Produced by the Alliance for the Chesapeake Bay with support from the Chesapeake Bay Program
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The Changing Face of Stormwater Management

What You Need to Know to Improve Stormwater Management in Your Community

What's Inside

Introduction

Stormwater is any water that results from a storm — typically a rainfall event. Three things can happen to that rainwater. It can enter the ground and recharge aquifers and help feed a nearby stream's baseflow (a critical role in those dry summer months). It can evaporate into the atmosphere or be used by plants in their life cycle, or it can flow over land to streams, wetlands, ponds, etc. All three avenues are part of the natural hydrologic system.

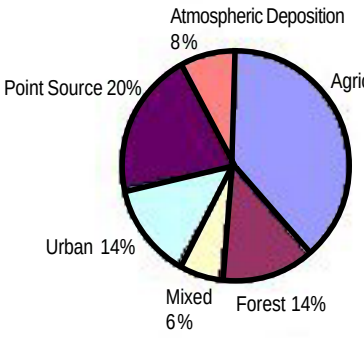
Over time, stormwater runoff has had a major influence on the characteristics of our waterways, helping to shape their floodplains, bank widths, stream slope, channel shape, and sinuosity (its curves and bends). These characteristics began to change as land that was historically covered in mature forests was cleared for logging and agriculture.

Over the last one hundred years, we have again changed the land and its associated runoff characteristics through increased suburban and urban development. That has meant more roads, parking lots, and buildings that are impervious to rain water infiltrating the ground. The result is greater volumes of runoff hitting our streams with greater frequency and more ferocity.

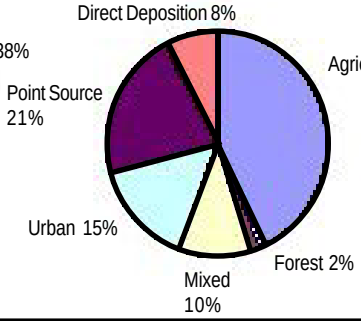
Stream characteristics that evolved under forest conditions cannot handle this added power and volume as the rainwaters move through the watershed. The erosive force of water gouges streambanks, smothers aquatic organisms, and changes the shape of stream channels. Flooding becomes more frequent and high waters increase bridge scour by undercutting bridge piers and supports. Downstream, increased loads of

Nitrogen, Phosphorus, and Sediment Sources to the Tidal Chesapeake Bay

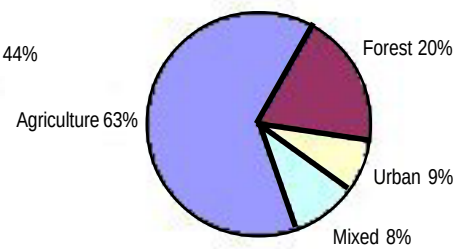
Urban makes up 14% of nitrogen loads



...15% of phosphorus loads.



...and 9% of total suspended sediment loads (range is 2.5 - 34%)



sediment and pollution are delivered to bays and reservoirs, adding costs to water suppliers that use stream intakes and disrupting the delicate balance of estuarine ecosystems, such as the Chesapeake Bay. Meanwhile, upstream groundwater reserves dwindle as more stormwater is literally exported to the mouth of the watershed.

Why is this important to you and what can you do about it? Afterall, stormwater management is the domain of engineers, you say.

Not exactly. While stormwater management practices are designed by engineers, a basic understanding of the latest management approaches and techniques will empower you to provide educated input into the making of local ordinances that are the backbone of stormwater management programs. In fact, much of the new thinking behind stormwater controls is easier to understand because it encourages the use of the landscape's natural features to reduce flooding and pollution. *Simple*, *effective*, and *economic* are words commonly used to describe the latest promotions in stormwater management.

