

Green Infrastructure for Stormwater Management

The traditional approach to stormwater is being turned on its head. The new "green infrastructure" approach is to slow down, retain, filter and let water infiltrate as much as possible. Advantages range from healthier streams, rivers, lakes and oceans to fewer overflows, less flooding and lower cost; and more beautiful communities.

by Carol Brzozowski

Arizona green builder John Wesley Miller is fond of saying most people don't care about stormwater until they get flooded. Municipalities do care, and are trying to learn how to manage stormwater in sustainable, low-energy, effective ways as they attempt to comply with National Pollutant Discharge Elimination System (NPDES) requirements.

In 1972, the Clean Water Act established NPDES, which controls water pollution by regulating point sources that discharge pollutants into United States waters. Phase 1 (1990) addresses municipalities with populations of more than 100,000. Phase 2 (1999) addresses smaller communities and construction activity on one to five acres.

"[Stormwater] is the major site issue we are confronted with all over the country," said Ann Archino Howe, a civil engineer specializing in sustainable site design. "We are looking much more carefully at the long-term effects of development on a particular site, in a particular watershed. What are the watershed's wide effects on streams, lakes, erosion issues and of sediment being carried from one place to another?"

Low Impact Development (LID)

According to Larry Coffman, a former regulator and current president of Stormwater Services in Chesapeake Beach,

Maryland, variance in storm behavior in different regions makes it difficult to apply any single approach everywhere for NPDES Phase II compliance.

One commonly applied low-energy approach, however, is Low Impact Development (LID). "[Low Impact Development] boils down to being more aware of how to work with the landscape, to make it work for us instead of against us," Coffman said. "If you want sustainability, you have to have technology that in some ways mimics natural ecological processes and serves receiving waters and their aquatic resources." With few exceptions, LID costs are lower than conventional approaches, Coffman says.

Howe says sustainable site design is vitally important as more building creates more impervious surfaces, resulting in more flooding events. She strongly favors preserving existing vegetation, which absorbs stormwater through leaves and roots. For example, in one office building project she designed, Howe reduced impervious areas by using grass for the shoulders and reducing the width of the entrance, the parking lot isle and parking space length.

Establishing good drainage with grading and enabling water to stay on site for as long as possible before burdening the municipal storm sewer system is key, say builders such as Miller. Green roofs—a tech-

Core question

How can communities use green infrastructure to manage stormwater and respond to the National Pollutant Discharge Elimination System (NPDES)?

Information base

The problem

Rain from storms (stormwater) runs off impervious surfaces (roofs and pavement) in large volumes and at high speed as it is collected in channels and pipes, causing damage and ultimately polluting surface waters. Many existing municipal systems are unable to handle existing flows, and as developed areas spread, the problem spreads. The National Pollutant Discharge Elimination System is an attempt to respond to this problem.

What is the NPDES?

The *National Pollutant Discharge Elimination System* (NPDES) is a US Federal law that grew out of the Clean Water Act of 1972. Its purpose is to decrease water pollution by regulating point sources that discharge pollutants into United States waters.

What is a point source?

The EPA defines a "point source" as: "Any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock concentrated animal feeding operation (CAFO), landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural stormwater runoff."

What is green infrastructure?

According to the Environmental Protection Agency: "Green infrastructure is an approach to wet weather management that is cost-effective, sustainable, and environmentally friendly. Green infrastructure management approaches and technologies infiltrate, evapotranspire, capture and reuse stormwater to maintain or restore natural hydrologies. At the largest scale, the preservation and restoration of natural landscape features (such as forests, floodplains and wetlands) are critical components of green stormwater infrastructure. By protecting these ecologically sensitive areas, communities can improve water quality while providing wildlife habitat and opportunities for outdoor recreation. On a smaller scale, green infrastructure practices include rain gardens, porous pavements, green roofs, infiltration planters, trees and tree boxes, and rainwater harvesting for non-potable uses such as toilet flushing and landscape irrigation."

A partial list of green infrastructure methods and approaches

- **Low Impact Development (LID):** A comprehensive stormwater management and site-design approach that mimics pre-development hydrology by using design techniques that infiltrate, filter, evaporate, and store runoff close to its source as opposed to costly large-scale systems.
- **Preserving existing vegetation:** Deep, established root systems easily take up stormwater and allow it to infiltrate into the ground.
- **Green roofs:** Vegetated rooftops with a shallow soil layer can support

nology popular in Europe for 50 years and cost-competitive with other techniques—have become a favored approach.

