Green City, Clean Waters:

How Plants Will Help Philadelphia Reduce Pollution from Stormwater Runoff

by Adam Levine and Paul Fugazzotto

As gardeners, many of us are more cheerful about rain than most of the general populace, especially after a stretch of hot, droughty days has stressed our plants and our nerves. While non-gardeners may curse a rainstorm for messing up their plans or their hairdos, we see rain and other forms of precipitation for what they are: the lifeblood of the planet and, more specifically, of our gardens. But too much precipitation, like too much of anything, can also cause problems. This is especially true in urban areas, where the primary color of the landscape is not green, but the red, gray, and black of brick, concrete, and asphalt. Stormwater is fine when it soaks into the ground or runs off slowly into streams, as it does in natural landscapes or in our gardens, but in drastically built-up and paved-over areas, it runs off too quickly and becomes a problem that needs to be managed.

With Mayor Michael Nutter making the greening of the city a priority, and a water department that has been working for more than a decade planning innovative stormwater strategies, Philadelphia has become a model in how to manage this problem with "green" rather than "gray" infrastructure. By using plants and specially designed containers and planting beds—on private property and on streets, in parks and on rooftops—the city is working with nature to capture runoff before it does its dirty work.

Background

The creation of the Environmental Protection Agency and the subsequent passage of the Clean Water Act in the early 1970s helped put an end to the most blatant sources of water pollution: sewers that once spewed untreated or barely treated wastes into our rivers, and industries that did the same. As a result, stormwater runoff has become the largest remaining source of stream pollution in many areas—nationwide, some ten trillion gallons of waterborne pollution annually, according to *Rooftops to Rivers II,* an excellent 2011 National Resources Defense Council report on innovative urban solutions to stormwater pollution (available online at http://www.nrdc.org/water/pollution/rooftopsII/default.asp). Runoff has become a focus of EPA efforts to clean up our waterways, and many communities, including Philadelphia, have been mandated to manage its flow to meet stricter federal standards.

photo ©Philadelphia Water Department

This green roof on the Friends Center at 15th and Cherry is one of a growing number in the city.

In Philadelphia, a small part of stormwater runoff flows directly over land into creeks or rivers, but most of it ends up in the sewer system. About half the city (or sixty-four square miles) is served by combined sewers, which carry stormwater and sewage from households and businesses in a single pipe. In the rest of the city (as well as in many suburban communities), sewage and stormwater are each carried in a separate pipe. Both these systems work well in dry weather, with all the sewage being carried to treatment plants, but each has its problems during wet weather. In the combined system, stormwater runoff can overload the sewers and result in combined sewer overflows, in which sewage diluted by stormwater is discharged, untreated, directly into the nearest river or stream. Such discharges amount to more than 12 billion gallons a year in Philadelphia alone. In the separate system, stormwater picks up all sorts of pollution, including pesticides from lawns and oily petroleum products from the streets, as it runs off into the storm sewers, which carry the pollution directly into the streams.

Solutions: Gray or Green?

In general, two different types of solutions are used to manage stormwater flows. "Gray" solutions (so-called for the massive amounts of concrete they use) depend on huge (and hugely-expensive) underground tanks or tunnels that capture runoff after it enters the sewers, hold it until the storm passes, and then slowly release it to the treatment plants. Decentralized "green" solutions aim to keep stormwater from entering the sewers at all, using a variety of planting and landscaping methods to retain water and allow it to filter slowly into the ground, or be released gradually into the system. In both cases, the result is the same: reduced overflows of polluted water from combined sewers, and less direct stream pollution from separate sewers. But the green options, besides being less expensive and more flexible than large-scale infrastructure fixes, have a number of added benefits, including "beautifying neighborhoods, cooling and cleansing the air, reducing asthma and heat-related illnesses, lowering heating and cooling energy costs, boosting economies, and supporting American jobs," according to the NRDC report.

Philadelphia's stormwater management program, "Green City, Clean Waters," was approved this April by the EPA after more than a decade in development, and it already serves as a model for similar programs elsewhere. The Philadelphia Water Department, the city agency in charge of both the water and sewer systems, plans to invest $2 billion in building green stormwater infrastructure over the next 25 years. Much of this effort will be focused in areas of the city served by combined sewers, with the goal of reducing combined sewer overflows by 85 percent. And as any gardener knows, this style of stormwater management, by supplementing the red, gray, and black of the city's hardscape with greenery, will make Philadelphia a more livable city, a more human-and wildlife-friendly city—dare we say, a better city?

photo ©Philadelphia Water Department

Saylor's Grove stormwater wetland uses the power of plants to filter pollutants from stormwater.

Green Infrastructure: Some Examples

Green infrastructure practices can be implemented on a variety of property types from residential to commercial, from city streets and parking lots, and as with any garden, planter, or planting bed, they can be arranged modularly, to be easily expanded or even replanted if necessary. One tree trench can be extended around an entire block; a rain garden or planter that takes water from one downspout can be enlarged to handle two or more; a green roof can be expanded from one section of a building to another. These adaptable qualities, along with the relatively low initial cost of installation compared to "gray" solutions, make green infrastructure attractive to any community of any size that is looking to reduce pollutants and manage the volume of stormwater reaching sewers or streams.

photo ©Philadelphia Water Department

Stormwater planters bring a swath of green to a standard city streetscape while reducing the amount of runoff that ends up in the sewer system.

