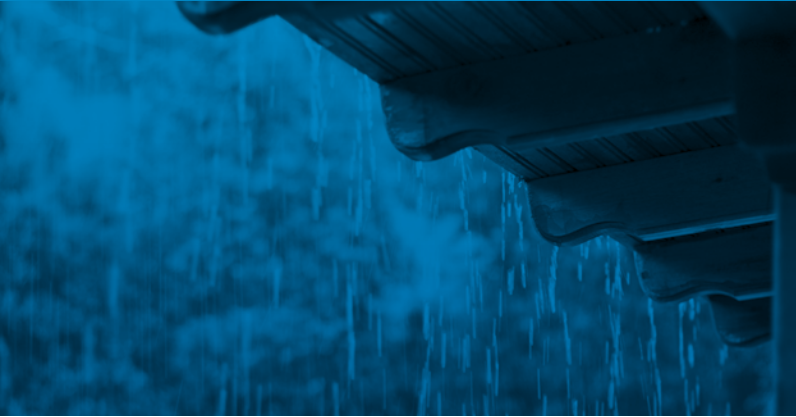


# Rooftops to Rivers II:

Green strategies for controlling stormwater  
and combined sewer overflows



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## **About NRDC**

The Natural Resources Defense Council (NRDC) is an international nonprofit environmental organization with more than 1.4 million members and online activists. Since 1970, our lawyers, scientists, and other environmental specialists have worked to protect the world's natural resources, public health, and the environment. NRDC has offices in New York City, Washington, D.C., Los Angeles, San Francisco, Chicago, Livingston, and Beijing. Visit us at [www.nrdc.org](http://www.nrdc.org).

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# TABLE OF CONTENTS

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**Introduction ..... 4**

**City And Region Updates ..... 7**

Aurora, Illinois ..... 7

Chicago, Illinois ..... 7

Kansas City, Missouri ..... 7

Milwaukee, Wisconsin ..... 8

Nashville, Tennessee ..... 9

New York, New York ..... 9

Philadelphia, Pennsylvania ..... 10

Pittsburgh, Pennsylvania ..... 12

Portland, Oregon ..... 13

Onondaga County, New York (Including Syracuse) ..... 13

Rouge River Watershed, Michigan ..... 15

Seattle, Washington ..... 15

Toronto, Ontario ..... 16

Washington, D.C. .... 17

**Composite Cities ..... 18**

Cleveland, Ohio ..... 18

Cincinnati, Ohio ..... 18

Indianapolis, Indiana ..... 18

Minneapolis, Minnesota ..... 19

Tucson, Arizona ..... 19

Los Angeles, California ..... 20

Endnotes ..... 21

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# INTRODUCTION

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Stormwater is a leading cause of urban waterway pollution across the country. An estimated 10 trillion gallons a year of untreated stormwater runs off roofs, roads, parking lots, and other paved surfaces, often through sewage systems, into rivers and waterways that serve as drinking water supplies. Stormwater also flows to our beaches, where it increases health risks, degrades ecosystems, and damages tourist economies.

In 2011, the Natural Resources Defense Council (NRDC) released *Rooftops to Rivers II* to showcase how 20 cities were using green infrastructure to better manage stormwater and achieve a host of non-water benefits, including capital and maintenance cost savings.<sup>1</sup> Green infrastructure helps stop runoff pollution by capturing rainwater and beneficially managing it by storing it for use, evaporating it back to the atmosphere, or letting it filter into the ground, where it can benefit vegetation and replenish groundwater supplies. Examples of green infrastructure include green roofs, street trees, increased green space, rain barrels, rain gardens, and permeable pavement. These solutions have the added benefits of 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.

In just the past two years, the cities profiled in *Rooftops to Rivers II* have made significant progress in implementing green infrastructure policies and programs, including three cities that improved their performance as measured by NRDC's Emerald City rating system. The Emerald City approach identifies key actions that cities should take to maximize green infrastructure investment (see chart and explanation on next page). Specifically:

- **The Milwaukee Metropolitan Sewerage District (MMSD)** developed a comprehensive Regional Green Infrastructure Plan, with a goal of capturing 740 million gallons of rainwater per storm event by 2035, equivalent to capturing the first 0.5 inch of rainfall on all impervious surfaces. MMSD's commissioners approved the plan in July, 2013, making MMSD the second city or region to achieve all six of the Emerald City criteria.
- **Tucson** gained two Emerald City points. One was for its new retention standard, requiring that stormwater harvesting features be integrated into all publicly funded roadway development and redevelopment projects; another point was given for the city's increasing incentives for private-party actions, specifically its rebate program for residential rainwater harvesting.
- **Pittsburgh** picked up one Emerald City point for guidance or other affirmative assistance to accomplish green infrastructure. In 2012, 3 Rivers Wet Weather, a nonprofit environmental organization created to address Pittsburgh's regional wet-weather overflow problems, launched RainWays, an online tool to help property owners, planners, and engineers site, cost, and determine the performance of green infrastructure in public and private spaces.

Three other cities also intensified their efforts in noteworthy ways:

- **New York City** finalized a consent order governing its combined sewer overflow (CSO) obligations, incorporating key aspects of the city's 20-year Green Infrastructure Plan. The order eliminated or deferred some planned "gray" infrastructure projects and substituted certain others, which are projected to achieve comparable CSO volume reductions on a citywide basis with a net savings of \$1.4 billion. Much of these savings will be reallocated to meet the order's new green infrastructure requirements, which include capturing the first inch of runoff from 10 percent of the impervious surfaces in the city's combined sewer areas by 2030.
- **Philadelphia** completed the first two years of its 25-year Green City, Clean Waters program, which relies primarily on green infrastructure to reduce CSOs. Highlights included creating a detailed planning and project management framework to carry out the citywide green infrastructure program; beginning to design and construct green infrastructure retrofit projects to meet "greened acre" targets; and creating grant programs to incentivize retrofits on private property.
- **Seattle's** Mayor Mike McGinn signed an executive order in March 2013 requiring city departments to work together to develop a comprehensive plan to capture 700 million gallons of stormwater per year using green infrastructure by 2025.

**“Emerald Cities,” listed darkest to lightest by the number of key green infrastructure actions taken**

| City                      | Long-term green infrastructure (GI) plan | Retention standard | Requirement to use GI to reduce some portion of the existing impervious surfaces | Incentives for private-party actions | Guidance or other affirmative assistance to accomplish GI within city | Dedicated funding source for GI |
|---------------------------|--|--------------------|--|--------------------------------------|---|---------------------------------|
| Philadelphia, PA          | ★  | ★                  | ★  | ★                                    | ★   | ★                               |
| Milwaukee, WI             | ★  | ★                  | ★  | ★                                    | ★   | ★                               |
| New York, NY              | ★  |                    | ★  | ★                                    | ★   | ★                               |
| Portland, OR              |  | ★                  | ★  | ★                                    | ★   | ★                               |
| Syracuse, NY              | ★  |                    | ★  | ★                                    | ★   | ★                               |
| Washington, D.C.          |  | ★                  | ★  | ★                                    | ★   | ★                               |
| Aurora, IL                | ★  | ★                  |  |                                      | ★   | ★                               |
| Toronto, Ontario, Canada  | ★  | ★                  |  | ★                                    | ★   |                                 |
| Chicago, IL               |  | ★                  |  | ★                                    | ★   |                                 |
| Kansas City, MO           |  |                    |  | ★                                    | ★   | ★                               |
| Nashville, TN             | ★  |                    |  |                                      | ★   | ★                               |
| Seattle, WA               |  |                    |  | ★                                    | ★   | ★                               |
| Tucson, AZ                |  | ★                  |  | ★                                    |   |                                 |
| Pittsburgh, PA            |  | ★                  |  |                                      | ★   |                                 |
| Rouge River Watershed, MI |  |                    |  |                                      | ★   |                                 |

Three of the cities and regions highlighted also received the prestigious U.S. Water Prize,<sup>2</sup> based on their commitment to use green infrastructure. In 2013, Onondaga County, NY was recognized for its Save the Rain program. The Milwaukee Metropolitan Sewerage District and the Philadelphia Water Department were each recognized in 2012.

