Low Impact Development:

A Case Study on Protecting Urban Streams

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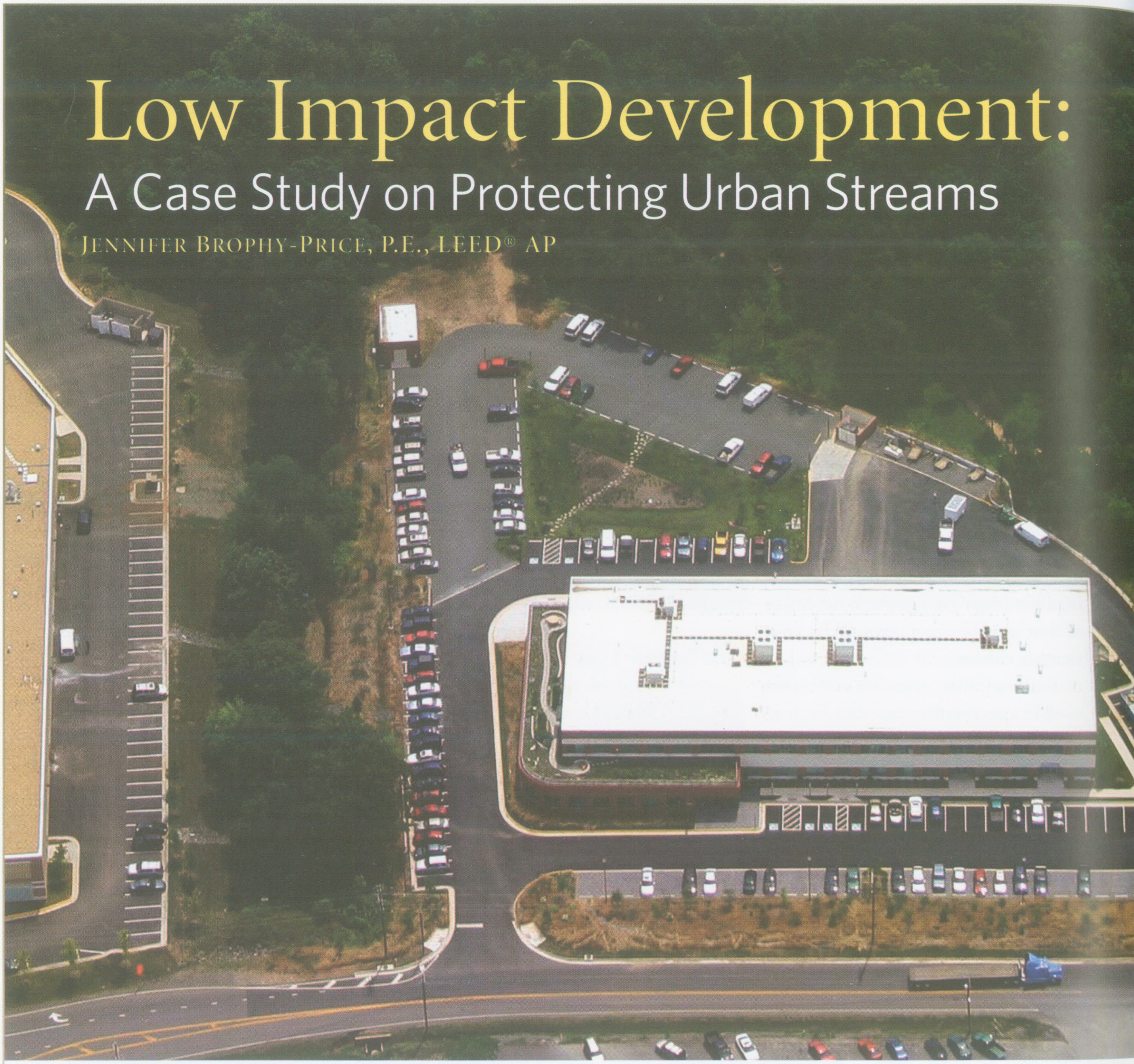


THE SITE OF THE GAINESVILLE, VIRGINIA, office of Wetland Studies and Solutions, Inc (WSSI) isn't like other office sites. This fact is evident from the moment you turn onto the driveway, pass the meadow grasses, and park on the pervious concrete pavers. A tour of the rest of the site reveals gravel parking areas; more pervious pavement; an underground cistern and drip irrigation; a green roof; a rain garden; and a vegetated water quality swale. Collectively, these practices come together to create an integrated Low Impact Development (LID) site.

LID is a method for managing stormwater that mimics the hydrologic function of a forested site. This method is important for many reasons; primary among these is the health of our streams. In an urban setting, water runs off roofs, parking lots, and other impervious surfaces in large volumes and at high velocities. Runoff concentrates in streams, scouring and eroding their banks, causing deep incisions, and increasing downstream sedimentation. In contrast, a forested site intercepts rain; captures it in pockets, wetlands, ponds, and vegetated plains, and infiltrates it slowly into the ground, where it is taken back up by plants, filtered into groundwater, and slowly released to the streams.

LID first seeks to replicate forested hydrology by conserving

From the air, it's hard to imagine the many steps taken at WSSI to protect surrounding wetlands.

