



---

September 2017

# STORMWATER MANAGEMENT

## EPA Pilot Project to Increase Use of Green Infrastructure Could Benefit from Documenting Collaborative Agreements

# GAO Highlights

Highlights of [GAO-17-750](#), a report to the Honorable Sheldon Whitehouse, U.S. Senate

## Why GAO Did This Study

Urban stormwater runoff is a major contributor to pollution in U.S. waters. Municipalities historically managed stormwater with gray infrastructure. In 2007, EPA began encouraging the use of green infrastructure to manage stormwater and reduce the need for gray infrastructure.

GAO was asked to examine the use of green infrastructure by municipalities to meet EPA's stormwater requirements. This report (1) describes the extent to which selected municipalities are incorporating, and funding, green infrastructure in stormwater management efforts; (2) describes what challenges, if any, municipalities reported facing in incorporating green infrastructure into stormwater management efforts; and (3) examines efforts EPA is taking to help municipalities use green infrastructure.

GAO surveyed two nongeneralizable samples totaling 31 municipalities with stormwater permits or consent decrees for CSOs and interviewed EPA officials to examine EPA efforts to help municipalities use green infrastructure. The municipalities were randomly selected from lists of municipalities that are required to have permits and have consent decrees.

## What GAO Recommends

GAO recommends that EPA document agreements, when working with municipalities and other stakeholders, on how they will collaborate when developing long-term stormwater plans. EPA generally agreed with GAO's recommendation and plans to implement it over the next 12 to 18 months.

View [GAO-17-750](#). For more information, contact J. Alfredo Gómez at (202) 512-3841 or [gomezj@gao.gov](mailto:gomezj@gao.gov).

September 2017

## STORMWATER MANAGEMENT

### EPA Pilot Project to Increase Use of Green Infrastructure Could Benefit from Documenting Collaborative Agreements

## What GAO Found

Almost all 31 municipalities GAO surveyed reported using green infrastructure to comply with their Clean Water Act permits or combined sewer overflow (CSO) consent decrees. The Environmental Protection Agency (EPA) regulates stormwater pollution under the Clean Water Act, which requires municipalities to obtain permits to discharge stormwater into waterbodies. EPA has also entered into consent decrees with municipalities that have CSOs—events where raw sewage is discharged into waterbodies. Green infrastructure uses natural processes to manage stormwater, such as capturing stormwater so it can seep into soil (see figure). However, of 27 municipalities responding, 15 reported that less than 5 percent of the area subject to their permit or consent decree drained into green infrastructure, with the remaining area draining into gray infrastructure, such as concrete sewers, or directly to waterbodies. Most of the municipalities reported funding green infrastructure with fees and general revenues.

Of the 31 municipalities GAO surveyed, 26 reported that green infrastructure was more challenging than gray infrastructure in aspects of infrastructure development, such as developing project operation and maintenance cost estimates. Nevertheless, 25 of these municipalities reported instances where they used green infrastructure even though it was more challenging. Some municipalities reported that they were less familiar with green infrastructure but used it anyway because it performed better or it provided additional benefits, the community wanted to use it, and the municipality saw an opportunity to learn about green infrastructure.

EPA provides multiple resources to educate and assist municipalities on the use of green infrastructure. In 2016, the agency launched a pilot project with five municipalities to encourage states, communities, and municipalities to develop long-term stormwater plans to increase their use of green infrastructure. Key to the success of the pilot project is collaboration among many stakeholders from across each community, such as members of the local utility, transportation, and recreation departments, as well as local organizations. GAO has previously identified key considerations, such as documenting agreements on how to collaborate that can benefit collaborative efforts. However, EPA has not yet documented collaborative agreements with pilot stakeholders. EPA could better assure that the stakeholders will successfully develop long-term stormwater plans if it documents how the stakeholders will collaborate.