## CITY EFFORTS OUTPACE PROGRESS AT FEDERAL LEVEL

Unfortunately, the progress being made by cities and municipalities is not being matched by our federal leaders, specifically the U.S. Environmental Protection Agency (EPA). As *Rooftops to Rivers II* went to press in November 2011, the EPA was poised to take advantage of a once-in-a-generation opportunity to reform the minimum requirements applicable to urban and suburban runoff sources.

The EPA has since missed multiple deadlines to propose new rules to curb stormwater pollution. As *Rooftops to Rivers II* explained, existing EPA regulations need significant improvement. Impervious sites are not commonly required to meet quantitative limits on stormwater runoff volumes and associated pollution levels. Moreover, current requirements typically do not apply to rapidly developing areas outside of existing urbanized areas.

The EPA most recently missed a June 10, 2013 deadline for proposed rules and has not publicly announced when it intends to release the rule for public feedback. When the agency finally acts, the EPA’s new rules must:

- adopt objective performance requirements for control of runoff volume from new development and redeveloped sites, which will create strong incentives for the deployment of green infrastructure approaches;
- ensure that existing developed areas are redesigned to eliminate their contributions to water quality impairments; and

- ensure that significant runoff sources are covered, wherever they are located.

The EPA's new rules can and should address new development and redevelopment in both combined sewer and separately sewered areas. Additionally, for combined sewer areas, the agency should update its 16-year-old guidance on the development of CSO Long Term Control Plans (LTCs) to make clear that, under the CSO Control Policy that Congress codified in 2000, CSO communities must conduct integrated planning that identifies opportunities to use green infrastructure in cost-effective combinations with (or, where appropriate, as substitutions for) gray infrastructure. The EPA should also provide detailed guidance to its regional offices and to states that explains how to draft enforceable green infrastructure requirements for inclusion in Clean Water Act permits and compliance orders pertaining to CSOs, Municipal Separate Storm Sewer Systems (MS4s), and Sanitary Sewer Overflows (SSOs).

## PETITIONING TO PROTECT CLEAN WATER

As *Rooftops to Rivers II* stated, the EPA can and should use its authority under current regulations to ensure that communities achieve critical water quality goals for receiving waters. One tool at its disposal, referred to as “residential designation authority,” empowers the EPA to require categories of sources to obtain pollution-limiting permits; indeed, EPA *must* require a permit for sources found to contribute to violations of water quality standards. Strong permits for existing sites would have dual benefits: ensuring reduced water pollution from these locations and enabling municipalities to better meet their Clean Water Act obligations to address contributions to violations of state water quality standards.

In July 2013, NRDC and its partners, American Rivers, Anacostia Riverkeeper, Anacostia Watershed Society, Blue Water Baltimore, Baltimore Harbor Waterkeeper, California Coastkeeper Alliance, Conservation Law Foundation, PennFuture, Potomac Riverkeeper, and the Shenandoah Riverkeeper, submitted petitions to the EPA that call on the agency to use this authority for sites that contribute to violations of water quality standards in three EPA regions: Region 1 (New England), Region 3 (mid-Atlantic), and Region 9 (Southwest and California).

# CITY AND REGION UPDATES

Please refer to *Rooftops to Rivers II* for a complete profile of each city and region.



## AURORA, ILLINOIS

In August 2013, Aurora announced plans to increase water bill rates and fees to fund the implementation of its long-term CSO control plan (LTCP). The LTCP includes the application of both green and conventional stormwater improvements to remove rainwater from the combined sewer system. The projects are expected to cost \$120 million over the next 20 years.<sup>3</sup>

Aurora completed the construction of a series of rain gardens in its downtown area in 2012. That same year, the Illinois Environmental Protection Agency awarded the city a grant to install rain gardens at 28 intersections within the combined sewer system.<sup>4</sup> By installing rain gardens instead of constructing gray infrastructure to manage stormwater, Aurora will save an estimated \$1.8 million in 2013.<sup>5</sup>



## CHICAGO, ILLINOIS

On October 7, 2013, Chicago Mayor Rahm Emanuel announced the Green Stormwater Infrastructure Strategy, which will invest \$50 million over the next five years to incorporate green infrastructure elements into capital projects to reduce basement and street flooding, as well as improve water quality.<sup>6</sup> The effort will also result in the creation of a comprehensive stormwater management plan that will determine the City's long-term investment in green stormwater infrastructure.

The Chicago Department of Housing and Economic Development is supporting the development of the green infrastructure plan by compiling a set of data layers to better pinpoint areas where green infrastructure could be more effective. A layer that shows how stormwater flows above grade is being analyzed with three other layers: areas susceptible to basement and street flooding; areas serviced by smaller pipes; and vacant, publicly owned land. This analysis will be available for the entire city by December 2013.<sup>7</sup> The department's Green Healthy Neighborhood Plan will apply these data layers in selected neighborhoods to identify areas where stormwater could be better managed through community gardens, rain gardens, and other green amenities.

The EPA filed a motion to enter a consent decree with the Metropolitan Water Reclamation District of Greater Chicago (MWRD) in June 2013 to resolve the district's violations of the Clean Water Act associated with its CSO discharges, which frequently cause dissolved oxygen levels in receiving waters to plummet and pollute those waters with sewage floatables. The consent decree, as lodged, is deficient in a number of ways, including its weak green infrastructure requirement.

For example, the consent decree contains a generally stated requirement that MWRD develop 10 million gallons in retention capacity using green infrastructure by 2015. But without robust modeling and targeting of the development of specific green infrastructure measures—neither of which is required of MWRD as it develops its green infrastructure plan—there is no basis to assume that the overall retention capacity requirement will be strategically implemented to achieve its goal “to reduce CSO discharges, localized flooding and stormwater impacts.”<sup>8</sup> Further, the consent decree does not require, as do many other plans profiled in this report, post-construction monitoring to assess its effectiveness.