IMAGE COURTESY WETLAND STUDIES AND SOLUTIONS, INC.

natural features that capture and use rainwater. LID then seeks to minimize and disconnect impervious surfaces so that only a small amount of water becomes runoff. Finally, LID uses a myriad of small-scale techniques, commonly referred to as Integrated Management Practices (IMP's) to manage the remaining runoff. A snapshot of the IMP's employed on WSSI's site follows:

WSSI's Integrated Management Practices

A 3,600-square-foot green roof captures rainwater as it falls on the building. The green roof is a combination of extensive and intensive areas. Extensive green roofs use a thin layer of soil (typically 3 inches deep or less) and hardy, succulent plants that are well adapted to the harsh, dry environment seen on a roof. Intensive green roofs have a deeper section of soil (up to 9 inches deep on the WSSI roof) and a more diverse plant palette. In WSSI's case, they closely resemble a natural ecosystem of Northern Virginia.

The WSSI roof also employs a drip irrigation system to protect the plants in times of drought.

The remainder of the roof, which is about 25,000 square feet, is covered with a high-albedo, or high-reflectance, membrane. This membrane reflects the sun's light away from the building, rather than absorbing the light and converting it to heat. This both reduces the heat island effect and lowers the building's cooling costs.

When water runs off the roof during a storm, it is captured in an 8,000-gallon, underground cistern. The water is then pumped into the drip irrigation system to water the landscaping, thereby allowing plants to utilize the nutrient loads from the runoff. WSSI used extensive native landscaping, including grasses, perennials, shrubs, and trees. By using hardy plants that are accustomed to the region's weather cycles and by watering those plants with captured runoff, WSSI will save an estimated 2.4 million gallons of potable water per year.

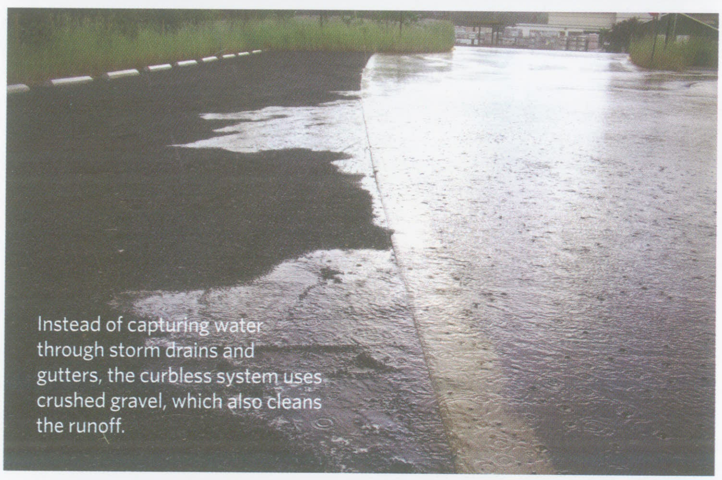
Water that overflows the cistern is transferred by a gravity-fed pipe to the upper layers of the 1,500-square-foot rain garden. The rain garden is comprised of several layers: from the bottom up, a gravel layer provides an underdrain to a gravel bed detention area (since the in-situ clay soils have very low infiltration rates); a sandy loam soil filters the water and allows it to percolate to the gravel; and a hardwood mulch layer completes the garden's appearance. The rain garden is planted with a variety of native species that enhance uptake of the collected nutrient pollutants. In addition to cistern overflow, the rain garden also receives runoff from the parking lot; therefore, it is surrounded by a sod buffer that filters pollutants and debris from the water before it enters a ponding area.

The underground gravel bed detention area is the workhorse of the site; it provides over 10,500 cubic feet of storage space for water, controlled by an orifice just over an inch and a half in diameter. The majority of the water that falls on the site is collected in that gravel bed, where it can rise to a depth of 3.5 feet in large storms. It is then released slowly to an existing stream system at the back of the site. In fact, it is released so slowly that the peak rate of runoff for the developed site is less than it was when the site was forested.

Because parking areas and paved surfaces are needed to service the building, WSSI employed several types of permeable pavement on the site to reduce their impact. Instead of generating runoff, pervious concrete, gravel pavement, and concrete paver blocks filter several inches of rainfall per hour to a crushed gravel substrate, where the water can infiltrate into the ground or, in larger storms, exit to the gravel bed detention or an existing vegetated floodplain through perforated underdrains.

Finally, a water quality swale (also called a bio-swale or vegetated swale) graces the southern edge of the site, transferring any remaining runoff from the pavement through three check

Gravel is key in keeping parking areas dry.



Instead of capturing water through storm drains and gutters, the curbless system uses crushed gravel, which also cleans the runoff.

Everywhere people look, they see evidence that WSSI's site is different from most office locations.

dams that filter pollutants, to the existing stream. The swale follows a sinuous route, slowing the water down so that the stream isn't overwhelmed during a storm event. The swale, like the rest of the site, is extensively planted with native landscaping.