## Examples of Green Infrastructure



Bioswale



Green roof



Rainwater harvesting

Source: Environmental Protection Agency. | [GAO-17-750](#)

---

# Contents

---

---

Letter		1
	Background	6
	Surveyed Municipalities Use of Green Infrastructure to Manage Stormwater Is Limited and Funded through General Revenues and Fees Charged to Utility Customers	13
	Surveyed Municipalities Reported That Using Green Infrastructure Was More Challenging Than Using Gray Infrastructure but Also Reported Continuing to Use It	18
	EPA Helped to Facilitate Municipalities' Use of Green Infrastructure, but in Launching a New Pilot Project Has Not Yet Developed Collaboration Agreements with Municipalities	25
	Conclusions	34
	Recommendation for Executive Action	34
	Agency Comments	34
Appendix I	Objectives, Scope, and Methodology	36
Appendix II	Questionnaires Used in the Survey	42
Appendix III	Comments from the Environmental Protection Agency	77
Appendix IV	GAO Contact and Staff Acknowledgments	79
Tables		
	Table 1: Key Issues to Consider for Implementing Interagency Collaborative Mechanisms	31
	Table 2: Location and Population Served by Municipalities with Permits Included in Our Survey	37
	Table 3: Location and Population Served by Municipalities with Consent Decrees Included in Our Survey	38
Figures		
	Figure 1: The Location of the 31 Randomly Selected Municipalities Included in Our Survey, by EPA Region	4

---

---

Figure 2: Types of Municipal Sewer Systems	7
Figure 3: How Green Infrastructure Allows Stormwater to Replenish Groundwater	9
Figure 4: Types of Green Infrastructure Illustrated on the Environmental Protection Agency’s Website	12
Figure 5: Types of Green Infrastructure Used or Installed by Selected Municipalities or That These Municipalities Encouraged or Required Private Property Owners to Use to Help Meet Permit or Combined Sewer Overflow Consent Decree Requirements	14
Figure 6: Percentages of the Areas Subject to Municipalities’ Permits or Consent Decrees That Drain into Green Infrastructure, as of April 2017, as Reported by Selected Municipalities	16
Figure 7: Number of Aspects That Selected Municipalities Reported Were Usually More Challenging for Green Infrastructure Than for Gray Infrastructure, as of April 2017	19
Figure 8: Number of Selected Municipalities Citing Aspects That Challenged Their Use of Green Infrastructure Compared to Gray Infrastructure	21

---

### Abbreviations

CSO	combined sewer overflow
EPA	Environmental Protection Agency
GPR	Green Project Reserve
NPDES	National Pollutant Discharge Elimination System

This is a work of the U.S. government and is not subject to copyright protection in the United States. The published product may be reproduced and distributed in its entirety without further permission from GAO. However, because this work may contain copyrighted images or other material, permission from the copyright holder may be necessary if you wish to reproduce this material separately.



September 28, 2017

The Honorable Sheldon Whitehouse  
United States Senate

Dear Senator Whitehouse:

Stormwater from urban areas is a major contributor to pollution in the nation's waterbodies and can contribute to disease outbreaks and beach and shellfish bed closings, as well as flooding. Stormwater—rain or snow that runs off paved surfaces or other impervious areas into water bodies—may contain pollutants such as bacteria, chemicals, and debris picked up as water runs over such surfaces. The Environmental Protection Agency (EPA) regulates stormwater pollution through the Clean Water Act's National Pollutant Discharge Elimination System (NPDES) program, under which some municipalities and others that operate sewer systems must obtain NPDES permits to discharge stormwater into nearby water bodies, such as creeks, lakes, and rivers.<sup>1</sup>

In 1987, Congress amended the Clean Water Act directing EPA to establish a program to regulate stormwater pollution. In 1990 and 1999, EPA issued regulations under the NPDES program requiring certain municipalities to have permits, depending on the size of the population served by the sewer system.<sup>2</sup> The permits prohibit non-stormwater discharges into storm sewers and require controls, including best management practices, to reduce pollutant discharges to the maximum extent practicable.

Municipalities have historically addressed stormwater using gray infrastructure, such as sewers consisting of concrete pipes and channels, designed to move stormwater quickly away from urban areas into nearby water bodies. In 2007, EPA began to promote the benefits of using green infrastructure to reduce stormwater pollution. Green infrastructure is designed to use natural processes to slow and capture stormwater and filter out pollutants, which can reduce the need for additional gray

---

<sup>1</sup>For the purposes of this report, we use the term municipalities to include cities, towns, and other public entities and to refer to utilities that operate sewer systems.