## KANSAS CITY, MISSOURI

In November 2012, Kansas City Water Services completed installation of the Middle Blue River Basin Green Solutions Pilot Project, which includes approximately 130 individual green infrastructure units along streets in a 100-acre portion of the Marlborough neighborhood. Community involvement was an important component of the project from the beginning, helping to streamline planning and construction. The EPA and the University of Missouri–Kansas City are tracking water flow from the sites. In the project's next phase, scheduled to begin in spring 2015, green infrastructure projects will be designed and constructed in the remaining 644 acres of the Middle Blue River Basin to reduce flows at two combined sewer outfalls by as much as 4.7 million gallons per rainfall event.<sup>9</sup> Kansas City Water Services' consent decree requires all green infrastructure to be installed by December 2017.<sup>10</sup>



## MILWAUKEE, WISCONSIN

With approval of its Regional Green Infrastructure Plan, the Milwaukee Metropolitan Sewerage District (MMSD) becomes the second city or region to achieve all six of NRDC’s Emerald City criteria identified in *Rooftops to Rivers*

II.<sup>11,12,13</sup> The plan identifies a goal of capturing 740 million gallons of stormwater per rain event and lays out a systematic approach to achieve that goal. MMSD underwent a detailed data analysis to identify the opportunities and constraints to implement green infrastructure strategies in seven watersheds in its service area; the process included the collection, creation, and analysis of data such as impervious area, soils, land use, property ownership, groundwater, topography, tree canopy, and separate/combined sewer areas.

The Regional Green Infrastructure Plan also identifies the need to develop a robust long-term funding strategy that includes regulatory requirements and incentives; NRDC is working with MMSD to identify innovative financial strategies to implement the plan.

MMSD has a number of projects under way that will contribute to the implementation of the plan:

- **Menomonee River Concrete Removal**—MMSD is leveraging internal funding with resources from the Great Lakes Restoration Initiative to remove 1,100 feet of concrete from the bed of the Menomonee River that had been installed as part of a previous flood control plan.<sup>14</sup> The project, which began in the summer of 2013, will restore a more natural, meandering streambed and eliminate a barrier to fish passage.
- **Kinnickinnic River Channel Restoration**—Begun in 2011, this project is transforming a portion of the Kinnickinnic River channel and floodplain by removing 500 feet of concrete channel lining and restoring habitat along 1,000 feet of the river channel and associated floodplain.<sup>15</sup>

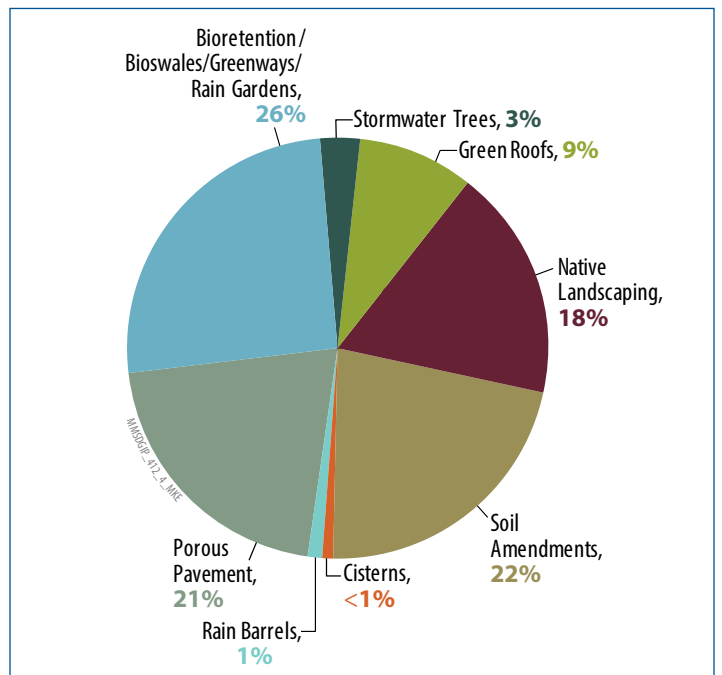
In addition, the MMSD’s 2012 Clean Water Act permit requires the district to add 1 million gallons of green infrastructure capacity to the region on an annual basis.



Courtesy of the Milwaukee Metropolitan Sewerage District



Before and after photos of the Kinnickinnic River Channel Restoration

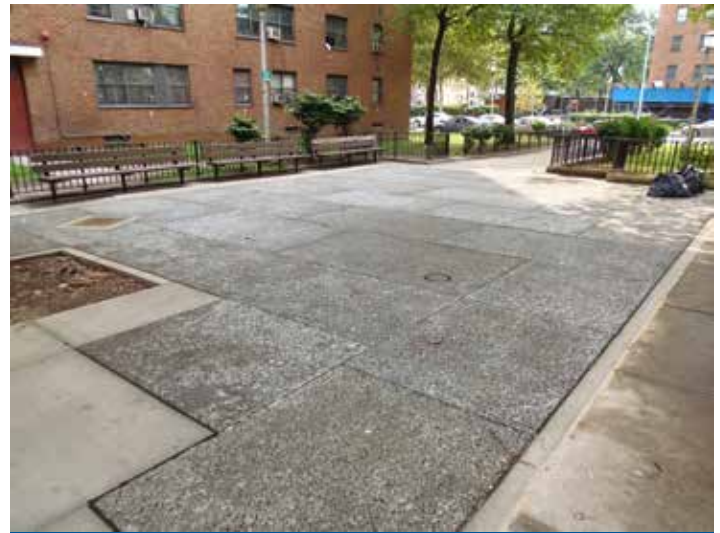


MMSD’s Regional Green Infrastructure Plan identified the storage capacity of each type of green infrastructure identified





Right of way bioswales, New York



Porous pavers at NYC Housing Authority, Seth Low Houses



## NASHVILLE, TENNESSEE

Metro Nashville's Department of Water and Sewerage Services (Metro Water Services) updated its stormwater management manuals in April 2012; a month later, it released a volume that introduces a voluntary site design approach utilizing green infrastructure. This manual will satisfy Nashville's 2012 MS4 permit requirement to attempt to infiltrate, evapotranspire, or harvest and use the first inch of rain, which will become mandatory in 2016.<sup>16</sup> Metro Water Services is in the process of updating its stormwater management manuals once more to align them with the Tennessee Department of Environment and Conservation and to correct mistakes and omissions in a previous manual.<sup>17</sup>

Metro Water Services continues to implement projects in its corrective action plan/engineering report for SSO mitigation.<sup>18, 19</sup> It has also reduced the amount of contaminated stormwater and wastewater flowing directly into the Cumberland River by eliminating two downtown CSO points and modifying existing infrastructure so that sewage and rainwater are routed to the Central Wastewater Treatment Plant instead of flowing untreated into the river.<sup>20</sup>

In January 2013, Metro Parks acquired 600 acres on the Stones River and along the Stones River Greenway to implement the city's open space plan and establish a 1,500-acre regional park system.<sup>21</sup> These greenways preserve riparian zones, including wetlands and riverbanks, which help prevent stormwater and pollutant runoff into waterways.<sup>22</sup>



## NEW YORK, NEW YORK

In March 2012, the New York City Department of Environmental Protection (DEP) and New York State finalized an amended administrative consent order ("order") governing its CSO obligations, which incorporates key aspects of the city's 20-year Green Infrastructure Plan. The order's requirements have also been incorporated into the city's Clean Water Act permits.<sup>23,24,25</sup>