LEED and the National Association of Home Builders are showing more municipalities how to encourage sustainable development techniques. The EPA's Stormwater Pollution Prevention Plan (SWPPP) is another guideline for developers and builders interested in sustainable developments. A well-designed Stormwater Pollution Prevention Plan is important in LID, Coffman says.

Low energy, low cost

Overall, low energy approaches mean low costs. Until recently, traditional stormwater management approaches have centered on pipes, basins and ponds, Howe says. However, sustainable designs can be expensive if they require adding a lot of plants or are improperly maintained.

John Moll is a founding member of the Stormwater Equipment Manufacturers Association (SWEMA). He contends improper maintenance of green approaches cause problems in the long run.

"No one thinks of cleaning out a constructed wetland, a pond or a bioswale," he said. "If a bioswale is catching lots of cancer-causing metals and other terrible stuff, where is it going? It's going downstream of influent. It's going to leach back out unless there's a maintenance program."

SWEMA promotes the idea that manufactured, proprietary devices have an important place in the systematic treatment of run-off. The organization calls for independent, third-party testing of all stormwater technologies, proprietary or otherwise, utilizing the same standards and protocols.

There are occasions—especially in developed and urban areas—where the footprint of a green infrastructure approach may be too large or inappropriate in some other way. Stormwater management equipment alone or in combination with a natural approach

having a smaller footprint—such as a green roof—may be best.

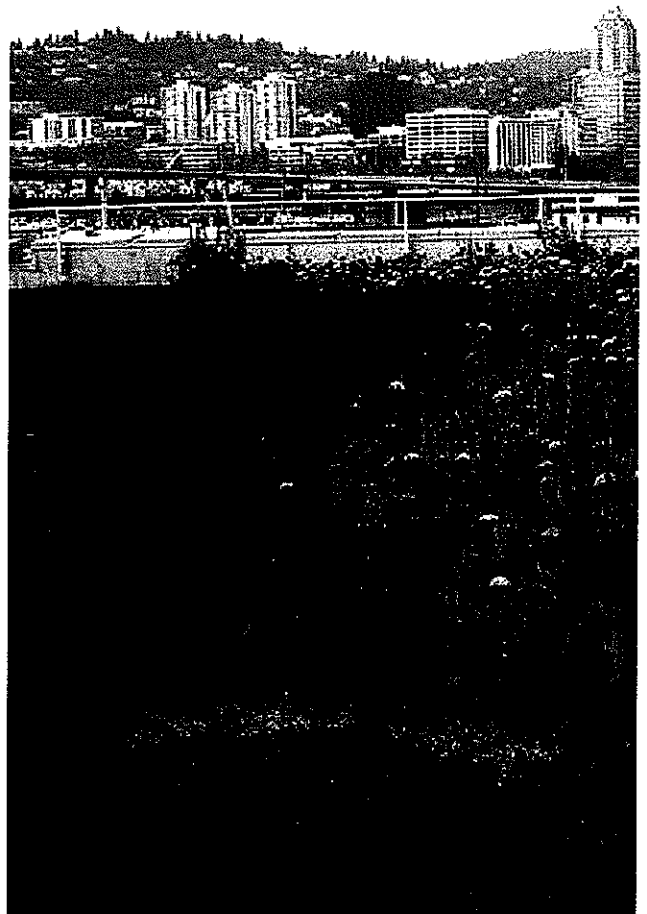
There are many low-energy stormwater management options, but what will municipal officials embrace? Coffman says developers will push sustainable technologies if local regulations encourage innovation, creativity and sustainability.

Learning in Portland, Oregon

Portland, OR is a pioneer in sustainable stormwater management and consistently tops lists of the most sustainable U.S. municipalities.

The municipality of 568,000 has embraced a variety of sustainable stormwater methods, including green roofs, rain gardens, porous pavement, vegetated swales and landscaping, downspout disconnection and rain barrels.

"Portland is a water community with a reputation for being a progressive city," said Dean Marriott, Portland's Director of Environmental Services. "That attracts



like-minded people into government and community activism. In the last few de-

manual encouraging green infrastructure to meet the requirement.

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—Dean Marriott

acades, that has led to a willingness to take on innovative approaches.”

Portland’s primary strategy for addressing capacity problems associated with combined sewer overflow (CSO) events was to emphasize decentralized stormwater management through green infrastructure. Building codes now require on-site stormwater management for all new construction, with Portland’s stormwater

connected from the sewer system. More than 45,000 households participate, resulting in the annual infiltration of an estimated one billion gallons of water.

The city—which has a stormwater utility—also plans to offer a stormwater fee discount of up to 35% for properties with on-site stormwater management.

