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When rain falls on natural landscapes, much of it is intercepted by vegetation or absorbed into the soil.

Stormwater

This factsheet is the fourth 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 fourth 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.

Introduction

The Clean Water Act and applicable regulations require that stormwater discharges from regulated construction sites, industrial sites, and Municipal Separate Storm Sewer System (MS4) communities can only occur if covered by a NPDES stormwater permit. Stormwater permits typically require implementation of control measures and Best Management Practices (BMPs) to limit or minimize pollutant discharges. While the implementation of structural and nonstructural BMPs has helped reduce pollutant loadings, in many cases stormwater has nevertheless been found to contribute to water quality impairments. Adverse impacts have been identified which are due to the volume of stormwater discharges and the associated energy, which erode stream channels and lake shorelines and otherwise degrade habitat and water quality. The recent report of the National Research Council ("Urban Stormwater Management in the United States," National Academy of Sciences Press, 2008) recommends that the NPDES stormwater program treat flow as a pollutant and as a proxy for other pollutants, and include appropriate volume control requirements in stormwater permits:

> "Flow and related parameters like impervious cover should be considered for use as proxies for stormwater pollutant loading. These analogs for the traditional focus on the 'discharge' of 'pollutants' have great potential as a federal stormwater management tool because they provide specific and measurable targets, while at the same time they focus regulators on water degradation resulting from the increased volume as well as increased pollutant loadings in stormwater runoff."

The report emphasizes that the current program fails to effectively reduce stormwater pollutant discharges. It also describes how many traditional stormwater practices, and the permit language that drives them, fail to address the hydrologic modifications that increase stormwater runoff quantity, and cause excessive erosion and stream channel degradation. Frequently the most serious degradation to aquatic systems caused by stormwater is attributable to discharge volumes, durations and velocities. To protect and restore the physical, chemical and biological integrity of receiving waters, flow controls should be an important element of stormwater permits.

Green infrastructure will be an important component of most stormwater volume control strategies. Green infrastructure practices help reduce stormwater discharge volumes through infiltration, evapotranspiration, and capture and use. Permitting agencies can advance implementation of green infrastructure practices through stormwater permits.

Permit Language

Permits can be written to foster green infrastructure implementation in a number of ways, including:

- Establishing performance standards for post-construction stormwater volume control for sites undergoing development/redevelopment. Performance standards to control the volume of discharges and to mimic the pre-construction hydrology of a site will lead to implementation of BMPs and green infrastructure to infiltrate, evapotranspirate, and/or harvest and beneficially use stormwater.
- Requiring that green infrastructure/low impact development measures be considered/ implemented as part of local building and site development approval processes.
- Establishing ceilings on effective impervious area.

Land development often includes the construction of buildings, parking lots, roads, driveways, and other impervious surfaces. The new impervious surfaces and changes to landscapes alter the hydrology of sites or neighborhoods, leading to higher stormwater discharge volumes and higher pollutant loads. MS4 permits and construction stormwater discharge permits can include requirements for post-construction stormwater management to reduce or eliminate the negative effects of land development and new impervious surfaces.

Effective post-construction stormwater performance standards should be centered on maintaining or restoring stable hydrology in receiving waters by having post-construction hydrology mimic the natural hydrology of the area. One way of approach for this is to stipulate in permits that pre-development (i.e., stable, natural) hydrographs match post-development hydrographs. If this approach is used, the permit must be very clear that all variables of the hydrograph (volume, rate, duration, frequency) be matched, and not just the discharge rate. Unfortunately, many current hydrology standards focus only on discharge rate, which is primarily a flood control approach, i.e., extended detention. In addition, a pre-development condition should also be defined, and that condition should be one that is reasonably 'natural', not simply the conditions (perhaps already fairly impervious) that existed immediately prior to the current development project. The "pre-post hydrograph match" approach will generally involve an in-depth analysis for each development project, which means that site plan reviews by the municipality may also be more complicated and time consuming.

A simpler, but reasonably approximate "mimicking the natural hydrograph" approach can often be accomplished by specifying in the permit that the volume of water from a certain size storm be managed on site. An example of this is to estimate a storm size that would generally equate to the size of storm that would be managed in a natural forest or grassland environment with no discharge, and to require that this size of storm be managed on site at new development/ redevelopment sites. A thorough explanation of this approach can be found in the document "Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act," available at: http://www.epa.gov/owow/NPS/lid/section438/pdf/final_sec438_eisa.pdf. This document covers in detail the concept that managing a 95th percentile storm would result in a site/neighborhood hydrology similar to a natural condition, and how to plan site features, including in particular green infrastructure, to effectively manage stormwater on site.