All of the Integrated Management Practices on WSSI's site are tied together with a network of perforated PVC underdrains. The underdrains allow the IMP's to work in parallel and in sequence to retain the natural functions of interception, retention, infiltration, and uptake, and to lower the impact of the built environment on the surrounding natural ecology.

Challenges

When using concepts as "new-fashioned" as LID, there are bound to be some snags, both physically and with public perception, along the way. WSSI was lucky because it had a champion within the county regulatory system who helped see the project through to completion. Since one of WSSI's goals was to create a showcase to assist agencies, engineers, and the public with understanding LID, it was also given allowances to deviate in certain ways from the local building manual. For instance, the manual specifies the use of standard asphalt, curbs, and gutters. WSSI minimized the use of asphalt and used no curbs and gutters.

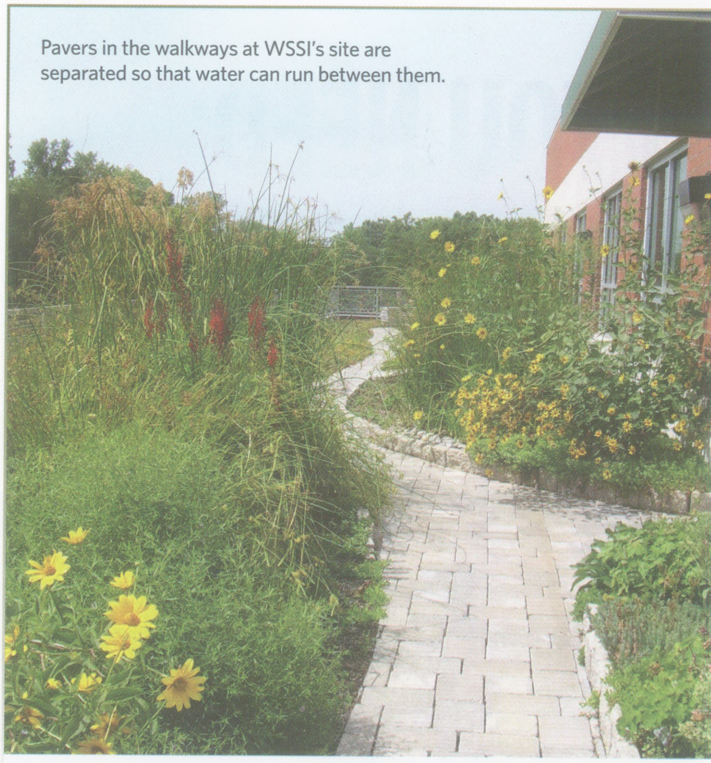
The organization did run into some regulatory issues that couldn't be smoothed over, however. Initially, they looked at installing a large cistern to provide gray water (rain water from the roof) to the building's toilets. However, because of health concerns as well as concerns regarding future accidental tie-ins with the system, WSSI would have been required to treat the water to potable standards, which would have been economically unfeasible. A smaller cistern was selected and used solely to water the landscaping.

During construction, the key to the success of the WSSI project was communication. Since the contractors on the project had never worked with IMP's before, it was imperative that the organization point out differences between conventional development and LID. Doing so assured that areas of infiltration—the areas where water percolates into the ground—would not be compacted by heavy equipment so that water couldn't flow properly, and that IMP's would not be accidentally clogged with sediment or debris. Education about LID also helped contractors to become more involved and engaged in the processes, which meant the project was more likely to succeed overall.

Looking Ahead

As with all showcase projects, WSSI needed a way to measure it against the average. With the help of some eager college interns, the organization designed and installed a monitoring system. Pressure sensors rest in customized wells at the inflow and outflow points of each IMP. Real-time changes in depth as water flows over each well describe the post-construction hydrologic regime. Among the many characteristics the data can ascertain are infiltration rates (the time it takes for water to soak into the ground), time of concentration (the time it takes for water to travel through the watershed), peak runoff times, and storage rates. These can be plotted against a theoretical conventional site to determine the ecological worth of the project.

The monitoring is currently being tested and fine-tuned. WSSI's next goal is to upload the data to a website where students, faculty, and the general public can download the information for their own studies.



Pavers in the walkways at WSSI's site are separated so that water can run between them.

Even without the benefit of numerical data, however, visitors to the WSSI site can see that it's exceeded expectations in the two years since its completion. The landscaping is full and lush; there have been no maintenance issues with the pervious parking surfaces; and the cistern has kept the landscape watered. WSSI will tell you that the site is performing better than expected hydrologically, as well. For instance, the rain garden and underground detention were designed to hold only the 10-year rain event level (the maximum amount that has occurred in 10 years) before overflowing. During the heavy storms of June/July, 2006, however, which were closer to a 100-year event than 10, the rain garden and detention filled to the brim, but did not spill over.

So why did WSSI do all this? Simply put, it's the right thing to do. The Chesapeake Bay Preservation Act states that, "healthy state and local economies and a healthy Chesapeake Bay are integrally related; balanced economic development and water quality protection are not mutually exclusive." WSSI firmly believes this and works with developers to create projects that reflect a commitment to healthy waterways. By building an integrated LID site, WSSI hopes to encourage others to do the same; and maybe one day, WSSI's site won't be so different from other sites, after all. **LD**

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