“We’ve done our share of grey or engineered solutions. Those will always be necessary when you have such an extensive array of infrastructure,” Marriott said. “But we decided a decade ago we liked the multiple benefits that come from the green approaches, particularly those visible to people. For instance, green street features can calm traffic, help with water quality and are good for aesthetics.”

Portland’s early objective was to make sustainable techniques visible throughout the city to generate a positive reaction. That is paying off as the techniques demonstrate their effectiveness, and neighborhood and business associations are requesting more of them.

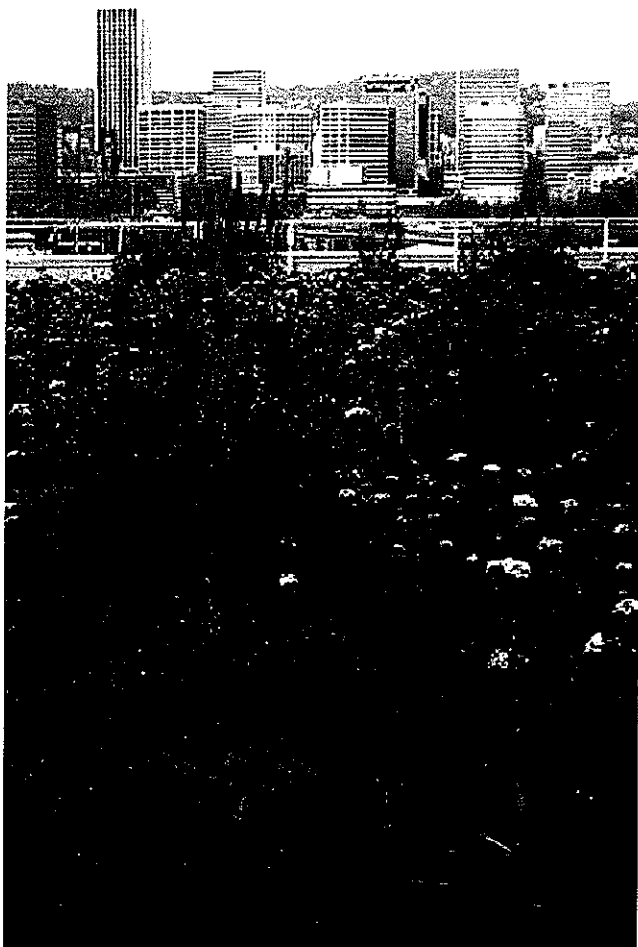
Meanwhile, Portland officials monitor their performance to ensure “[W]e’re not just building things that are nice to look at but aren’t really working,” Marriott said. “When you start out with sustainable stormwater approaches, you have to be willing to learn as you go.” He added, “What has surprised me overall is just how effective most of these simple green solutions have turned out to be. A lot of people have suggested it’s mostly for aesthetics and you have to rely on grey infra-

turf, grass or other ground cover. Thick soil layers can support a variety of plant or tree species. One benefit is reduced stormwater run-off.

- **Grass swales:** Open, wide channels next to roads and other runoff areas, with plant-covered slopes. Swales filter run-off and reduce flow, allowing infiltration, sedimentation and filtration. They can convey run-off to a downstream discharge location without erosion. Check dams in swales can further slow flow rate, creating small, temporary ponds and promoting infiltration.
- **Roadside infiltration gardens and rain gardens:** Captures runoff in often very attractive planted areas, from which it infiltrates.
- **Reducing impervious areas:** Minimizing the constructed footprint reduces runoff, as does pervious pavement.
- **Rainwater harvesting:** Cisterns (both above and below ground) can collect rainwater from roofs for irrigation and toilet flushing.
- **Tree wells:** Depressed areas around trees can collect water and allow it to infiltrate. Caution: A raised ring around the base of a tree will diminish the effectiveness of this method.
- **Depressed parking islands:** Capture stormwater and facilitate control.
- **Constructed wetlands:** Slowing the flow, these clean water and pass it through a functional habitat. Water quality is maximized through natural aerobic and anaerobic treatment.
- **Wet ponds:** Also called stormwater ponds, retention ponds or wet extended detention ponds, these add runoff to a permanent pool and treat and filter the water through settling and nutrient uptake by plants and other aquatic organisms.

structure to get environmental performance. We’ve demonstrated we’re going to need to continue to have a mix of grey and green infrastructure, but green infrastructure is more than holding its own.”

Even green roofs, which get mixed performance reviews, are effective when properly constructed, says Marriott. While some remove only 10% to 20% of run-off, Portland has others with an 80% peak flow removal.