Example Permits

The following are some examples of stormwater permits with relevant performance provisions.

West Virginia

The West Virginia Department of Environmental Protection has issued a small MS4 permit that includes the following performance standard for new and redevelopment projects:

> "Performance Standards. The permittee must implement and enforce via ordinance and/or other enforceable mechanism(s) the following requirements for new and redevelopment: […]
>
> Site design standards for all new and redevelopment that require, in combination or alone, management measures that keep and manage on site the first one inch of rainfall from a 24-hour storm preceded by 48 hours of no measurable precipitation. Runoff volume reduction can be achieved by canopy interception, soil amendments, evaporation, rainfall harvesting, engineered infiltration, extended filtration, and/or evapotranspiration and any combination of the aforementioned practices. This first one inch of rainfall must be 100% managed with no discharge to surface waters."

The 1-inch stay-on volume requirement is based on an analysis of 60 years of rainfall data in the state, which indicated that, on average, 90% of the rainfall events in West Virginia are 1 inch or less. Rainfall patterns do not vary significantly across the state.

This permit also includes provisions for:

- Revising codes and ordinances accordingly.
- Reviewing planning policies for opportunities to protect natural resources.
- Incentives for redevelopment, Brownfield redevelopment, and other higher density urban situations, i.e., disincentives for sprawl.
- options for payment-in-lieu and off site mitigation when fulfillment of the 1" standard cannot be met.
- A requirement for road retrofits assessment when standard road maintenance is occurring.
- Specific accountability provisions (operation and maintenance, inspections, tracking, and reporting).

More details are available: http://www.dep.wv.gov/WWE/Programs/stormwater/MS4/permits/Documents/WV%20MS4%202009%20General%20Permit.pdf

North Carolina

The North Carolina Permit to Construct, Operate and Maintain Impervious Areas and BMPs Associated with Residential Development Disturbing Less Than 1 Acre, includes the following provisions for control of post-construction stormwater runoff:

> "Stormwater runoff shall be managed using any one or combination of the following practices:
>
> a. Install rain cisterns or rain barrels designed to collect all rooftop runoff from the first one and one-half inches of rain. Rain barrels and cisterns shall be installed in such a manner as to facilitate the reuse of the collected rainwater on site and shall be installed in such a manner that any overflow from these devices is directed to a vegetated area in a diffuse flow. Construct all uncovered driveways, uncovered parking areas, uncovered walkways, and uncovered patios out of permeable pavement or other pervious materials.
>
> b. Direct rooftop runoff from the first one and one-half inches of rain to an appropriately sized and designed rain garden. Construct all uncovered driveways, uncovered parking areas, uncovered walkways, and uncovered patios out of permeable pavement or other pervious materials.
>
> c. Install any other stormwater best management practice that meets the requirements of 15A NCAC 02H .1008 to control and treat the stormwater runoff from all built upon areas of the site from the first one and one-half inches of rain."

More details are available: http://portal.ncdenr.org/c/document_library/get_file?uuid=724171cc-c208-4f39-a68c-b4cd84022cd9&groupId=38364

New Jersey

The New Jersey Department of Environmental Protection developed performance standards reflecting the concept of mimicking natural hydrology, and based the measurement of specifically for groundwater recharge.

The New Jersey Stormwater Management Rules at N.J.A.C. 7:8 require that a "major development" project, which is one that disturbs at least 1 acre of land or creates

at least 0.25 acres of new or additional impervious surface, must comply with one of the following groundwater recharge requirements:

- "Demonstrate through hydrologic and hydraulic analysis that the site and its stormwater management measures maintain 100 percent of the average annual preconstruction groundwater recharge volume for the site; or
- Demonstrate through hydrologic and hydraulic analysis that the increase of stormwater runoff volume from pre-construction to post-construction for the two-year storm is infiltrated."

The State has a spreadsheet for documenting how the recharge rate requirement is being met. Chapter 6 of the New Jersey Stormwater Best Management Practices Manual discusses the groundwater recharge methodology, the groundwater recharge design storm, and the details of the New Jersey Groundwater Recharge Spreadsheet.