<sup>2</sup>Permits are issued by the 46 states that EPA has authorized to implement the program. EPA issues permits for U.S. territories, tribal lands, certain federal facilities, and the remaining four states: Idaho, Massachusetts, New Hampshire, and New Mexico.

---

infrastructure to manage stormwater. Green infrastructure includes practices such as disconnecting downspouts from sewers, which allows stormwater to flow over land or other permeable areas and seep into the soil, and physical structures such as bioswales, which drain runoff into vegetated areas that slow and filter stormwater, allowing it to seep into the soil.

A sewer system that collects stormwater can be separate from, or combined with, a sewer system that carries wastewater, such as raw sewage, from households, businesses, industrial plants, or other developments. Systems that move stormwater from yards, parking lots, streets, and other open areas and drain it directly into a water body are called municipal separate storm sewer systems. Other systems, called combined sewer systems, carry both stormwater and wastewater in the same pipes to a wastewater treatment plant. During storm events, combined sewer systems can overflow and release untreated wastewater into nearby water bodies. These types of releases are called combined sewer overflows (CSO). EPA has identified more than 850 municipalities with combined sewer systems, primarily in the Northeast and Midwest regions of the United States. EPA has taken enforcement actions against municipalities with CSO events and has negotiated more than 50 consent decrees with municipalities, requiring them to take corrective actions to reduce the amount of untreated wastewater flowing into water bodies.<sup>3</sup> Nationally, drinking water and wastewater utilities face an estimated \$655 billion in costs to rebuild and replace their infrastructure, including \$48 billion for corrective actions to treat CSOs.<sup>4</sup> In some cases, according to EPA and interest groups, using green infrastructure may cost less than using gray infrastructure to help meet permit requirements and provisions specified in consent decrees.

---

<sup>3</sup>Consent decrees are negotiated agreements between relevant parties; in this case, usually EPA and the state are coplaintiffs and the municipality is the defendant. Consent decrees are entered as court orders and thus enforceable by the court.

<sup>4</sup>EPA's most recent water estimate indicated that drinking water infrastructure funding needs totaled \$384 billion (as of 2011) and wastewater infrastructure needs totaled \$271 billion (as of 2012), including \$48 billion for corrective actions. EPA conducts a separate needs survey and cost assessment for drinking water and wastewater infrastructure on separate 4-year schedules. These cost estimates reflect the 20-year projected drinking water and wastewater infrastructure costs, starting with the year that each survey was conducted. See Environmental Protection Agency, *Drinking Water Infrastructure Needs Survey and Assessment: Fifth Report to Congress*, EPA 816-R-13-006 (Washington, D.C.: April 2013), and *Clean Watersheds Needs Survey 2012: Report to Congress*, EPA-832-R-15005 (Washington, D.C.: January 2016).