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Consider also the costs associated with *not* managing stormwater effectively -- the expense of flood control projects, flood repair, drinking water purification, dredging of shipping channels clogged with sediment, maintenance of stormwater infrastructure, and habitat restoration. There's the aesthetic and ecological value that stormwater management devices can have in your community as well. Did you know that there are alternatives to the detention basins that are fixtures in today's suburban developments? Many of these alternatives are better looking, provide better habitat for wildlife, and are a better buy for reducing runoff and pollution to our streams. In short, they promise good-looking, multi-functional landscapes.

Changing Paradigms

Historically, there have been major shifts in how stormwater runoff has been managed by society. More than a hundred years ago, open ditches in towns and cities carried away stormwater, human wastewater, and debris, creating nothing more than urban cesspools. Fifty years ago, storm runoff and wastewater were put into pipes, all of which was discharged directly into streams and rivers with no treatment systems. (Today, these combined stormwater and sanitary sewers are still found in many older cities and there remains the problem of "combined sewer overflows," or CSO's, which allow untreated sewage to be discharged to streams during storm events.)

By the 1940's, health problems led to the separation of stormwater and waste water pipes, and the modern urban drainage infrastructure was born, consisting of an efficient drainage system with catch basins and pipes leading to the nearest stream. By the 1970's, however, the unforeseen fruit of such a system was downstream flooding and channel erosion. Back to the drawing board.

Older stormwater management facilities were often designed only to provide larger storm control (water quantity control) and not water quality or channel protection control.
Source: Center for Watershed Protection

The paradigm of the 70's was to keep post-development stream flow at pre-development flow levels. The answer seemed to be large, stormwater detention basins, which were designed to detain runoff from diffuse areas for a period of time, slowing releasing it to a receiving stream. The goal was to get stormwater off site as fast as possible. Roof runoff was channeled through gutters, down driveways, into the street and through storm sewers to the nearest detention pond. Quick conveyance was the thinking of the day.

The biggest problem with detention basins is that they only control flood peaks, not the total volume of water released to a stream. A good analogy is a city traffic jam in which three major events all end within a half-hour of each other. Each parking lot releases only so many cars at once, much like a detention pond. But dozens of lots are all letting out cars at a controlled rate to the same main artery. The problem is a car volume problem, not a peak-flow problem. With stormwater, the peak of runoff may be controlled directly below a detention pond, but, downstream, where the total drainage area may be ten times the area detained by one basin upstream, the stream cannot handle the cumulative volume of the water being released simultaneously. The result is more flooding, combined sewer overflows, and stream habitat degradation and thermal pollution.

The other problem with large detention basins is that they do little to improve water quality, which became the 1980's challenge in stormwater management as a result of the movement to reduce "nonpoint source pollution," or pollutants that run off the land from diffuse points. Efforts to control stormwater *quantity* and stormwater *quality* became increasingly intertwined, and detention basins generally fell short of meeting both goals. (Some contaminants that attach to sediment may be broken down by microorganisms in detention basins, but to a limited degree.) New approaches were being tested in stormwater management to positively impact the biological health of a stream. No longer could engineers work alone in designing stormwater systems — they needed the expertise of ecologists and biologists to address the whole picture.

Current thinking revolves around looking holistically at the local watershed, since everything that happens in a watershed affects its stream corridors. Development standards, gardening, changing the oil in your car, floodplain uses, road maintenance, local ordinances, etc. can all be done differently to protect our streams.

Stormwater management is but one component of watershed protection that is undergoing a revolution of sorts to create functional, environmentally-friendly, sustainable, and beautiful living environments.

Managing stormwater is now part of the paradigm that promotes small-scale, distributed controls that reduce the impacts of development. As with past paradigms, some innovations will work while others will fail. Regardless, this approach demands that local governments understand the rapid departure from conventional thinking — gathering and storing runoff from a large area and getting rid of it as quickly as possible — to today's thinking that promotes dispersed, on-site practices that slow down and cleanse runoff as it flows to underlying groundwater or a receiving stream.

Stormwater management is no longer the sole province of engineers. Ecologists, biologists, planners, and economists should all have input into the direction and implementation of stormwater management programs. Citizens, whether motivated by the financial, environmental, or recreational aspects of the big picture, can play an important role in how the latest stormwater management paradigm plays out.

