

Green Infrastructure:

The Great Shift in Stormwater Management

□ BY TIM ORMOND □

There was a time when stormwater was primarily considered a problem to be removed.

Get it off site as quickly as possible through constructed systems of gutters, pipes, ditches and concrete-lined channels. Out of sight and out of mind. But that limited view of stormwater management resulted in many unintended consequences, which often worsen over time, especially with increasing population, development and the proliferation of impervious surfaces.

These negative consequences include downstream flooding, streambank erosion, polluted receiving waters, impeded groundwater recharge, and degraded ecosystems and wildlife habitats.

The light at the end of the storm sewer is that a shift is happening. Just like the great shift we are seeing in the energy sector toward solar, wind and other renewables, a shift is taking place in the way we understand and manage stormwater. This new paradigm views stormwater no longer as merely a problem but sees it, in its rightful place, as a valuable and integral part of the interconnected hydrologic cycle that is essential to all life.

Nature as Teacher

Green infrastructure (GI) or green stormwater infrastructure (GSI) are terms now being used to describe an approach to stormwater management that is rooted in the function of natural watersheds. If you've ever been for a hike in the woods in the rain, you've seen the principles behind green infrastructure in action.

In a natural forested watershed, much of the rainfall is intercepted by the tree canopy and other vegetation, and soaks into the spongy leaf litter layer and soil below. Only a small fraction will run off in the form of stormwater runoff. Contrast this to what you'll observe in most urban watersheds, dotted with impervious roofs, streets, parking lots and other hardscape. In the urban landscape, most of the rainfall becomes stormwater runoff with only

a small fraction infiltrating the soil.

With green infrastructure, practitioners design systems where stormwater is intercepted, captured, stored, evapotranspired, dispersed, infiltrated and filtered through natural soil-based vegetated systems. And as the vegetation grows, green infrastructure can actually improve in function over time, taking up even more stormwater and removing more pollutants.

You may already be familiar with some green infrastructure practices, including cisterns for rainwater harvesting, rain gardens and bioretention cells, bioswales, wetlands, green roofs, permeable pavement, street trees, etc. Others may be less familiar, such as simple earthworks, sheet mulching (to build spongy top soil), redirecting downspouts to vegetated areas, creek daylighting, blue roofs, regenerative step pool conveyance, stormwater cascades, terraced bioretention, mushroom mycelium filtration, key-lining techniques and many more.

All of these practices employ basic strategies of slowing, spreading and sinking stormwater and, in the process, preventing the stormwater from conveying pollutants downstream. Green infrastructure also goes beyond individual practices by approaching stormwater holistically at a watershed scale and considering how combining and integrating these practices can provide even greater benefit. Protecting steep slopes, conserving forest and riparian buffers, preserving trees and open pervious space during development are also essential parts of a watershed-based green infrastructure approach.

People and Green Infrastructure

In addition to restoring natural hydrologic function, there are many other benefits to green infrastructure. Many of us who live in Western North Carolina have been drawn here by the stunning natural environment. We come for the mountains and the creeks, rivers and waterfalls which give life to the remarkable biodiversity of our region. A primary reason Asheville has emerged as Beer City is because

of our pristine mountain watersheds and pure water resources.

People love to be connected to water. Our very bodies are 60 percent water. One of the underlying benefits of green infrastructure is how it can reconnect people and communities to the water flowing within our landscape. Researcher Kathleen Wolf at the University of Washington has compiled more than 2,900 articles, many peer-reviewed, demonstrating the "co-benefits" of green infrastructure, which include everything from better public safety, reduced crime, increased property values, improved mental health and well-being, and green job creation.

Opportunities for connecting green infrastructure and local urban food production are also being ex-

plored. For example, the East Capitol Urban Farm in Washington, D.C., is harvesting rainwater from a public housing development and using it to create a three-acre community food oasis in the middle of an historic food desert.

Climate Change and Resilience

According to the most recent National Climate Assessment, heavy downpours are increasing throughout the U.S. and that trend is projected to continue. Already, very heavy precipitation has increased by approximately 30 percent in the southeastern U.S. over the past 50 years. The mountain region of Western North Carolina also has the most variable rainfall patterns in our state, with areas like Weaverville, Mars Hill and parts of Asheville



Stormwater management project in Mars Hill. Tim Ormond photos



having among the lowest annual rainfall, averaging less than 40 inches per year. And on the other extreme, nearby Brevard receives almost 70 inches and Cashiers almost 90 inches per year on average.

Green infrastructure is a key strategy for providing resilience during both water scarcity (by promoting infiltration to recharge groundwater and stream base flow)



as well as water excess (by capturing and storing stormwater). In fact, many are recognizing that green infrastructure is no longer optional for managing stormwater in our changing climate, but is vital for adapting to climate change in ways that conventional infrastructure cannot. Additionally, green infrastructure improves air quality, sequesters carbon, moderates urban heat island effects, and reduces energy consumption for heating and cooling buildings, as well as providing many ecosystem services.

Gray or Green?

Although the need for conventional "gray" stormwater infrastructure will continue as long as we humans live in cities and drive vehicles, green infrastructure can work in harmony with existing conventional infrastructure by helping restore that natural watershed function and improving water quality. In combination, it can also alleviate pressure from gray infrastructure, delaying the need for enlarging and replacing infrastructure and reducing overall costs.

Some major cities in the U.S. have already embarked on ambitious green infrastructure programs. Philadelphia has allocated \$2.4 billion dollars to its green infrastructure program, and in the process, it anticipates saving \$5.6 billion in gray infrastructure costs over the long-term. To be truly effective, a green infrastructure approach should be applied at many levels, including site scale, neighborhood scale and

watershed scale.

Until recently, green stormwater infrastructure was often overlooked as being an essential part of the green building process. Many developers have been unaware of the potential benefits, including cost savings, with green infrastructure. Fortunately, the level of awareness is rapidly changing as well. Applying GI during front-end plan-

ning is generally more cost-effective than retrofitting later.

I've been learning that personally with the green infrastructure retrofit of my own 1920s West Asheville bungalow by incorporating more than 1,800 gallons of rainwater harvesting for edible landscape irrigation, with an integrated stormwater wetland, rain garden, swales, and permeable driveway all in the works.

Stormwater ordinances in municipalities throughout the country are also being rewritten to promote the use of green infrastructure and overcome policy barriers. Some communities are offering financial incentives such as cost-sharing for residents and businesses interested in applying GI on their properties. Even in the case where no applicable stormwater regulations exist, there can be great benefits to both the prospective homeowner and the developer by designing GI measures into the site plan.

The Future is Green

The shift in stormwater management to green infrastructure is here and will continue to grow in the future. Green infrastructure offers numerous benefits for all involved - for the property owner, the developer, the neighborhood, our towns and cities, and our entire bioregion. Using our creativity and skills, within a supportive policy framework, we can develop practical, cost-effective strategies to implement green infrastructure and work together to create more healthy, livable, resilient communities, which honor our watersheds and streams, and the many people and diverse species that inhabit them.

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