The order eliminated or deferred some planned gray infrastructure projects and substituted certain others, which are projected to achieve comparable CSO volume reductions on a citywide basis with a net savings of \$1.4 billion. Much of these savings will be reallocated to meet the order's new green infrastructure requirements, including capturing the first inch of runoff from 10 percent of the impervious surfaces in the combined sewer areas by 2030. Under the order, an adaptive management approach includes interim green infrastructure targets in 2015, 2020, and 2025, along with monitoring and modeling requirements to evaluate the effectiveness of green infrastructure projects. It also defers two costly CSO detention tunnels, providing an opportunity to develop green alternatives that could substitute for, or allow the downsizing of, those tunnel projects. Also under the order, DEP is preparing 11 CSO Long Term Control Plans for state review and approval, including one city-wide plan, to evaluate and select additional CSO controls, as needed, to achieve the highest attainable water quality standards.<sup>26</sup>

In 2012–13, the city quickly ramped up the design and construction of green infrastructure projects, especially in the public right-of-way. As of June 2013, it had installed 135 right-of-way bioswales and expects to rapidly accelerate construction in the coming years, with near-term goals of 2,000 bioswales by the end of 2014 and 6,000 by the end of 2015. These projects are based on a bioswale standard design

developed by an interagency Green Infrastructure Task Force and approved by the Public Design Commission. The DEP also collaborated with the city's parks and transportation departments to develop a standard streamlined siting procedure for new bioswale and stormwater green street locations to ensure that each site does not create utility or other spatial conflicts and has suitable soil and groundwater conditions to facilitate infiltration. To rapidly implement projects in several "priority CSO tributary areas," identified on the basis of water quality of the receiving water body and the frequency and volume of sewage overflows, the DEP expanded staffing within its own Office of Green Infrastructure, and it is partnering with several other city agencies, each of which has assumed day-to-day responsibility for soliciting and managing design and construction contracts within a priority area. The goal of DEP's "area wide" approach is to leverage the capacity of multiple agency partners to simultaneously proceed on implementation and meet near and future targets efficiently and on time.<sup>27,28</sup>

The DEP also completed construction of three Neighborhood Demonstration Areas, installing dozens of bioswales to measure any volume reductions in the combined sewers from green infrastructure projects on a multi-block scale. Together, the three demonstration areas are projected to collect more than 7 million gallons of stormwater a year and keep it out of the combined sewer system.<sup>29</sup>

The city developed initiatives for on-site retrofits at public facilities, with an initial focus on schools and public housing. The DEP partnered with the Schools Construction Authority and the Trust for Public Land on the design of more than a dozen schoolyard retrofits, and with the New York City Housing Authority on multiple green infrastructure retrofits at each of several public housing projects.<sup>30</sup>

With regard to private property, green infrastructure efforts include a new performance standard for new development and redevelopment, continuation of the Green Infrastructure Grant Program, and support for an enhanced green roof tax credit. The performance standard, adopted in 2012, reduced the allowable release rate for runoff from properties into the combined sewer system and was accompanied by technical design guidelines that include both stormwater detention practices (such as subsurface vaults and blue roofs) and retention practices (such as infiltration and green roofs) that can be used to meet the standard.<sup>31</sup> Through the Green Infrastructure Grant Program, the DEP has committed approximately \$11.5 million to 29 green infrastructure retrofit projects on private property since the program began in 2011.<sup>32</sup> In 2013, the city worked with local advocates to secure legislative reauthorization of its green roof tax credit,

increasing the credit value to \$5.23 per square foot, with a maximum of \$200,000 per project and expanding eligibility to include rooftop farms.<sup>33</sup>

The DEP is preparing for the ongoing maintenance and operation of green infrastructure installations. To support the operations of the quickly expanding program, the agency is developing a tracking and asset management system to facilitate efficient maintenance and operations by field crews and operations staff. In 2014, the DEP will begin a robust research and development program that will provide scientific data measurements of performance of several types of green infrastructure practices over the long term, allowing the department to incorporate improvements during design and construction.<sup>34</sup>



**Stormwater bump-out outside the Queen Lane Drinking Water Treatment Plant in Philadelphia**

Courtesy of Louis Cook for the Philadelphia Water Department



## PHILADELPHIA, PENNSYLVANIA

In 2011, Philadelphia launched its 25-year Green City, Clean Waters program, which relies primarily on green infrastructure to reduce CSOs. Implementation efforts are proceeding under its 2011 administrative consent order with the state of Pennsylvania, as well as a new, parallel administrative consent order with the EPA.<sup>35</sup> Philadelphia and the EPA are working together, through a unique partnership agreement, on several initiatives to use the city as a learning laboratory for green infrastructure. These include greening a public school and adjacent streets, linking the effort to the science curriculum; creating a model green block in an underserved community in partnership with local residents and businesses; and using developments in Philadelphia as sites for EPA research projects on best practices for green infrastructure design.<sup>36</sup>



**Stormwater rain garden at Nebinger School in Philadelphia**

Over the past two years, highlights have included creating a detailed planning and project management infrastructure to carry out the citywide green infrastructure program; beginning to design and construct green infrastructure retrofit projects to meet greened acre targets; and creating grant programs to incentivize retrofits on private property.

The Philadelphia Water Department (PWD) has submitted, for state and federal agency review, a proposed Comprehensive Monitoring Plan identifying short- and long-term green infrastructure monitoring methods at both site and system scales. Its Implementation and Adaptive Management Plan outlines the overall compliance strategy. A green infrastructure maintenance manual, which will apply to both city-owned and privately owned installations, is scheduled to be completed in June 2014.<sup>37</sup>

To track and manage thousands of individual green infrastructure projects—from the concept phase through construction, monitoring, and maintenance—PWD is developing several inter-connected information management systems, including GreenIT to track critical design and performance metrics for all public green infrastructure projects, and a companion system that tracks private projects. PlanIT compiles and tracks information from all potential green infrastructure sites, facilitating the siting and prioritization of new projects. A maintenance

management database tracks inspection, monitoring, and maintenance activities in the field.<sup>38</sup>

To meet its initial five-year target of 744 greened acres, PWD is relying on three programmatic strategies: (1) PWD-initiated green infrastructure projects; (2) green infrastructure add-ons to other public works projects, such as street and sidewalk construction, water and sewer line replacements, and city tree planting initiatives; and (3) installation of new green infrastructure on private property.<sup>39,40</sup> In the first two categories, PWD has completed a combined 62 projects totaling 61 greened acres, and an additional 207 projects totaling 283 greened acres are in the planning, design, contract development, or construction phase.<sup>41</sup> Examples of completed projects—often built in partnership with other city, state, or federal agencies or nonprofit organizations—include a rain garden on a vacant lot; pervious paving on a basketball court; stormwater planters and infiltration trenches in a public square; and stormwater tree trenches, curb bump-outs, and swales along roadsides.<sup>42</sup>

On private property, 146 greened acres have been generated to date, through PWD's implementation of its regulations requiring new development and redevelopment projects to manage the first inch of runoff on-site.<sup>43</sup> Additionally, the Stormwater Management Incentive Program (SMIP), a joint effort of PWD and the Philadelphia