Getting Started

In its recently revised publication *Stormwater Strategies: Community Responses to Runoff Pollutants*, the Natural Resources Defense Council provides some excellent guidance for communities as they begin or continue to address stormwater issues. Its review of over 100 case studies led NRDC to offer the following set of recommendations for communities to consider when planning, implementing, or improving stormwater programs:

1) Plan in advance and set clear goals.
2) Encourage and facilitate broad participation.
3) Work to prevent pollution first; rely on structural treatment only when necessary.
4) Establish and maintain accountability.
5) Create a dedicated funding source.
6) Tailor strategies to the region and setting.
7) Build broad-based programs.
8) Evaluate and allow for evolution of programs; and
9) Recognize the importance of associated community benefits.

Innovative Techniques -- Simple, Effective, Economic

Low-impact development, better site design, conservation development, sustainable development, and urban stormwater retrofits are all popular phrases that promote controlling stormwater close to its source. Generally speaking, these practices use natural functions in the landscape to trap and treat runoff. The bottom line is to mimic the natural hydrologic regime to minimize the impacts of stormwater runoff.

A review of the latest literature on these small-scale innovations in stormwater management reveals a long list of practices that can be incorporated into the design of roofs, buildings, down spouts, yards, sidewalks, parking lots, landscape areas, streets, and open space. There are literally hundreds of techniques that can be creatively mixed and matched to meet the needs of local stormwater objectives.

All of these practices are building blocks for stormwater design, the combination of which makes them multifunctional. They reduce stress on streams by controlling the peak flow rates of water released to receiving streams. They control erosion and cleanse water of pollutants, and they enhance wildlife habitat and add to the aesthetic value of properties.

Stormwater Management Toolbox

1) **detention/retention practices**
   - stormwater ponds
   - stormwater wetlands
   - rooftop detention
   - rain barrels/cisterns

2) **infiltration practices**
   - infiltration trenches
   - shallow infiltration basins
   - porous pavements

3) **filtering practices**
   - sand filters
   - organic filters

4) **bioretention practices** (plants and soils remove pollutants from stormwater naturally)
   - raingardens
   - parking lot islands

5) **open channels**
   - grassy swales, buffers, & channels
   - bio swales
   - filter strips

The irregular shape of this long wet pond is aesthetically pleasing, and the resulting longer flow path enhances pollutant removal.

A multiple cell pocket pond.

Sedimentation chamber and filter bed design of a perimeter sand filter.

An attractive rain garden with well-defined borders.

A dry swale is often the preferred open channel option in residential settings since it is designed to prevent standing water that makes mowing difficult and generates complaints.

Source of photos: Center for Watershed Protection

Economical

A landmark survey by the National Institute for Urban Wildlife found that 75 percent of the residents of Columbia, Maryland prefer urban runoff ponds that contain permanent pools of water, wetlands, and wildlife over the traditional, dry detention ponds. Furthermore, 75 percent of Columbia homeowners felt that permanent bodies of water added to real estate values and 73 percent said they would pay more for property located in a neighborhood with stormwater control basins designed to enhance fish or wildlife use. Such a public response supports the finding of a National Association of Home Builders study that states "whether a beach, pond, or stream, the proximity to water raises the value of a home by up to 28 percent."

Other economic benefits include the fact that many of these alternative designs are simply cheaper to build and maintain. Take for instance the case in Lansing, Michigan, where Lansing Township was faced with a new mandate to manage its own stormwater. A local official turned to a less traditional option — a constructed wetland. After extensive public input and education, the township built a 3,000-gallon-per-minute recirculating wetland system to collect and treat stormwater and sump pump water from the neighborhood. It was built entirely on public land, part of which holds a municipal golf course. In the end, the township saved $14 to $17 million by not piping the stormwater to the nearest river.

