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Green Light for Green Infrastructure

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Natural solutions can be the answer to many of society's water quality problems. But regulators need to work collaboratively with cities and nongovernmental organizations to remove the obstacles that have slowed a wider embrace

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City leaders are finding that when faced with the simultaneous challenges of regulatory requirements, infrastructure limitations, and financial constraints, the best answer is green infrastructure — solutions that put nature to work to protect aquatic ecosystems and at the same time support our advanced society's water needs. Green projects are delivering on the water quality side while responding to urban Americans' desire to harmonize city living with the natural environment. The nation's mayors have already stepped up to the plate by passing a green infrastructure policy resolution at their annual meeting last year. But support from other stakeholders will be needed to really put these ideas into play.

Green solutions are being put into effect across the country. Communities are experimenting with artificial drainage systems designed to mimic natural landscapes, discovering that they can be more aesthetically pleasing than traditional piped systems for controlling storm and wastewater discharges, and just as cost-effective. An example is the $8 million program in Portland, Oregon, that saved the city $250 million in infrastructure improvements by offering households subsidies for disconnecting their downspouts from the stormwater system. The program diverts one billion gallons annually from the combined sewer system — which mingles wastewater with rainfall — by allowing precipitation to soak into the ground.

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Chicago has a 20,300-square-foot demonstration green roof on its own City Hall. The roof can retain over 75 percent of the volume from a one-inch storm, preventing the water from reaching the combined sewer system. Seattle has the Street Edge Alternative pilot project, which reduces impervious surfaces by 11 percent compared with traditional construction. It also provides surface detention in swales and adds trees and shrubs to help hold water in the soil. During five years of monitoring, the SEA pilot has retained 99 percent of rainfall, preventing runoff into sensitive receiving waters that are home to endangered salmon while improving the landscapes of participating neighborhoods.

Population growth and urbanization trends make green solutions like these essential to protecting and improving water quality. Standard infrastructure and pollution controls are imperfect and insufficient when it comes to reducing the amount of stormwater runoff from urban environments or effectively removing contaminants. With sprawl and population growth, managing wastewater and stormwater in urban areas will only get more challenging, and mitigation efforts more costly and difficult.

Our country's natural landscapes are disappearing at a frighteningly fast pace. An estimated 25 million acres of impervious surface covers the continental United States — nearly one-quarter of non-federal land. In many urban areas, it is not uncommon for impervious surfaces to account for 45 percent or more of the land cover. Nearly 70 million additional acres will be developed in the period from by 2025, driven mostly by population pressure. By 2030, half of the built environment in the United States will have been constructed since 2000. Enlightened policies can have a huge effect on minimizing the impact that would otherwise result from this boom.

Loosely defined, green infrastructure is the use of soil, trees, vegetation, and wetlands and open space (either preserved or created) in urban areas to capture rain while enhancing wastewater and stormwater treatment. Green solutions can include vegetated swales and green roofs, as seen above, as well as constructed wetlands and conservation easements. The term also includes such non-living complementary solutions as porous pavement or rain barrels. Green infrastructure can be used in lieu of or in conjunction with traditional hard infrastructure approaches such as pipes, retention basins, and treatment facilities.

Although used widely overseas for decades, green infrastructure is just getting off the ground in the United States. Cities are beginning to introduce green infrastructure as a component of comprehensive stormwater management plans aimed at reducing runoff, combined sewer overflows, or both. This approach is significant in that it can be used to address the stormwater problem at the source through efforts aimed at restoring some of the natural hydrologic function of areas that have been urbanized. Green infrastructure can also be used to limit the adverse impacts of development in sensitive headwaters and groundwater recharge areas by avoiding the segmentation and isolation of ecosystems and their natural resources.

For both public policy and infrastructure management reasons, green infrastructure needs to be much more widely embraced. But regulatory and enforcement authorities will need to work collaboratively with environmental groups and cities to overcome lack of knowledge and significant obstacles that have to date held back green solutions.

Those cities that have implemented green design are already reaping the benefits. Following the lead from City Hall, 80 more green roofs have been constructed in the Windy City, totaling over one million square feet. Other localities are also pioneering green infrastructure solutions. Kansas City, Missouri, has a 10,000 Rain Garden initiative recognizing the fact that all citizens have a role in helping the city implement its 20-year Wet Weather Solutions Program — possibly the largest infrastructure project in city history. Milwaukee's innovative flood management "greenseams" program permanently protects key lands containing water absorbing soils along stream corridors to connect the region's public properties.