Large-Scale Practices

Constructed wetlands and **bio-retention basins** are essentially excavated depressions that store runoff diverted from surrounding areas. In both examples, the larger and heavier pollutants in the runoff have a chance to settle out before the water infiltrates, evaporates, or is slowly released back into a local waterway or existing sewer system. Where water returns to a stream, these solutions help slow down its flow (which reduces erosion) and greatly reduce the level of pollutants it carries. The portion of water that infiltrates helps recharge groundwater flows. The constructed wetland is designed to mimic a natural wetland and is planted with water-loving plants to provide habitat for wildlife and visual beauty. Philadelphia's best example of a constructed wetland is at Saylor's Grove, built on a former park at the intersection of Lincoln Drive, Wissahickon Avenue, and Rittenhouse Street, in the Wissahickon Creek watershed.

Greening the Streets

Because streets and paved driving surfaces are a major source of stormwater runoff, specially designed practices for collecting runoff in

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this setting have been developed. This is no easy feat. Streets often cover a complex network of infrastructure—including telecommunications cables, water and gas lines, and sewer pipes—making any excavation an exercise in caution. Another complication is the politics of city parking: it is a hard sell to convince residents to give up any on-street spaces to make room for a garden.

photo ©Philadelphia Water Department

At street level, a tree trench looks like a series of standard street trees. Below grade, thousands of gallons of stormwater can be stored.

Most of the streetside practices consist of a below grade planter filled with gravel and topped with soil and plants. Depending on the planter depth, the gravel layer is capable of storing a large volume of water that slowly infiltrates into the ground or is slowly released into the existing sewer system; some methods use both infiltration and slow release.

One example of a streetside solution is a **stormwater tree trench**—a long underground structure beneath the sidewalk, into which water is directed through an inlet in the street. On the surface, the tree trench appears to be a series of street trees in standard tree pits, but these pits are connected by an underground system, with a gravel layer for water storage; this large pit also helps trees thrive, by allowing them more room for root growth.

photo ©Philadelphia Water Department

Downspout planters are a low cost residential method of managing stormwater in a variety of spaces.

A second example is a **stormwater bump-out.** Positioned at intersections or mid block, these features take the form of street-level planted areas which protrude slightly into the street and are surrounded by curbing. Runoff enters the system through a curb cut, to be stored in the stone bed, eventually infiltrating into ground below. An overflow drain leading into the sewer provides relief during heavy rains. The height of plantings is a key consideration; they are generally kept low to avoid obscuring sight lines for drivers, cyclists, and pedestrians. Added benefits of these bump-out systems include a shortening of pedestrian crossing distances when positioned at intersections, as well as general traffic calming.

Residential Practices

The popularity of **rain barrels** is one indication that homeowners are beginning to grasp the concept of stormwater management. Some rain barrels now have a place for plantings on top, upping the aesthetic value of this basic cistern. While residential scale practices can rarely manage all of the runoff coming off a roof in a storm, when their use is common in a particular neighborhood they can achieve significant water quality benefits while slowing the flow of unchecked runoff.

Similar to the large-scale street planters, **downspout planters** have a stone bed for storing water, which comes in from a downspout, and a top layer of soil for plantings. An overflow pipe connecting back to the downspout helps prevent a messy mix of water and soil from spilling over the sides in a heavy rain. These planters can be made of wood, metal, or plastic; a do-it-yourself wooden planter can be made in a weekend with supplies from the local hardware store. (Instructions can be found online at www.phillywatersheds.org/residents.) Rain gardens are an increasingly popular way to manage stormwater and enhance a residential landscape. These shallow depressions can be planted with a wide variety of plants; deep-rooted species that can tolerate both wet and dry conditions are good place to start.

photo ©Philadelphia Water Department

The largest of a number of rain gardens at Herron Playground in South Philadelphia.

Rain gardens are very effective at filtering pollutants, and when enough space is available, they can also handle large amounts of runoff. Even a small rain garden will offer stormwater benefits while beautifying an area that may have previously been unused because it was low or soggy. It is important to know that your rain garden is going to drain adequately to avoid standing water for more than 24 hours. An infiltration test is necessary to make the best decision on the placement, size, and depth. Instructions for performing such a test, along with much more good information, is available online at the Rutgers Rain Garden Information Center.

As a garden writer, Adam Levine has written many articles and a handful of books; he is also an environmental historian and a consultant to the Philadelphia Water Department, for whom he manages the web site www.phillyh2o.org. Paul Fugazzotto, a Public Affairs Specialist for PWD, is part of a growing team of people helping promote and implement the "Green City, Clean Waters" program in a variety of ways, including through the web site www.phillywatersheds.org. Besides the NRDC report mentioned above, more details about Philadelphia's stormwater management program can be found in an excellent 9-minute video at http://youtube/BtTI1galu4U.

Ed Note: For a full-color version of this article, go to the HPS/MAG web site, www.hardyplant.org.