As for construction costs of new homes, Prince George's County, Maryland, compared construction costs for conventional lots versus low-impact lots at a development called Patuxent Riding. The unit cost, which included grading/roads, storm drains, and installation of a stormwater pond vs. bioretention areas, was $14,679 for the conventional design compared to $9,193 for the low-impact design. In addition, the low-impact design gave the developer seven more units for the same acreage.

In another case in Prince's George County, a total cost savings of $780,000 was realized once the expenses for curbs, gutters, four stormwater ponds, and associated pipes and structures were eliminated in lieu of a rain garden system that was one-third the cost of conventional designs.

A Perfect Fit for Urban Retrofits

Experts are quick to point out that many of these alternative techniques also work well in highly urban areas because they use only a small amount of land on any given site. Many practices, such as bioretention, roof gardens, and rain gardens are easily integrated into existing infrastructure, such as roads, parking lots, and buildings.

Bioretention technology can turn parking lot islands, street medians, tree planter boxes, and landscaped areas near buildings into specialized stormwater treatment systems. Parking lots can be redesigned to reduce impervious cover and increase stormwater infiltration while optimizing parking needs and opportunities. Permeable pavement can be used in low traffic areas, parking areas, and walking paths. Many strategies can help beautify the urban environment and create desirable public open space.

A Quick Look at Parking Lot Retrofits...

Parking lots make good candidate retrofit sites and there are numerous types of practices that are effective at reducing the pollutant load from these areas.

Before

During construction of infiltration trench

After

Source: Center for Watershed Protection

Pioneers in the Field

Two nationally known experts in the field of stormwater management call the Chesapeake Bay watershed home.

Prince George's County, Maryland (Department of Environmental Resources) has pioneered many new tools and practices in the field and have published a number of guidance documents on the subject of low-impact development. (See *Tools & Helpful References*.) The county promotes a comprehensive approach to its low-impact development program, which includes the following key components:

1) Conservation of natural resources
   - protect floodplains, stream buffers, wetlands, woodland conservation areas, important trees, steep slopes, and highly permeable and erosive soils.
2) Minimization
   - reduce hydrologic impacts to a site by locating development in areas having lower value in hydrologic function
   - limit amount of clearing, grading and paving
3) Strategic Timing
   - lengthen flow paths
4) Integrated Management Practices
   - controls that store, filter, detain, and reuse runoff on site
5) Pollution Prevention
   - traditional approaches to reducing nutrient, sediment and toxic contaminants

The **Center for Watershed Protection (CWP**), headquartered in Ellicott City, Maryland, is a well-established research center that has done extensive work in model land development principles and practices. The CWP also operates the web-based Stormwater Managers' Resource Center, which includes a wealth of introductory and highly technical information on stormwater management practices. *www.stormwatercenter.net.* (See *Tools and Helpful References*.)

Much of the CWP's work focuses on reducing impervious cover and utilizing green space for stormwater treatment. According to the Center's *Better Site Design* handbook, the volume of stormwater runoff and the mass of pollutant loads can be reduced as much as 20 to 60 % at most development sites by implementing the land development practices advocated in its handbook. Better site design is viewed as a critical first step in solving stormwater management problems. Most developments, says the handbook, will still need stormwater Best Management Practices to control the runoff from the site.

A Quick Look at...

Roof Areas

Roof areas can represent up to 50% of the imperviousness in new developments. Simple and effective methods can trap roof runoff that would otherwise be directed to a nearby surface stream. Infiltration methods include the use of splash pads and the dispersal of roof stormwater onto landscaped or biorention areas downslope. Storage methods include the use of roof runoff cisterns. On-site storage and later reuse of roof runoff provides an excellent opportunity to conserve water and reduce water costs for the homeowner. If stormwater reuse is not intended, storage facilities can be emptied through the use of a slow release valve.

The first 1/2 inch of runoff from a 1000 ft^2 house can be adequately stored and attenuated using four or five 55-gallon barrels or cisterns located at downspouts.