More details are available: http://www.state.nj.us/dep/stormwater/tier_A/index.htm

Ohio

The Ohio Environmental Protection Agency has also developed performance standards based on groundwater recharge. The Ohio construction general permit for the Big Darby Creek Watershed near Columbus, where significant growth is projected, includes post-construction infiltration requirements. This permit requires that post-development groundwater recharge be equal to or exceed the pre-construction groundwater recharge.[1] The permit specifies that the Stormwater Pollution Prevention Plan (SWPPP) must describe the conservation development strategies, stormwater control measures and other practices deemed necessary by the permittee to maintain or improve pre-development rates of groundwater recharge. The permit includes a formula and standard values for gauging groundwater recharge rates, and includes provisions to ensure preservation of open space where infiltration will occur. Protection of open space (infiltration areas) is to be achieved by binding conservation easements that identify a third party management agency, such as a homeowners association, condominium association, political jurisdiction or third party land trust. If the post-development recharge volume will be less than the pre-construction recharge volume, mitigation is required. This permit also has a riparian buffer establishment and protection provision.

More details are available: http://www.epa.state.oh.us/dsw/permits/GP_ConstructionSiteStormWater_Darby.aspx

California

There are examples in California of permits that establish performance standards for runoff volumes from development sites, and permits that establish requirements addressing effective impervious area:

Performance Standards for Development Sites: California's Santa Ana Regional Water Quality Control Board has issued an MS4 permit for Orange County and the municipalities in the County calling for permittees to:

"Require that each priority development project infiltrate, harvest and reuse, evapotranspire, or biotreat the 85th percentile storm event ("design capture volume")... Any portion of the design capture volume that is not infiltrated, harvested and re-used, evapotranspired, or bio-treated onsite by LID BMPs shall be treated and discharged in accordance with the requirements set forth in Section XII.C.7 and/or Section XII.E, below."

Priority development projects are specifically defined in the permit, and include redevelopment projects. Biofiltration can only be used if infiltration, harvesting and re-use, and evapotranspiration cannot be feasibly used at the project site. The permittees must submit both feasibility criteria and design, operation, and maintenance criteria for biotreatment systems for public review and Regional Board approval. Sections XII.C.7 and Section XII.E, which must be used if LID is infeasible on-site, include provisions for implementing LID at another location away from the project site (a mitigation measure), or achieving alternative compliance by paying in-lieu fees.

More details are available: http://www.swrcb.ca.gov/rwqcb8/board_decisions/adopted_orders/orders/2009/09_030_OC_MS4_as_amended_by_10_062.pdf.

1 Brown and Caldwell. Municipal NPDES Stormwater Permits. http://depts.clackamas.cc.or.us/wet/documents/MS4_Update.pdf

Effective Impervious Area: The California Los Angeles Regional Water Quality Control Board has included the following standard in the MS4 permit for Ventura County:

> "New Development/Redevelopment Performance Criteria
>
> 1. Integrated Water Quality/ Flow Reduction/ Resources Management Criterion
>
> (a) ...Permittees shall require all New Development and Redevelopment projects identified in subpart 4.E.II to control pollutants, pollutant loads, and runoff volume emanating from impervious surfaces through infiltration, storage for reuse, evapotranspiration, or bioretention/ biofiltration by reducing the percentage of Effective Impervious Area (EIA) to 5 percent or less of the total project area."

More details are available: http://www.swrcb.ca.gov/rwqcb4/water_issues/programs/stormwater/municipal/ventura_ms4/Final_Ventura_County_MS4_Permit_Order_No.09-0057__01-13-2010.pdf.

The Elmer Avenue Neighborhood Retrofit Project in Los Angeles reduced effective impervious area by routing stormwater from paved areas to vegetated swales, rain gardens, rain barrels, and an underground infiltration gallery. Photo Courtesy of Los Angeles and San Gabriel Rivers Watershed Council.

Stormwater Program Elements

Permits should be as specific about expectations and outcomes as possible.[2] However, regardless of how comprehensive the permit is, many of the activities and projects will be detailed in the permittee's stormwater plan and not in the permit itself. Stormwater permittees are required to provide details of their programs in plans, and permitting authorities should review those plans as a facet of providing permit coverage, and/or as a facet of evaluating permit compliance.

Permits should require many of the following elements as part of a program with a solid green infrastructure focus.

Policies and Standards

Stormwater programs should institutionalize changes in order to be effective. There are a variety of issues to be addressed. MS4 permittees should:

- Evaluate transportation design specifications, plumbing codes, landscaping requirements, and other standards that might prohibit the use of practices. Identify language that may be incompatible with green infrastructure and work with other municipal departments to discuss the changes and identify alternatives. Develop new code language and propose changes to the relevant ordinance. This should include the specified performance standard from the permit. Communities can use the Water Quality Scorecard to evaluate and modify local policies, codes, and ordinances to address a number of issues that influence environmental outcomes. (http://www.epa.gov/smartgrowth/pdf/2009_1208_wq_scorecard.pdf).