Courtesy of City of Pittsburgh, Office of Neighborhood Initiatives

**Pittsburgh's Green Up Program transforms city-owned vacant lots into community gardens, urban farms, and greenspace**

Industrial Development Corporation, awards grants to private nonresidential property owners for green infrastructure retrofits. In 2012, its first year, the program awarded \$3.2 million to eight applicants for projects that will create approximately 23 greened acres in the CSO drainage area, as well as 43 additional greened acres in other parts of the city. Those grantees are collectively providing an additional \$800,000 in matching funds.<sup>44</sup> In 2013, SMIP awarded \$6.4 million in grants to 16 projects, which will create 88 additional greened acres.<sup>45</sup> PWD also initiated a grant program for Business Improvement Districts (BIDs) to conduct retrofit feasibility studies.<sup>46</sup> And a Rain Check pilot program provides residential homeowners free property assessments and cost-sharing for green infrastructure projects. Following Rain Check site assessments, 60 green infrastructure practices were installed and 36 more are in process at a total of 90 properties. PWD has partnered with the Energy Coordinating Agency to provide job training for the site assessments and construction work.<sup>47</sup>

PWD is working with outside partners—including the NatLab consortium, comprising NRDC, The Nature Conservancy, and EKO Asset Management Partners—to evaluate other opportunities to stimulate private investment in green infrastructure retrofits.<sup>48</sup> On the basis of a 2013 NatLab report, PWD is currently developing a pilot “pay for performance” public-private partnership initiative.<sup>49</sup> Under that approach, a private entity would build and maintain a portfolio of green infrastructure retrofits on PWD’s behalf, at lower cost than if PWD developed individual projects through ordinary means; the private partner would receive payments from PWD based on the number of greened acres it built and maintained.<sup>50</sup>



**PITTSBURGH, PENNSYLVANIA**

A number of organizations are working with city and state agencies to expand awareness of the value of green infrastructure and implement projects to better manage stormwater. One of those efforts, RainWays, earned Pittsburgh a second Emerald City point for guidance or other affirmative assistance to accomplish green infrastructure. RainWays, launched by 3 Rivers Wet Weather, a nonprofit environmental organization created to address Pittsburgh’s regional wet-weather overflow problems, is an online tool that helps property owners, planners, and engineers site, cost, and determine the performance of green infrastructure in public and private spaces. Other efforts include:

- **TreeVitalize Pittsburgh**—This partnership organization has planted more than 19,000 trees in Allegheny County and will reach its goal of 20,000 in the fall of 2013.<sup>51</sup> The organization is also completing two large bioswales, totaling 6,000 square feet, through the Millvale TreeVitalize Project.<sup>52</sup>
- **Panther Hollow Watershed Restoration**—The Pittsburgh Parks Conservancy, the city of Pittsburgh, the Pittsburgh Water and Sewer Authority, and the Allegheny County Sanitary Authority (ALCOSAN) are implementing a comprehensive plan to reduce runoff and restore the Panther Hollow Watershed. Green infrastructure projects to be installed by spring 2014 include infiltration trenches, level spreaders, retentive grading (methods of landscape grading that slow surface runoff, allow infiltration into soil, and prevent erosion), and “no mow” lawns consisting

of native plants.<sup>53</sup> The Pittsburgh Parks Conservancy, in partnership with the University of Pittsburgh and ALCOSAN, is monitoring how these projects affect stream flow, groundwater levels, soil-water dynamics, and stormwater infiltration.<sup>54</sup>

- StormWorks 2010—This program supplies runoff mitigation products, such as rain barrels, rain gardens, and trees, as well as consultation, installation, and landscape design services, to communities in Allegheny County.<sup>55</sup> Pittsburgh’s Nine Mile Run Watershed Association, which works to improve, restore, and protect the Nine Mile Run Watershed, launched this effort in 2010.



### PORTLAND, OREGON

In December 2011, Portland completed its 20-year CSO control program and activated the East Side CSO Tunnel, reducing CSOs to the Columbia Slough by more than 99 percent and to the Willamette River by 94 percent. It also

reduced the number of Willamette River CSO events from an average of 50 each year to an average of four in the winter and one every three years in the summer.<sup>56</sup>

Portland’s ongoing use of green infrastructure to manage stormwater runoff has increased since 2008, when the Grey to Green initiative, a multiyear, \$55 million investment in natural system approaches, was launched. From 2008 to 2013, the city planted 32,200 new street and yard trees, installed 867 green street facilities, treated 7,400 new acres to remove invasive plants, re-vegetated 4,400 acres of natural areas, removed or replaced five culverts to improve fish passage and water quality, and created 460 acres of natural areas to help protect natural stormwater management functions and clean water sources.<sup>57,58</sup>

Portland’s Tabor to the River Program is a concurrent effort that blends green and gray solutions to solve combined sewer and watershed challenges.<sup>59</sup> Since 2008, it has constructed 138 green street facilities and 55 private stormwater facilities, planted 770 street trees, replaced or repaired 10,000 feet of sewer pipe, removed 66 acres of invasive plants, and planted 23,000 native shrubs and trees.<sup>60</sup>

In 2013 alone, the Environmental Services’ Urban Canopy Program, which includes the Treebate incentive, a rebate program for those who plant trees in their residential yards, planted 900 new street trees in East Portland. According to recent monitoring, 94 percent of trees survive beyond two years.<sup>61</sup> In addition, there are currently 398 ecoroofs in Portland.<sup>62</sup>



**Portland’s Tabor to the River Program** partnered with a property owner to manage an average of 176,000 gallons of stormwater annually



### ONONDAGA COUNTY, NEW YORK (INCLUDING SYRACUSE)

Onondaga County exceeded its goal of completing 50 green infrastructure projects in calendar year 2011, with 60 projects accomplished by year’s end. More than 40 additional projects followed in

2012, and 33 are underway in 2013 (as of June 25).<sup>63</sup> High-profile projects in 2013 include:

- Major streetscape projects on West Onondaga, Westcott, and East Washington Streets feature subsurface infiltration trenches, porous pavement parking lanes, vegetated swales, and street trees to capture runoff. Together, these redesigned streets will capture nearly 8 million gallons of runoff annually.
- On Interstate 690 in downtown Syracuse, about 1.25 million gallons of annual runoff from nearly 100,000 square feet of pavement will be diverted away from the combined sewer system into rain gardens and subsurface infiltration trenches, utilizing pockets of available space without disrupting existing land uses.

- At the Rosamond Gifford Zoo, the parking lot is being renovated with bioretention trenches and porous asphalt, and two stormwater wetlands are being created; together, these projects are projected to capture 6 million gallons of runoff annually.

Save the Rain projects are financed primarily through the county's Department of Water Environment Protection, which is funded by sewer use fees. Several of the county's projects are funded in part through New York State's Green Innovation Grant Program (GIGP), using federal assistance from the Clean Water State Revolving Fund. Onondaga County has received a total of \$2.3 million from GIGP. Additionally, the New York State Department of Environmental Conservation awarded a \$3 million grant for green projects within the "civic strip," including renovations to the county's convention center complex. Many of the streetscape projects are developed in partnership with the city of Syracuse, allowing them to incorporate other roadway improvements such as dedicated bike lanes, improved sidewalks, and roadway narrowing to calm traffic and improve pedestrian safety.<sup>64</sup>

For retrofits on private property, Onondaga County expanded and refined its Green Improvement Fund grant program. Since its inception as a pilot project in 2010, it has evolved to prioritize projects that provide the most cost-effective stormwater capture opportunities in the highest-priority drainage areas for CSO reduction. As of June 26, 2013, 38 projects on private property have been completed, funded by approximately \$3.8 million in grants and capturing more than 14 million gallons of runoff annually. Some 45 more projects are under contract, and additional proposals are under review.<sup>65</sup>