Maintenance: Key to Long-Lasting Success

Over the next decade, thousands of new structural and nonstructural stormwater practices will be planned and installed, largely as a result of federally mandated stormwater and water quality controls. Ultimately, it is the local community's responsibility to meet stormwater management and cleanup goals. A big part of this responsibility is the maintenance of all stormwater practices. As one engineer from Florida put it, "All BMPs require maintenance to remain effective long term, and herein lies the rub."

The "rub" has a number of implications. Communities that take the route of micro-managing stormwater runoff must have active inspection and enforcement programs for the construction and long-term maintenance of practices installed by the development industry. Inevitably, there will be more engineering, more reviews, and more work for code enforcement officers. The additional burden upon limited local budgets will be substantial.

Secondly, there is the issue of homeowners and homeowner associations being expected to maintain the low-impact swales, buffer strips, and other backyard/on-lot practices that cumulatively make up a neighborhood's stormwater management program. While this is an issue under current debate, it's important to remember that no technology is maintenance-free — even conventional stormwater controls carry hefty maintenance costs over the long run.

In Florida, individual lot ponds are no longer allowed in most areas because of long-term maintenance and enforcement issues. On the other hand, larger ponds that could be maintenance headaches for homeowners' groups are treated by some communities as multi-use facilities that offer hiking trails, parks, fishing areas, and wildlife habitat. Properly maintained, these ponds add immensely to property values and are considered worth the occasional, minor maintenance expense.

Maintenance is an issue requiring extensive education of homeowners and homeowner associations. Prince George's County, Maryland, has learned that education needs to be an ongoing effort. It has outlined a four-step process in developing an effective public outreach program, which should be tailored to specific objectives and audiences in the community. (See *Low Impact Development Design Strategies: An Integrated Design Approach* under *Tools and Helpful Resources*.) The labor and costs associated with ensuring that a low-impact development is maintained are tremendous, says county executive Larry Coffman. On the other hand, he says, the best enforcement mechanisms are the understanding of the importance of the maintenance functions and the pride a homeowner takes in maintaining attractive landscape features.

The important point is that communities need to look at the whole picture and consider the long-standing implications for staff, budget, enforcement, education, and maintenance requirements for systems to properly function over the long run.

A Quick Look at ...

Bioretention Areas

Bioretention areas use constructed or naturally landscaped zones as stormwater management areas and can be designed to blend into the suburban landscape. Sizes and shapes vary, but bioretention areas generally comprise about 5 percent of their catchment area. Bioretention systems remove pollutants carried in stormwater through physical filtration or trapping and by adsorption. Maintenance of these areas can become part of the landowner's property management responsibilities, thereby reducing the burden and costs of stormwater management to the local government.

Smaller bioretention cells are easily and attractively incorporated into individual lots.

Source: Center for Watershed Protection

Changing Local Mindsets is Long Term Process

The reality of actually implementing ordinances that establish effective standards and require specific stormwater practices raises political and technical challenges. Alternative stormwater management practices don't stand a chance unless local codes and ordinances allow for innovation in site planning for new development and redevelopment. Site design practices should preserve natural drainage features, minimize impervious surface areas, disconnect impervious surfaces, and protect natural depression storage. Yet, today's ordinances still hold to drainage philosophies that encourage just the opposite.

Streets and adjacent storm sewers typically are located in natural headwater valleys and swales, thereby replacing natural drainage functions with a completely impervious system. Runoff and pollutants generated from impervious surfaces flow directly into storm sewers with no opportunity for attenuation, infiltration, or filtration. Traditional development patterns also eliminate natural depressions by filling or draining, thereby obliterating their ability to reduce surface runoff volumes and trap polllutants.

Changing these approaches requires educating local citizens and public officials, who have learned to expect runoff to disappear shortly after a rainfall event. Many elected officials are reluctant to employ new techniques that they consider unproved. Liability falls on them, afterall, if practices fail and there is loss of life or damage to downstream homes or businesses from local flooding.

Some communities have found that pilot programs and extensive public education are important first steps in building local support for innovative approaches.

