4 permits. The construction general permit for sites in the Big Darby Creek watershed in Ohio is an example of an NPDES permit that will foster green infrastructure implementation. The permit includes groundwater recharge requirements, which will be accomplished in many cases through use of green infrastructure practices. See:

http://www.epa.state.oh.us/dsw/permits/GP_ConstructionSiteStormWater_Darby.aspx

An IP can include mechanisms for implementing green infrastructure practices where they were anticipated in calculating the "future growth allocation." For example, local jurisdictions can establish requirements and standards for green infrastructure implementation in local codes and ordinances. The Conservation Design ordinance adopted by the Village of Homer Glen (Illinois) is an example of a local ordinance that will reduce stormwater volumes and pollutant loads from areas where new development occurs.

See: http://www.homerglenil.org/Ordinances/OR05-062ConstructionHours.pdf

Following are two additional examples of IPs which include green infrastructure components to control pollutant loads:

Machado Lake Toxics TMDL - Machado Lake in Los Angeles, California is impaired for pesticides and PCBs. The sources of impairments are primarily stormwater discharges. Numeric targets have been set for water, sediment, and fish tissue to protect aquatic life, fishing, and other recreational uses in the lake. WLAs are mass-based and established to control the suspended sediment associated contaminants. The implementation plan identifies various green infrastructure best management practices (BMPs) as effective means of controlling the pollutant loads. The implementation plan notes, "Structural BMPs may include the placement of stormwater treatment devices designed to reduce sediment loading, such as infiltration trenches, vegetated swales, and/or filter strips at critical points in the watershed. These types of BMPs generally reduce stormwater velocity, which allows sediment to settle out and to infiltrate runoff."

See: http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/79_New/2010_1122/final_staff%20report.pdf

Los Angeles River Bacteria TMDL - The Los Angeles River in California is impaired for bacteria, and this TMDL sets California's bacterial indicator standards for E. coli as the numeric targets. The implementation plan includes multiple GI approaches. BMPs such as retention, filtration, bioretention, and biofiltration are identified as methods to reduce pollutant loads. The implementation plan states, "Local, on-site, or subwatershed-based projects may be placed in parks, public land, vacant property, and other open spaces within the Los Angeles River Watershed.... The types of projects could vary significantly, but would generally focus on multiple benefits including water quality improvements, water conservation (either reduced water use or local recharge), and potentially recreation or aesthetic benefits." The plan estimates that 406 million gallons of water per day (MGD) could be managed by implementation of infiltration projects.

See: http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/80_New/LARiverFinal/Staff%20Report%20LAR%20Bact%2015Jul10%20final.pdf

Watershed Planning

In some cases, watershed organizations, municipalities, or regional planning agencies may develop watershed plans to restore and/or protect waters. Watershed plans that are developed or implemented with Clean Water Act Section 319 funds to address 303(d)-listed waters must include at least nine minimum elements.

See http://www.epa.gov/EPA-WATER/2002/August/Day-26/w21652.htm.

One of those nine elements is a description of the management measures that will need to be implemented to achieve target load reductions (as well as to achieve other watershed goals identified in the watershed plan). Where there are wet weather-related pollutant loadings or other impacts from stormwater (eroded stream channels, imbeddedness in the substrate), watershed plans can identify opportunities to use green infrastructure approaches to restore and protect water quality and aquatic habitat.

TMDL Case Studies

Supplement 2 of this fact sheet series (see [link]) provides information on two case studies where the hydrology of the watershed was specifically addressed as part of the TMDL: the Olentangy River (Ohio) and Barberry Creek (Maine).

The Olentangy River TMDL identifies the management of stormwater quantity and quality in developing areas as an important step to preserving natural stream function through channel protection, and restoring stream habitat in agricultural areas. Several sections of the TMDL describe implementation of green infrastructure measures to restore/maintain natural hydrology.

The Barberry Creek TMDL addresses the problem of metals from stormwater runoff through the reduction of impervious cover. The implementation plan contains discussion of green infrastructure practices including general stream restoration techniques, disconnection of impervious surfaces, and conversion of impervious surfaces to pervious surfaces.

Vegetated riparian zones act as a living filter, removing excess nutrients, sediment, and other contaminants from stormwater runoff. ***Photo courtesy of USDA NRCS***

Green roofs not only reduce stormwater discharges, but can provide habitat, reduce energy consumption, and provide aesthetic benefits as well. The green roof shown here is located in New York City.

Green Infrastructure Permitting and Enforcement Series

*This series on integrating green infrastructure concepts into permitting, enforcement, and water quality standards actions contains six factsheets plus four supplemental materials that can be found at **http://water.epa.gov/infrastructure/greeninfrastructure/gi_regulatory.cfm#permittingseries**.*

Factsheets

1. Potential Challenges and Accountability Considerations
2. Combined Sewer Overflows
3. Sanitary Sewer Overflows
4. Stormwater
5. Total Maximum Daily Loads
6. Water Quality Standards

Supplemental Materials

1. Consent Decrees that Include Green Infrastructure Provisions
2. Consent Decree Language Addressing Green for Grey Substitutions
3. Green Infrastructure Models and Calculators
4. Green Infrastructure in Total Maximum Daily Loads (TMDLs)

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For additional resources on green infrastructure, go to the EPA Green Infrastructure Web page: http://www.epa.gov/greeninfrastructure/.