2 In April of 2010, EPA released the "Municipal Separate Storm Sewer System Permit Improvement Guide" to assist permit writers in strengthening MS4 permits. The guide is available at: http://www.epa.gov/npdes/pubs/ms4permit_improvement_guide.pdf.

Permits could include many of the following elements as part of a program with a solid green infrastructure focus:

- Review and revise local policies and standards
- Employ green infrastructure for capital improvement projects
- Educate developers and maintenance crews
- Establish a maintenance tracking system
- Incentivize green infrastructure

- Implement standards for construction site stormwater runoff. Preservation of open space, trees, and other natural features reduces the amount of area cleared and graded, decreasing costs for erosion and sediment control. Municipalities can include this practice as one of their required or recommended control measures for construction activities, and can incorporate this practice into capital improvement projects.
- Provide guidance for implementing the performance standards for new development and redevelopment. Develop a standards manual or adopt the state manual if it meets the community's needs. Wherever possible, adapt existing resources to local situations in order to conserve resources. Prince George's County, Maryland, developed two design manuals with technical specifications for green infrastructure practices: "Low-Impact Development Design Strategies: An Integrated Design Approach" and "Low-Impact Development Hydrologic Analysis," both of which are available on EPA's website at: www.epa.gov/owow/nps/lid. The "Low Impact Development Manual for Michigan" is another very good resource: http://library.semcog.org/InmagicGenie/DocumentFolder/LIDManualWeb.pdf.
- The use of native plants in landscaping reduces the need for municipal crews to irrigate or use pesticides, herbicides, or fertilizers. Municipalities can incorporate selection of native plants into its landscaping guidelines and can train its maintenance crews to use integrated pest management.
- Evaluate constraints (areas of high groundwater, poorly drained soils, etc.) and adapt local guidance to address such site conditions.

Employ Green Infrastructure for Capital Improvement Projects

A municipality can set a good example, show confidence in the use of new technology, and demonstrate success with projects in the public right-of-way. Municipalities have jurisdiction over development activities in the right-of-way and on public lands, which allows greater design flexibility and more reliable maintenance using municipal crews. Green infrastructure projects adapt well to linear applications (streetscapes, courtyards, medians, etc.) and small-scale open spaces. It will be necessary to work with facilities management and landscaping crews because maintenance of vegetated green infrastructure practices sometimes requires special handling, such as hand-weeding and prohibiting heavy equipment and pesticide use.

Educate Developers and Maintenance Crews

Allow time and dedicate staff resources for bringing design engineers and landscape architects up to speed on new requirements. Provide checklists to help ensure compliance with new procedures. Develop locally based coefficients where appropriate in order to streamline sizing calculations and include example calculations to ensure consistency and transparency in project submittals. Hold periodic training sessions on green infrastructure applications, and request that plan reviewers provide specific comments when submitted designs do not meet standards.

Establish a Maintenance Tracking System

Communities need to determine whether property owners or the municipality will be responsible for maintenance. If property owners will be responsible, there are a number of ways in which the municipality can assure maintenance:

- Require maintenance agreements, which are recorded with the property deed, for new and existing control measures.
- Require a performance bond for new controls.
- Perform spot inspections to identify maintenance problems and check maintenance records.
- Require that property owners submit maintenance records or other evidence that maintenance was performed as prescribed.

Communities should maintain a database or geographic information system to manage information on the design parameters and locations of green infrastructure practices. A database or other tracking system is critical for maintenance assurance and can also be used for other efforts, such as watershed modeling, stormwater master planning, and inspection programs.

Incentivize Green Infrastructure

Communities can offer incentives to developers to preserve open space, protect or plant trees, and implement green infrastructure site design techniques by offering stormwater credits and other incentives. Incentives can be in the form of a density bonus, reduced size of required drainage infrastructure, discounted utility fees, and tax credits. The goal of the credits is to reduce the required capacity (and therefore the cost) of stormwater treatment practices using non-structural site design and conservation measures. Credits can also be used to reduce the stormwater utility rate or user fee, if applicable. A number of municipalities across the nation offer some form of stormwater credit, and some states have developed guidance to encourage municipalities to adopt a credit system. For more information on incentives, see "Incentive Mechanisms," an installment of EPA's "Managing Wet Weather with Green Infrastructure Municipal Handbook Series": http://water.epa.gov/infrastructure/greeninfrastructure/upload/gi_munichandbook_incentives.pdf.

Green infrastructure practices such as rain gardens and permeable pavement can serve as a community amenity. Photo Courtesy of Wenk Associates.

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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