---

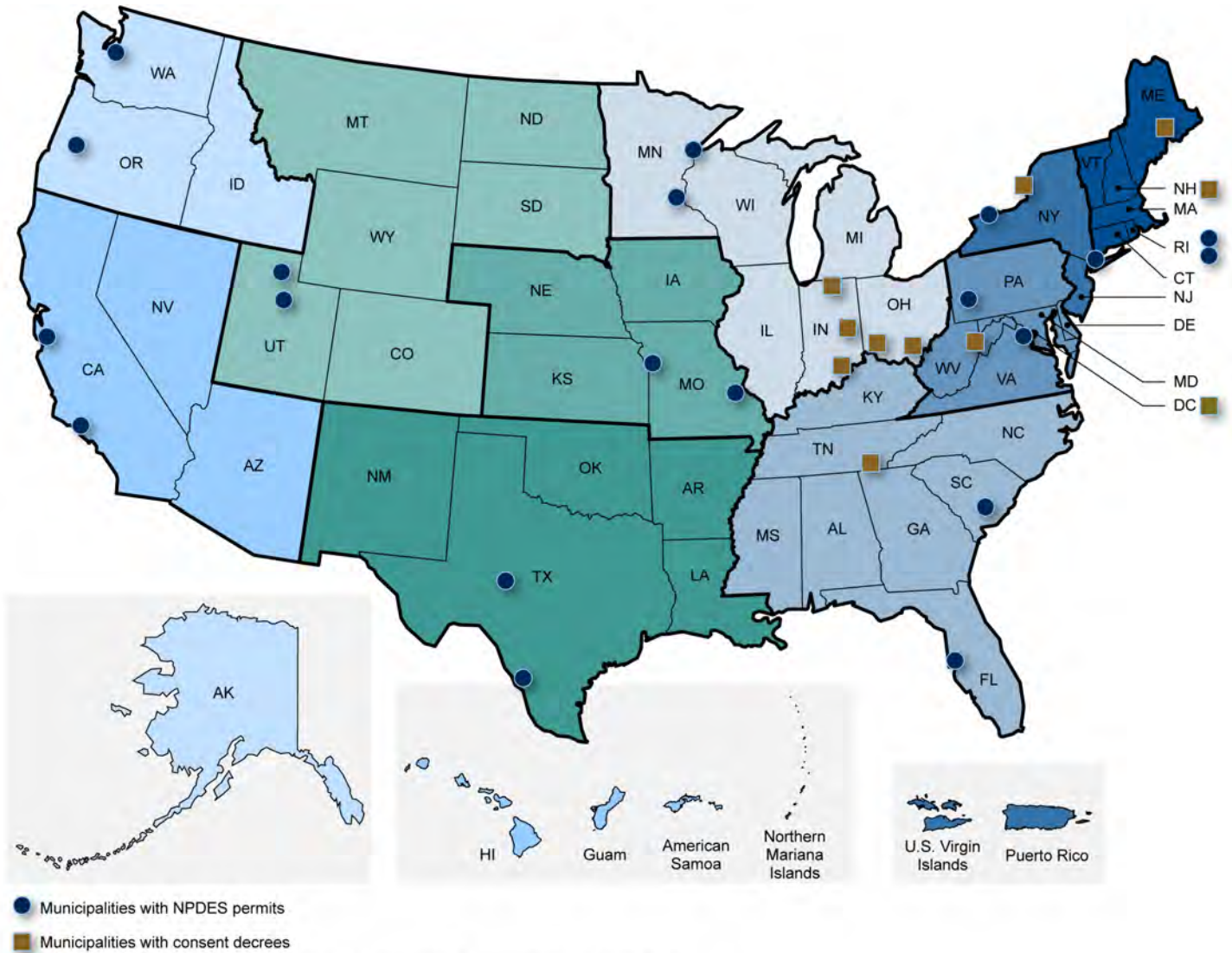
You asked us to examine the use of green infrastructure by municipalities to meet EPA's stormwater requirements.<sup>5</sup> This report (1) describes to what extent selected municipalities are incorporating green infrastructure into their efforts to comply with NPDES permits and consent decrees that address CSOs, and what is known about funding for such efforts; (2) describes what challenges, if any, these municipalities report facing to incorporate green infrastructure into their efforts to comply with those permits and consent decrees; and (3) examines efforts EPA is taking to help municipalities use green infrastructure.

To address all three objectives, we conducted a survey of representatives of 31 municipalities, including representatives of 20 municipalities with NPDES permits and representatives of 11 municipalities that have entered into consent decrees with EPA to address CSOs. Our sample of 31 municipalities cannot be generalized to all municipalities in the United States; however, we selected these municipalities at random from a range of geographic locations and a range of sizes. We randomly selected the 20 municipalities with permits from a list of more than 5,000 municipalities that EPA identified in its 1999 rule on the NPDES stormwater program. We restricted our selection of municipalities to those in the 50 states and Washington, D.C. We stratified our sample of municipalities with permits by size and location. We randomly selected the 11 municipalities that have entered into consent decrees with EPA from a list of 36 municipalities with consent decrees that EPA provided to us. These were consent decrees that EPA entered into with municipalities in the 50 states or Washington, D.C., after August 2007 when EPA began encouraging the use of green infrastructure to address the requirements of permits and enforcement activities, such as consent decrees. An analysis of these 36 consent decrees showed that about half included some reference to green infrastructure and about half involved municipalities in the Midwest. We stratified our sample of 11 municipalities with consent decrees to represent these two characteristics. Figure 1 shows the location of the municipalities with permits and consent decrees included in our survey.