A new component to Save the Rain is a Vacant Lots Program, which converts city- and county-owned empty lots into usable spaces for public benefit while capturing stormwater at the same time. Through 2012, four such projects have been constructed; combined, they are capturing more than half a million gallons of stormwater runoff each year.<sup>66</sup>

The county's green infrastructure initiatives continue to stimulate job training opportunities. The Onondaga Earth Corps, a local workforce development organization for ages 15–21, is a key member of the Save the Rain education and outreach team. Youths are trained in green infrastructure construction and maintenance and help to teach their communities about the advantages of green infrastructure. They have also completed a series of rain garden demonstration projects at various locations.<sup>67</sup> Using a



**Vegetated planter box at 100 Clinton Square, funded by a Green Improvement Fund grant from Onondaga County**

Courtesy of Onondaga County, savetherain.us

\$60,000 grant from EPA's National Urban Waters program, announced in August 2013, the Onondaga Environmental Institute will sponsor two green infrastructure training workshops for low-income, unemployed adults. Participants will learn how to create and maintain rain gardens, bioretention basins, rain barrels, and green roofs. In addition, the program will include training on life skills, job readiness, and workplace safety as well as exposure to a variety of green careers. The Onondaga Environmental Institute will also host two monthlong after-school programs to train young people aged 15–21 about these issues.<sup>68</sup>

Onondaga County is applying green infrastructure techniques to solve additional water quality issues and to reduce inflow and infiltration into the sanitary system in Municipal Separate Storm Sewer (MS4) areas. In 2012, the county launched a Suburban Green Infrastructure Program that awarded \$3 million to 14 projects in 12 municipalities within the Onondaga County Consolidated Sewer District. These projects will capture a combined 38 million gallons of runoff annually, reducing sewage overflows by limiting inflow and infiltration into the sanitary sewer system. The county allocated \$2 million for a second round of this program in 2013.<sup>69</sup>



## ROUGE RIVER WATERSHED, MICHIGAN

In 2013, the Detroit Water and Sewerage Department (DWSD) developed a green infrastructure plan for the Upper Rouge Tributary on the city's west side, pursuant to the requirements of the new

discharge permit for its wastewater treatment plant.<sup>70</sup> The plan establishes a comprehensive process for incorporating green infrastructure into DWSD's CSO control program. It prioritizes green infrastructure opportunities on the basis of CSO drainage districts, vacancy classifications, and property ownership. DWSD has contracted with a consultant to help develop a process for identifying, evaluating, selecting, implementing, monitoring, and tracking specific near-term green infrastructure practices.

DWSD is required to invest \$50 million in these green infrastructure programs over the next 20 years. By 2017, Detroit must install enough green infrastructure to reduce flows into the sewer system during a two-year, 24-hour storm event by at least 2.8 million gallons. DWSD is currently developing a stormwater fee to help finance these green infrastructure programs.<sup>71</sup> The department is calculating impervious areas for city parcels to establish a fee structure, slated to go into effect in 2014. DWSD is also considering implementing a green infrastructure incentive program associated with this fee, which would allow customers to earn credits by reducing runoff from their properties.

DWSD ramped up its green infrastructure installation over the past two years. Since 2011, the department has planted 3,054 trees and demolished and greened 277 vacant properties,<sup>72</sup> reducing runoff volume entering the combined sewer system by an estimated 450,000 gallons.<sup>73</sup> Beyond Detroit, the Alliance of Rouge Communities (ARC) implemented a green infrastructure campaign to reduce runoff into the Rouge River. The ARC completed a land cover survey to establish an impervious cover baseline and installed enough green infrastructure retrofits to eliminate more than 200,000 gallons of runoff from the river.<sup>74</sup>

Finally, the Southeast Michigan Council of Governments (SEMCOG) assembled a task force to develop a long-term green infrastructure plan for the region, including the Rouge River watershed, and is currently soliciting citizen input on the desired outcomes of the plan.<sup>75,76</sup> When complete, the task force's Green Infrastructure Vision will develop metrics to enhance green infrastructure and identify targets of opportunity, including specific recommendations on actions and policies to achieve its goals.



## SEATTLE, WASHINGTON

In March 2013, Seattle Mayor Michael McGinn signed an executive order directing city agencies to develop a community-wide green stormwater infrastructure (GSI) plan with the goal of managing 700 million gallons of

stormwater runoff annually with green infrastructure by 2025.<sup>77,78</sup> That goal was endorsed by the Seattle City Council, which, in July, passed its own resolution establishing that "green stormwater infrastructure is a critical aspect of a sustainable drainage system" and adopting a policy to "rely on GSI for stormwater management wherever technically feasible and aligned with urban development priorities."<sup>79</sup>

These high-level policy statements direct city agencies, including Seattle Public Utilities (SPU), Seattle City Light, and the Seattle Departments of Transportation, Planning and Development, Parks and Recreation, and Finance and Administrative Services, to collaborate in a number of ways, such as:

- establishing a coordinated approach for the integration of green stormwater infrastructure in the public right-of-way, including the development of tools such as standard design templates and funding structures;
- revising development-related codes, rules, and standards;
- ensuring that green stormwater infrastructure is incorporated into capital projects to the maximum extent feasible; and
- conducting economic analyses to consider a range of public and private benefits, including the identification and promotion of job opportunities attributable to green stormwater infrastructure.

Seattle's Office of Sustainability and Environment has been directed to coordinate the development of the 2025 GSI Implementation Strategy by June 2014.

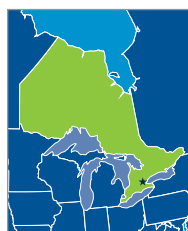
In February 2013, the Seattle Department of Planning and Development and SPU also released a Director's Rule, further interpreting and clarifying the 2009 Stormwater Code requirement that green stormwater infrastructure be used to the maximum extent feasible for single-family residential and parcel-based projects.<sup>80</sup> To help sites meet the requirement, a range of best management practices (BMPs) are identified, including bioretention, use of permeable paving, retention of existing trees, rainwater harvesting, and installation of green roofs.

SPU also has a number of capital improvement projects almost completed or under way, including:

- **Ballard Natural Drainage System**—This project, which is in the design and preconstruction planning phase, will retrofit existing streets with roadside natural drainage systems to protect Salmon Bay and to keep sewage from overflowing when it rains.<sup>81</sup> The siting and design are being coordinated with potential future bicycle and pedestrian improvements; the project will be constructed in 2015.
- **Capitol Hill Water Quality Project (the Swale on Yale)**—Completed in September 2013, the Swale on Yale will treat an average of 190 million gallons of stormwater annually flowing from Capitol Hill into Lake Union, greatly reducing the amount of pollution discharged into the lake.<sup>82</sup> Stormwater will be diverted into a series of four swales along Yale Avenue North and Pontius Avenue North, which slow the flow and remove pollutants. The project also includes a large underground storage facility and about 2,000 feet of new stormwater pipeline to convey untreated stormwater into the diversion vault and then into the biofiltration swales. The treated stormwater then will go back into the storm drain system for discharge into Lake Union.
- **Delridge Natural Drainage System**—This project, which is currently in the design and preconstruction planning phase, will retrofit existing streets with natural roadside drainage systems to protect Longfellow Creek from polluted runoff.<sup>83</sup> The siting and design of natural roadside drainage is being coordinated with the Seattle Department of Transportation's bicycle and pedestrian improvements in the neighborhood, to take advantage of co-benefits and to minimize overall disruption to the community. SPU will also replace existing control systems at two combined sewer facilities, allowing the utility to better monitor and regulate the flow allowed to enter the downstream sewer systems.
- **Venema Natural Drainage System**—Venema Creek is a tributary flowing into Piper's Creek in North Seattle.<sup>84</sup> Currently in the design phase, the project will create a series of cascading bioretention swales that will channel rainwater off the street, remove pollutants, slow the flow, and allow significant volumes to seep slowly into the soil. The goals of the project are to restore the natural hydrological cycle of Venema Creek, improve water quality

in Venema Creek and Piper's Creek as well as Puget Sound, and provide additional green space and vegetation to reduce air and water pollutants. The project will also improve pedestrian safety in the neighborhood by adding sidewalks and will contribute to community-wide urban forestry goals by retaining mature street trees and planting new street trees where feasible.