In Maplewood, Minnesota, for example, the city focused on demonstration, education, and outreach to sell the idea of incorporating rain gardens, shallow swales, and small depressions in the rights-of-way that were designed to collect 1/2 inch rainfalls. Its efforts included extensive neighborhood meetings and printed educational materials that dealt head-on with such fears as creating "holes in backyards that breed mosquitos." Homeowners were also given seven varieties of garden themes to choose from, including the "easy shrub garden," "butterflies and friends garden," or "Minnesota prairie garden." To top it off, the city provided all the plants necessary and a landscape plan at no extra cost. All the homeowner had to do was plant! And that job was made easy through block-party-style planting days, in which about one-half to three-quarters of the homeowners participated. Said the city's assistant engineer, "Implementing this project has required more public outreach and education that I was expecting — but the best solution isn't always the easiest…"

Leading by Example — Chesapeake Bay Program Stormwater Management Directive

To help educate developers, local officials, and the public about innovative stormwater management techniques, the Chesapeake Bay Program adopted a stormwater directive in December 2001 that essentially calls for federal, state and district governments to lead by example. It calls for establishing 60 demonstration projects on state, federal, and district lands, all aimed at having a no-net increase in runoff from the site. Retrofitting stormwater controls in urban areas will be part of this showcase of government-led success stories.

In addition, the directive calls for transportation departments in the Bay states to develop programs that ensure that stormwater systems along 177,000 miles of roadways in the watershed are designed to not just get runoff off the road, but also to protect water quality. Furthermore, the directive encourages the Bay jurisdictions to work with universities to teach future engineers, landscape architects, and others about alternative stormwater management approaches — and to develop demonstration sites on campuses.

Information about the design, cost and performance of stormwater management techniques featured at the demonstration sites will be made public. Progress will be reported online at www.chesapeakebay.net and www.bayjournal.com.

Tools and Helpful References

Stormwater Managers' Resource Center

www.stormwatercenter.net

This website was designed by the *Center for Watershed Protection* to provide NPDES Phase II communities with the technical tools and techniques needed to comply with current EPA regulations. On-line tools include:

- Stormwater Design Manual Builder to help engineers comply with local ordinances
- Slideshows on a variety of stormwater design practices
- Fact sheets on innovative stormwater practices
- Guidance on stormwater management ordinances

Stormwater Strategies: Community Responses to Runoff Pollution

Natural Resources Defense Council

Updated to include a chapter on low-impact development. Thirteen new LID case studies demonstrate that LID can be used for both stormwater and combined sewer overflow controls and in core urban areas as well as in the suburbs, often at less cost than traditional management approaches.

Publication and CD-ROM format. Contact Carol James at cjames@nrdc.org.

Stormwater Runoff: Lost Resource or Community Asset? A Guide to Preventing, Capturing and Recovering Stormwater Runoff

Delaware Riverkeeper Network

This handbook strives to inform and encourage citizens, decisionmakers, and professionals to progress beyond the limited and damaging management practices that have been the standard for the past three decades. User-friendly, the guide walks the reader through the problems and solutions. Fact sheets that are meant for copying and distribution are included, packed with information about conservation design methods, best management practices, and natural resource protection techniques.

Contact: Delware Riverkeeper Network, PO Box 326, Washington Crossing, PA 18977; $15 plus $4 postage and handling.

Low-Impact Development: An Integrated Design Approach

Prince George's County, Maryland,
Department of Environmental Resources, Programs, and Planning Division

This guidance manual was prepared for local planners, engineers, developers, and officials to describe how to develop and implement LID methods. The LID principles discussed address runoff issues associated with new residential, commercial, and industrial surburban development in Prince George's County, Maryland. The manual describes how LID can achieve stormwater control through the creation of hydrologically functional landscape that mimics the natural hydrologic regime.

A companion document, *Low-Impact Development Hydrologic Analysis*, contains methodologies to estimate changes in site hydrology due to new development, along with other computational procedures.