"It depends on how they are built and designed," Marriott said. "We are learning a lot about the difference between various techniques. It paid off to try different things. Now we're able to make suggestions because we have quite a bit of information about their performance."

Marriott acknowledges green infrastructure is beholden to regional differences. A New England municipality may be concerned about how snow affects green stormwater management techniques, while Florida's two seasons—wet and dry—may pose other concerns.

"You have to find what works for you," Marriott said. "We're in the process now of trying to figure out how to put a green roof on City Hall. It's an old historic build-

ing renovated 10 years ago, so we're trying to figure out how we can put a green roof on it that keeps the historic preservation people happy. We've got new buildings going up and we're talking to folks about incorporating green techniques early in the planning process."

Portland residents are inclined to take advantage of incentives to reduce stormwater fees. Those began in the 1970s when the city charged for impervious surfaces, which led to more on-site stormwater management.

"Some communities tell me that works great for us because we have a direct financial incentive, but they don't bill people individually for stormwater management so they can't figure out how to do the same thing," Marriott said.

Suamico Rain Gardens

The Village of Suamico, Wisconsin (population 10,895) is also exploring green stormwater management techniques. When the Bay Port Heights subdivision was constructed, developers funded rain gardens to eliminate the need for an additional stormwater pond to capture roof runoff.

"Because these rain gardens were put in place, [the developer] is able to have an extra lot he can sell," said Graham Callis, Suamico's Community Development Director. "It gives everybody an attractive garden right off the bat, allows the homeowner to have something they can enjoy and also helps treat roof runoff."

That result led the University of Wisconsin-Extension to contact Village officials to determine interest in a demonstration rain garden. In late spring of 2008, the Village partnered with the Northeast Wisconsin Master Gardeners program to create a 260 sq. ft. demonstration rain garden at the Village Hall. The garden treats one-quarter of the roof runoff and is a living classroom for community programs on how to construct, maintain and winterize a rain garden.

A garden requires more maintenance in its first year as the plants get established, Callis says. But after that, the plants start to develop a root system that breaks up tougher soil, allowing more water to infiltrate into the ground. Residents are taking notice of the garden and asking for information for their own properties.

Callis is assembling a task force to meet next year to study sustainable and renewable energy approaches, including a possible code requiring rain gardens in new subdivision developments.

"I hope to look at things we can incorporate into everyday municipal business in addition to programs to educate the community on practices they can do in their own home," he said. "We've got a lot of land to be developed, so we want to make sure we have the right practices and policies in place when that happens." ♦

Carol Brzozowski is a freelance writer specializing in stormwater issues. All photos courtesy Environmental Services, City of Portland, OR.

Resources

Publications

- *Rooftops to Rivers: Green Strategies for Controlling Stormwater and Combined Sewer Overflows*
- The Natural Resources Defense Council *Local Water Policy Innovation: A Road Map for Community Based Stormwater Solutions* (pdf)
- *Regional and Collaborative Approaches to Water, Sewer, and Stormwater Management in Pennsylvania*—examples of collaborative municipal and regional approaches to water resources and infrastructure management
- *Stormwater* magazine

EPA reference materials

- All things NPDES
- The EPA's *Municipal Handbook* has information on funding
- National Menu of Stormwater Best Management Practices
- Sample Stormwater Pollution Prevention Plan

Some specifics

- Managing Wet Weather with Green Infrastructure
- Low Impact Development (LID) Urban Design Tools Website
- Green Parking
- Green Highways and Green Infrastructure

Organizations

- The Low Impact Development Center
- The Association of State and Interstate Water Pollution Control Administrators
- American Rivers
- The National Association of Clean Water Agencies

EPA Stormwater Program Reviewed

According to the National Research Council, hired by the Environmental Protection Agency (EPA) to evaluate the stormwater permitting program, the EPA's current stormwater management program leaves US waters far short of the Agency's stated goal of "fishable and swimmable." The EPA works within a system originally designed for sewage and industrial waste water that has failed to improve stormwater accountability or water quality. The Council suggested five major changes and numerous smaller ones.

- Permitting systems should be based on watershed boundaries and encompass all discharge permits, with a lead municipality in each watershed acting in cooperation with the others.
- Integrated monitoring—construction and industrial sites, for example—should be monitored under the jurisdiction of the municipalities where they operate.
- Future land development should be considered in present-day permitting.
- More focus on high volumes of water causing erosion and consequently sediment pollution than on chemical pollutants.
- The Federal government should supply more funding to state and local governments to support local regulation of stormwater.

Ref: nationalacademies.org (search EPA + stormwater)