Finally, in March 2012, SPU convened a group of stakeholders, the Green Infrastructure Partnership, to share information and collaborate on projects. Composed of nonprofit and civic organizations as well as university staff and government agencies, the partnership meets on a monthly basis and serves primarily as an information sharing venue.



## TORONTO, ONTARIO

In July 2013, Toronto made retention of the first 10 millimeters (approximately 0.4 inch) of rainfall during wet-weather events a mandatory requirement for buildings to qualify for Tier 2 of Toronto's Green Standard, a set of performance measures encouraging sustainable site and building design.<sup>85</sup> All new buildings are required to meet the Tier 1 environmental performance standards; buildings that also meet Tier 2 standards qualify for refund incentives.<sup>86</sup>

The Toronto City Council approved a bylaw requiring property owners to disconnect their downspouts; this bylaw comes into effect in three phases. Phase I, completed in November 2011, required owners of property in areas served by combined sewers to disconnect their downspouts. Phase II requires disconnection on properties in basement flooding study areas and is slated for completion in December 2013. Phase III requires all property owners to disconnect their downspouts by 2016.<sup>87</sup> Toronto also expanded its Eco-Roof Incentive Program, which provides grants for installing green roofs on residential, industrial, commercial, and institutional buildings. Green roof grants of up to \$100,000 and cool roof grants of up to \$50,000 are available for existing buildings. New buildings with a gross floor area of less than approximately 21,500 square feet and all Toronto Public and Separate School Board buildings also qualify for green roof grants.<sup>88</sup>





## WASHINGTON, D.C.

The District of Columbia's MS4 permit was modified in November 2012 as a result of settlement negotiations in a permit challenge brought by NRDC and local watershed groups.<sup>89</sup> The modifications strengthen the permit's requirement that

the District meet local water quality standards, and the District Department of the Environment (DDOE) recently began developing its plans and schedules to meet those standards. These plans likely will depend upon—and substantially encourage—the use of green infrastructure techniques.

In July 2013, DDOE finalized new District-wide stormwater regulations, updated as required to implement the MS4 permit's 1.2-inch retention standard for newly developed and redeveloped properties.<sup>90</sup> In addition, the regulations require that substantial improvements to existing properties (such as significant interior renovations) incorporate stormwater management practices to meet a 0.8-inch retention standard. The retention standard must be met using practices that infiltrate, evapotranspire, and/or reuse stormwater, including green infrastructure. The regulations include a first-of-its-kind trading program that allows regulated properties to purchase retention "credits" from properties that are retrofitted with excess retention capacity. This trading program is expected to result in the installation of

new green infrastructure practices more broadly throughout the District. Because the program contains several loopholes that threaten its effectiveness—including unlimited banking of credits, a lack of geographic restrictions on trades, and issuance of credits for previously installed projects—implementation must be monitored closely to ensure that the program will function as intended.

DDOE recently finalized a discount program, RiverSmart Rewards, for its stormwater fee that allows residents to receive a discount of up to 55 percent when they manage stormwater using green infrastructure.<sup>91</sup> Discounts are available for new and previously installed practices.

In December 2012, DC Water entered a partnership agreement with the EPA and the District government, committing to use more green infrastructure techniques in its wet-weather pollution controls.<sup>92</sup> The partnership agreement identifies a process by which DC Water will propose a modification to its CSO consent decree schedule that allows it time to implement a green infrastructure demonstration project. If the demonstration project is successful, DC Water intends to seek approval for a modified plan that substitutes green techniques for some of the underground storage tunnels the consent decree currently requires. Unfortunately, the extended time frame associated with this pilot project would lead to delays of up to eight years in reducing CSOs and attaining water quality standards in the Potomac River and Rock Creek.

# COMPOSITE CITIES

## CLEVELAND, OHIO

In 2012, the Northeast Ohio Regional Sewer District (NEORS) released a Green Infrastructure Plan that identifies how projects will be sited, implemented, and monitored to achieve the terms of its 2010 CSO consent decree.<sup>93</sup> The district continues to implement the plan; recently developing conceptual designs for 15 potential project areas and initiating design for an urban agriculture green infrastructure project and one on Fleet Avenue.<sup>94</sup> The District also completed construction, in partnership with University Circle Incorporated, of a green infrastructure project as part of the newly constructed Courtyard by Marriott in Cleveland's thriving University Circle neighborhood. This green infrastructure project allows for annual infiltration of approximately 1 million gallons of stormwater through pervious pavers and underground storage chambers, taking advantage of historic Lake Erie beach sands.

## CINCINNATI, OHIO

In May 2013, the EPA approved the Metropolitan Sewer District of Greater Cincinnati's Revised Original Lower Mill Creek Partial Remedy plan, a sustainable integrated watershed solution to remove 1.78 billion gallons of CSOs annually from the Mill Creek area by 2018. This stormwater management plan is part of Project Groundwork, the sewer district's consent decree program. A key component is daylighting the mile-long buried Lick Run creek to redirect stormwater runoff from the combined sewer system. This and other projects in the Lower Mill Creek Watershed form the green alternative to the original gray solution of building

a deep underground storage tunnel.<sup>95</sup> Not only is the green alternative \$200 million less expensive than the gray solution, but it is also expected to create nearly 1,000 full-time jobs. Other green infrastructure projects in the remedy plan include stormwater detention basins and stream restoration.<sup>96,97</sup>

## INDIANAPOLIS, INDIANA

Indianapolis's Clean Water Initiative—which includes the renegotiation of the EPA consent decree, the transfer of water and wastewater utilities to Citizens Water, and the RebuildIndy program—was one of 111 government programs nationwide recognized with a Bright Idea Award from the Ash Center for Democratic Governance and Innovation at Harvard University's John F. Kennedy School of Government. Indianapolis residents will benefit from more than \$740 million in cost savings and a significantly reduced debt load. These initiatives are also expected to reduce flooding, create cleaner waterways, and revitalize streets, sidewalks, parks, and bridges.

In 2013, Indianapolis proposed an adjustment to its stormwater user fee structure to fund a 20-year capital improvement program addressing \$320 million in stormwater infrastructure needs, including a high-priority list with \$81 million in projects to be completed by the end of 2018, and to better maintain the existing system. It also creates a stormwater credit program with discounts for incorporating green and infiltrative practices on residential and nonresidential properties, as well as credits for schools that add water quality education to their curriculum.