Contact: National Service Center for Environmental Publications, PO Box 42419, Cincinnati, OH 45242-2419; Phone (800)490-9198; www.epa.gov/ncepihom/index.html.

Protecting Natural Wetlands: A Guide to Stormwater Best Management Practices

Environmental Protection Agency

Provides information for decisions regarding the potential benefits, limitations, and appropriate applications of BMPs to protect the many functions of natural wetlands from the impacts of urban stormwater dischargers and other diffuse sources of runoff.

Contact: www.epa.gov/owow

Local Ordinances: A User's Guide

Terrene Institute/EPA

Designed for local planners, this guide explains recent findings on urban runoff, legislative requirements, and urban vegetative and structural BMPs. It poses questions to reveal potential ordinance requirements, and recommends funding options.

Contact: Terrene Institute, 1717 K Street, NW, Suite 801, Washington, D.C. 20006; Phone (202) 833-8317. $14.95

- **Maintaining Your BMP: A Guidebook for Private Owners and Operators in Northern Virginia**
  Northern Virginia Regional Commission
  This guidebook is applicable to any area where stormwater BMP maintenance is the responsibility of property owners, homeowner associations, and property managers. The 21-page guide introduces types of alternative stormwater BMPs, maintenance needs for each, and an explanation of who should conduct maintenance activities and how to fund maintenance tasks. Limited number of guides are available from the Northern Virginia Regional Commission for $3. Address: 7535 Little River Turnpike, Suite 100, Annandale, VA 22003. Also available for download on www.novaregion.org on the Environmental Services page.

- **Bioretention Sites for Stormwater Management**
  National Homebuilders Association Research Center
  A three-page fact sheet. www.nahbrc.org/toolbase/pandt/tech/abstracts/bioreten.html

- **2000 Maryland Stormwater Design Manual, Volumes 1 and 2**
  Maryland Department of the Environment
  Maryland's new approach to stormwater management is reflected in its latest design manual. Volume I contains basic technical information for stormwater design in Maryland, and Volume II contains appendices with supporting information such as landscaping, construction specifications, design examples, and tools for BMP design. Maryland's Department of the Environment also offers 22 publications on stormwater management, covering financing, sample local ordinances, survey results, amd design facts. www.mde.state.md.us or 410-631-3551.

- **Pennsylvania Handbook of Best Management Practices for Developing Areas. 1998.**
  Pennsylvania Association of Conservation Districts, Inc.
  A tool created to assist developers, engineers, municipal officials, conservation district personnel and others involved with the planning, design, review and approval or building development projects. It describes practices and principles that are aesthetically pleasing and space efficient, while protecting water quality and improving wildlife habitat. Thirty-seven practices are described in the handbook.
  Contact: PACD, 4999 Jonestown Road, Suite 203, Harrisburg, PA 17109. $25. www.pacd.org

- **Virginia Stormwater Management Handbook**
  Virginia Department of Conservation and Recreation
  In 1999, DCR published the Virginia Stormwater Management Handbook to serve as the primary guidance for stormwater management programs regarding basic hydrology and hydraulics, stormwater best management practice design and efficiency, and administrative guidelines to support compliance with state stormwater regulations. Also available are several associated technical bulletins not addressed in the handbook.
  www.dcr.state.va.us/sw/stormwat.htm

Other Helpful Links

Pennsylvania
Bureau of Watershed Management
PO Box 8555
Harrisburg, PA 17105-8555
www.dep.state.pa.us

The Low Impact Development Center, Inc.
5010 Sunnyside Avenue, Suite 200
Beltsville, Maryland 20705
301-982-1781
Fax 301-982-1994
www.lowimpactdevelopment.org

National Small Flows Clearinghouse
West Virginia University
POBox 6064
Morgantown, WV 26506-6064
800-624-8301
Fax 304-293-3161
http://www.nsfc.wvu.edu

An Internet Guide to Financing Stormwater Management
www.stormwaterfinance.urbancenter.iupui.edu/