At least seven green roofs have been installed in the Milwaukee region, improving quality of life and conserving resources. The city received federal loans and joined with public and private entities to install a 20,000-square-foot green roof at the Highland Gardens housing project, a 114-unit mid-rise for senior citizens and people with disabilities, at a cost of $380,000. The roof will be able to retain 85 percent of a two-inch downpour. The remaining 15 percent of the water is directed to rain gardens and a retention basin for on-site irrigation. And it isn't just large communities. The Village Homes neighborhood in Davis, California, uses a system of vegetated swales and meandering streams to manage stormwater. The natural drainage system is able to retain and filter a rainfall volume greater than a 10-year-storm without discharging to the municipal storm sewer system.

Green infrastructure practices are also behind the use of wetlands for stormwater management, sometimes creating new wetlands where more are needed to retain and clean water naturally. At a cost that has averaged out to less than $50,000 a year, a decade-old demonstration project in the Rouge River area of Michigan has been using 14 acres of wetlands (nearly two-thirds constructed) along the river's banks to naturally treat stormwater before it enters the stream. Previously, discharge pipes routed stormwater directly to the river. A study found that in addition to dampening stormwater flows, the wetlands also reduced concentrations of suspended solids by 80 percent, phosphorus by 70 percent, and both oxygen depleting compounds and heavy metals by 60 percent.

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Greening the ways to better stormwater management

When green infrastructure is introduced to an city, the benefits ripple across the area. Unlike traditional solutions, green infrastructure boasts numerous benefits other than water quality improvement, such as filtering airborne pollutants, offsetting the heat island effect, and reducing building heating and cooling demands. Temperatures above Chicago's City Hall average 10 to 15 degrees lower than a nearby black tar roof — as much as 50 degrees cooler in August. The energy savings for the building are an estimated $3,600 annually. And there are the aesthetic benefits from introducing vegetation into a city center. In most cities, unfortunately, green infrastructure, if used at all, remains a garnish, not the meal.

What can be done to eliminate obstacles — real or perceived — to green infrastructure solutions? First, we need to make accessible user-friendly models to quantify their effectiveness and life-cycle cost, and develop better tools for measuring their economic and environmental benefits. Measuring the costs and benefits of small scale projects can be done with relative ease. For example, to address localized flooding caused by runoff from a single alley, the city of Chicago removed the asphalt from a 630-foot-long, 16-foot-wide area and replaced it with a permeable paving system. Calculations showed that, instead of generating runoff, the alley will filter and retain the rain from a three-inch gully washer. The permeable pavement requires little maintenance and has a life expectancy 25 to 35 years.

In Maryland and Illinois, new residential developments using conservation-design approaches are saving $3,500 to $4,500 per lot (from a quarter-acre to half-acre in size) compared with conventional stormwater controls. These developments were designed to lessen runoff and manage flows by preserving natural vegetation and landscaping, reducing overall site imperviousness, and installing green stormwater controls. Because conventional controls consume more land, developments utilizing green infrastructure normally yield more lots for sale. And lots in green developments generally have a higher sale price because of the premium that buyers place on vegetation and conservation development.

New residential developments using conservation-design approaches are saving up to $4,500 for a half-acre lot.

Methods for predicting the effectiveness of large-scale or large-area green infrastructure projects prove more challenging and are still evolving. But they do exist: for example, researchers at the University of California at Davis have estimated that 1,000 deciduous trees planted in California's Central Valley will reduce runoff by nearly 1 million gallons a year, saving $7,000 over conventional methods.

Second, we need to find sources of federal, state, and local funding for green infrastructure projects. Experience shows that when public financing is on the table, government decisionmakers will pick up the green infrastructure ball and run with it. As just one example, in 2006 the Chicago Department of the Environment announced that it would provide $5,000 grants for small-scale commercial and residential green roofs — and received 123 applications.

There are a variety of other ways to create funding for green solutions. These include the creation of stormwater utilities, similar in function to water and wastewater utilities, which then allows for the assessment and collection of user fees dedicated to a stormwater management program. The funds can then be applied in part to green infrastructure solutions or they can include incentives to encourage voluntary use of green infrastructure. For example, Portland's River Rewards program provides a credit of up to 35 percent of the standard stormwater fee for properties that retain stormwater on site. Another option is dedicating a certain portion of collected local tax revenues to a special fund, thereby removing stormwater management from the intense competition for often-volatile general revenue funding at the local level. These dedicated funding sources could identify a preference for green infrastructure or establish a funding scale based upon the relative use of green management techniques. Existing revenue collection mechanisms may need to be changed or abolished.

Third, the role of regulation must be explored, both in terms of how rules can facilitate the use of green infrastructure and how they may be hindering it at present. Research shows that a common driver among many cities using green infrastructure is the need to assure compliance. For example, a key incentive for Portland, Oregon's green infrastructure program is a need to satisfy a number of environmental regulations, including limitations on combined sewer overflows, discharges into groundwater used as drinking water supplies, and total maximum daily load allocations for sources discharging into impaired surface waters.