Courtesy of the Metropolitan Sewer District of Greater Cincinnati



Completed bioinfiltration basin project at the St. Francis Court Apartments, adjacent to the Lick Run Project corridor



FedEx employees plant trees along Pogues Run Creek

Courtesy of Keep Indianapolis Beautiful

Indianapolis also works with a number of nonprofit and philanthropic organizations to further stormwater management goals. Since 2011, the nonprofit organization Keep Indianapolis Beautiful (KIB) has continued to plant trees throughout the city.<sup>98</sup> In 2012, a drought severely impacted the normal planting schedule of 5,000 trees per year, and the message of preserving trees was emphasized. Since 2011, KIB has planted more than 3,000 trees through the NeighborWoods program.

Indianapolis developed a Storm Drain Marking program to prioritize and mark storm drain inlets, catch basins, and public access points. In 2012, Eli Lilly and Company partnered with Reconnecting to Our Waterways, a nonprofit coalition seeking to boost quality of life in Indianapolis, to mark 20,000 storm drains to remind residents that these drains flow to local waterways and to inform them of the environmental hazards of dumping pollutants into the stormwater system.

## MINNEAPOLIS, MINNESOTA

The policy focus on stormwater management has shifted in Minnesota from the municipal level to the state and regional levels.<sup>99</sup> The state legislature funded the formulation of minimal impact development (MID) standards that include an extensive section on green roofs and walls and other best management practices using green infrastructure technologies. It is anticipated that the pace of new regulatory initiatives will increase again at the municipal level as the new MID standards become integrated with city planning. Regional activity on stormwater management has been robust and has mostly centered on the various watershed districts, which are state-authorized, multi-jurisdictional organizations that have tax and regulatory authority over most water management issues. These include the Mississippi Watershed Management Organization (MWMO), Minnehaha Creek Watershed District (MCWD), and Ramsey-Washington Watershed District (RWWD). The MWMO recently completed a watershed management plan for downtown Minneapolis that sets a goal of reducing stormwater runoff, sediment, and thermal pollution in the Mississippi River to 1970 levels.



Curb inlet allows stormwater runoff to enter a street-side basin

Courtesy of Watershed Management Group

## TUCSON, ARIZONA

Tucson gained two Emerald City points. One was for its new retention standard, requiring that stormwater-harvesting features be integrated into all publicly funded roadway development and redevelopment projects; a second was awarded for the city's increasing incentives for private-party actions, specifically its rebate program for residential rainwater harvesting.

Tucson's Green Streets policy also promotes equity by extending tree canopy to low-income communities.<sup>100</sup> The development of this policy was led by the Watershed Management Group, a nonprofit organization that provides green job training and green infrastructure resources and partners with city organizations such as the Department of Transportation and the Bike and Pedestrian Program to integrate green infrastructure into city projects.<sup>101</sup>

The city also expanded its rebate program for residential rainwater harvesting. The two-level funding system will rebate the costs of qualifying rainwater harvesting systems to a maximum of \$2,000. Levels of funding are based on the amount of water applicants aim to capture and the practices that are implemented.<sup>102</sup> Households that install a permanent gray water irrigation system can also apply for Tucson Water's Single Family Residential Gray Water Rebate Program for reimbursements up to \$1,000.<sup>103</sup>

Finally, in November 2013, Tucson will vote on replacing its 2001 General Plan with "Plan Tucson, which includes a focus on green infrastructure."<sup>104</sup>

## LOS ANGELES, CALIFORNIA

Los Angeles, the country's second-largest city, is located at the heart of the densest urban area in the United States.<sup>105</sup> In the early 20th century, a rush of development along the floodplain of the Los Angeles River coincided with several catastrophic flood events, resulting in deaths and massive damage to property in the region. Because the river is situated in a semiarid climate, it tends to be dominated by seasonal storms, often of short duration and high intensity. During peak flows, the river can carry more than eight times the average flow of the Hudson River in New York.<sup>106,107</sup> To address future flooding concerns, in the 1930s the U.S. Army Corps of Engineers decided to channelize the river and line many of its major tributaries with concrete; today more than 90 percent of the Los Angeles River's approximately 52-mile course is concrete-lined.<sup>108</sup>

Because of dense urbanization, the Los Angeles River and other local river courses, such as Ballona Creek, as well as the coastal waters these rivers drain to have substantial issues associated with polluted stormwater runoff.<sup>109,110</sup> Los Angeles County and 84 cities operate an interconnected web of separate storm sewers that discharge runoff to these waters. Urban pollution from impervious areas flows to storm drains and then is dumped, typically untreated, into local waterways, tainting rivers and beaches with metals, nutrients, ammonia, bacteria, toxins, and pesticides.<sup>111</sup>

In 2012, the L.A. County Regional Water Quality Control Board renewed a Clean Water Act stormwater permit for Los Angeles County; the revised permit will require new development and significant redevelopment, and in some circumstances existing development, to use green infrastructure practices to retain the runoff from the 85th percentile storm event. This improved green infrastructure mandate will augment Los Angeles's existing efforts to use green infrastructure practices to clean up its waterways. In 2004, voters passed Proposition O, which authorized a series of general-obligation bonds of up to \$500 million for pollution control projects.<sup>112</sup> Many completed projects and those under construction have a significant green infrastructure component.<sup>113,114</sup> For example, in South Los Angeles, the city transformed a former bus yard into the South Los Angeles Wetland Park, which provides open space for a lower-income community and treats stormwater runoff to remove trash and pollutants.<sup>115</sup> The city also completed a project that reroutes a storm drain carrying polluted runoff to Arroyo Seco, a tributary to the Los Angeles River, to two large cisterns installed under the park with 1 million gallons of total storage capacity. Water from the cisterns either is allowed to filter into the ground, naturally treating and cleaning the runoff and replenishing groundwater supplies, or is used to irrigate the park during dry periods.<sup>116</sup>

Los Angeles launched a green streets initiative known as Green Streets L.A. and adopted Green Streets Standard Plans, a series of preapproved engineering documents that can be incorporated into other construction documents.<sup>117,118,119</sup> In the Sun Valley neighborhood north of downtown, the city partnered with numerous agencies and stakeholders to complete a green street retrofit for Elmer Avenue, an area that was previously subjected to frequent and damaging flooding from rain events due in part to a lack of storm drains.<sup>120</sup> By installing an infiltration facility coupled with curb cuts, drainage swales, porous pavement, and other green infrastructure, Elmer Avenue can now sustain large rainfall events. The street can now drain and infiltrate the runoff from a 2 inch storm event from nearly 40 acres of surrounding, primarily residential, development with no runoff. The project greatly reduces flooding and pollution, provides up to 16 acre-feet of groundwater recharge per year, and is now a beautiful centerpiece for the neighborhood.<sup>121</sup>

Finally, in 2011, before the county's MS4 permit was adopted, Los Angeles passed a Low Impact Development ordinance setting numeric requirements for retention of stormwater runoff for development.<sup>122</sup> Development and redevelopment projects over a certain size threshold are required to retain the 85th percentile storm event on-site, and all new development projects of more than 500 square feet are required to implement green infrastructure BMPs into their design.

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