However, these same regulatory requirements have more often hindered opportunities for creativity and the willingness of municipalities to promote green infrastructure. For example, models have shown that trees with mature canopies can absorb the first half-inch of rainfall — but trees take decades to create a mature canopy. In contrast, a pipe can capture water as soon as it is installed and on-line. Because our regulatory enforcement system requires immediate results, green infrastructure can be snubbed in favor of tried and true hard infrastructure solutions. Many cities are reluctant to use green infrastructure as part of their combined-sewer-overflow remediation programs because enforcement officials generally prefer to see water quality benefits expressed in traditional terms, such as percentage of water captured. Unfortunately, percent-capture through green solutions is seen as unreliable — and thus, possibly less enforceable.

Green infrastructure projects need to become an acceptable alternative to hard solutions in federal, state, and local permitting and enforcement contexts, even if they may take more time to become fully effective. To continue with the same example, because a tree can take 20 years or more to develop a full canopy that will maximize its stormwater retention and other environmental benefits, regulators may be reluctant to include planted trees in long term control plans for combined sewer overflows. But it can take almost as long to design and build underground storage tunnels to retain wet weather flows. And those tunnels provide no benefits until they are completed, whereas trees provide some measure of retention, shade, property enhancement, air quality benefits, and aesthetics while they are growing. Regulatory and enforcement officials should focus on the big picture and ensure that the remedies they seek are the most beneficial over the long haul.

Many stormwater regulations focus on peak flow rate control and flood control, not on retaining stormwater and recharging groundwater. Revising these regulations to require reducing impervious surfaces, protecting vegetation, maintaining pre-development runoff volume and infiltration rates, and providing water quality improvements can encourage green infrastructure because it can meet these objectives. New Jersey's stormwater management standards require 300-foot riparian buffers and stipulate a preference for nonstructural best management practices. These standards also institute water quantity as well as quality regulations. The water quantity standards require no change in groundwater recharge volume following construction and that infiltration be used to maintain pre-development runoff volumes and peak flow rates. Any increase in runoff volume must be offset by a decrease in post construction peak flow rate. The standards require a reduction in stormwater nutrient loads to the "maximum extent feasible" and total suspended solids reductions of 80 percent. If the receiving water body is a high-quality water under state standards, the required total suspended solids reduction is 95 percent.

Existing local zoning requirements and building codes often inadvertently discourage the use of green infrastructure. Provisions requiring downspouts to be connected to the stormwater collection system foreclose disconnection programs and the use of green space for treatment of rooftop runoff. Mandatory street widths and building setbacks can unnecessarily increase imperviousness. Stormwater requirements that favor centralized collection and treatment and prescribe treatment options offer little incentive to use green infrastructure. Jurisdictions should review their applicable stormwater and wastewater ordinances and revise them to remove these barriers and encourage more environmentally friendly regulations.

Some of the most significant barriers to incorporating green infrastructure into urban areas are the costs and challenges associated with retrofitting these systems into built-out, space-constrained neighborhoods. For example, green infrastructure solutions may be more appealing to developers and municipal officials when they are part of a large capital investment in projects that will upgrade existing infrastructure. Rain gardens or trees in median strips are often installed along with other street improvements when a street is torn up and construction crews are on site. It is often less expensive to install a green roof on a municipal building when an existing roof needs to be replaced. But not every city has a thriving economy — and the accompanying stream of new investment revenue — to make retrofitting green solutions part of the planning process.

Fourth and last, we need to increase the public's and policymakers' awareness and acceptance of green infrastructure. Although natural solutions in many cases are less costly than traditional methods of stormwater and sewer overflow control, business as usual is often the path of least resistance. That makes it incumbent on local decisionmakers, leaders, and citizens to promote cleaner, more environmentally attractive methods of reducing the water pollution produced by their communities. Green infrastructure thus presents an opportunity for community outreach and education. Downspout disconnections, rain barrels, rain gardens, and green roofs may individually manage a relatively small volume of stormwater, but collectively they can have a significant impact.

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Leadership will make the difference in introducing novel approaches

A commonality among cities that have incorporated green infrastructure is a commitment from city personnel. Whether elected officials or professional staff, these leaders have recognized the benefits of green infrastructure and communicated its value to the public. These cities have been looking for alternative approaches to addressing stormwater and combined sewer overflow problems. Their efforts often prove popular because of the public's positive response to the "greenscaping" that accompanies the programs. As many local leaders are discovering, using green infrastructure in place of or in combination with less conventional methods of managing water pollution and stormwater runoff can have benefits beyond just economic cost savings and reduced pollution.

Finding an effective approach to achieve urban water quality has been elusive. However, it should be clear now that the many cities that have stepped up to the plate as lead-off batters are developing an impressive record of success. They are demonstrating on an ongoing basis that green infrastructure is an economically and environmentally viable approach for water management and natural resource protection in urban areas. The green light is on. •