---

<sup>5</sup>This review was conducted in response to a December 2015 request from Senator Whitehouse, then Ranking Member, Subcommittee on Fish, Water, and Wildlife, Committee on Environment and Public Works.

**Figure 1: The Location of the 31 Randomly Selected Municipalities Included in Our Survey, by EPA Region**



Sources: GAO analysis of Environmental Protection Agency (EPA) data.; Map Resources (map). | GAO-17-750

The questions we asked municipalities in our survey focused on (1) the extent to which the municipalities were using green infrastructure to comply, at least in part, with requirements of their permits or consent decrees; (2) the amount and source of capital expenditures for green infrastructure to comply, at least in part, with requirements of their permits or consent decrees; and (3) the challenges the municipalities may have



---

experienced in using or considering green infrastructure to comply, at least in part, with requirements of their permits or consent decrees.

The time frames for which we asked for information from the survey respondents varied by the questions we asked and whether a municipality was included in our survey because it has an NPDES permit or a consent decree to address CSOs. For questions to municipalities with permits about the extent to which the municipalities were using green infrastructure and questions about the challenges the municipalities may have experienced in using or considering green infrastructure, we asked for information for the approximately 5-year period prior to our survey. For questions to municipalities with consent decrees, we did not specify a time frame for these questions. For information on the amount and source of capital expenditure for municipalities with permits and municipalities with consent decrees, we asked survey respondents for the information from the respondents' last 3 completed fiscal years. We limited these questions to 3 fiscal years to reduce the work burden on the respondents.

For the purposes of our survey, we define gray infrastructure as all stormwater infrastructure that is not considered green infrastructure.<sup>6</sup> We conducted our survey over the phone from November 2016 through April 2017. To examine efforts EPA is taking to help municipalities use green infrastructure to manage stormwater, we interviewed EPA officials in the Office of Wastewater Management and examined documents and other resources available on EPA's website regarding green infrastructure.

For all three objectives, we reviewed pertinent documents and studies about green infrastructure and stormwater management from EPA, other federal agencies, public interest groups, and others. We also interviewed EPA officials in the agency's Office of Wastewater Management and Office of Enforcement and Compliance Assurance, as well as representatives from several public interest groups, about municipalities'

---

<sup>6</sup>We explained to the municipalities that participated in our survey that for the purposes of our survey, we are making a distinction between green and gray infrastructure. Specifically, we said that in general green infrastructure is a set of decentralized practices that minimize stormwater runoff volume and the pollutant load carried by stormwater. Gray infrastructure is the traditional infrastructure used to address stormwater—often made of concrete. It includes everything that is not green infrastructure. We also listed 11 examples of green infrastructure. The 11 examples are bioswales, downspout disconnection, green parking, green roofs, green streets and alleys, land conservation, permeable pavement, planter boxes, rain gardens (bioretention), rainwater harvesting, and urban tree canopy.

---

use of green infrastructure. Further information about the scope and methodology of our review is presented in appendix I, and the questionnaires administered to the municipalities with NPDES permits and the municipalities with CSO consent decrees are presented in appendix II.

We conducted this performance audit from February 2016 to September 2017 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

---

## Background

This section provides information on the Clean Water Act and stormwater management including green infrastructure.

---

## Clean Water Act and Stormwater Management

The objective of the Clean Water Act is to “restore and maintain the chemical, physical, and biological integrity of the nation’s waters.”<sup>7</sup> The act generally prohibits the discharge of pollutants from “point sources”—such as discharge pipes from industrial facilities and wastewater treatment plants—without an NPDES permit.<sup>8</sup> The act specifies that NPDES permits may not be issued for a term longer than 5 years.

In 1987, Congress amended the Clean Water Act to require that EPA implement a comprehensive national program for addressing stormwater discharges; EPA implemented the program in two phases. In the first phase, EPA regulated stormwater discharges from large and medium municipal separate storm sewer system. In the second phase, EPA extended these requirements to smaller systems. Municipalities include cities, towns, villages, or other public entities that provide residents with services, such as drinking water and sewage treatment. Municipalities

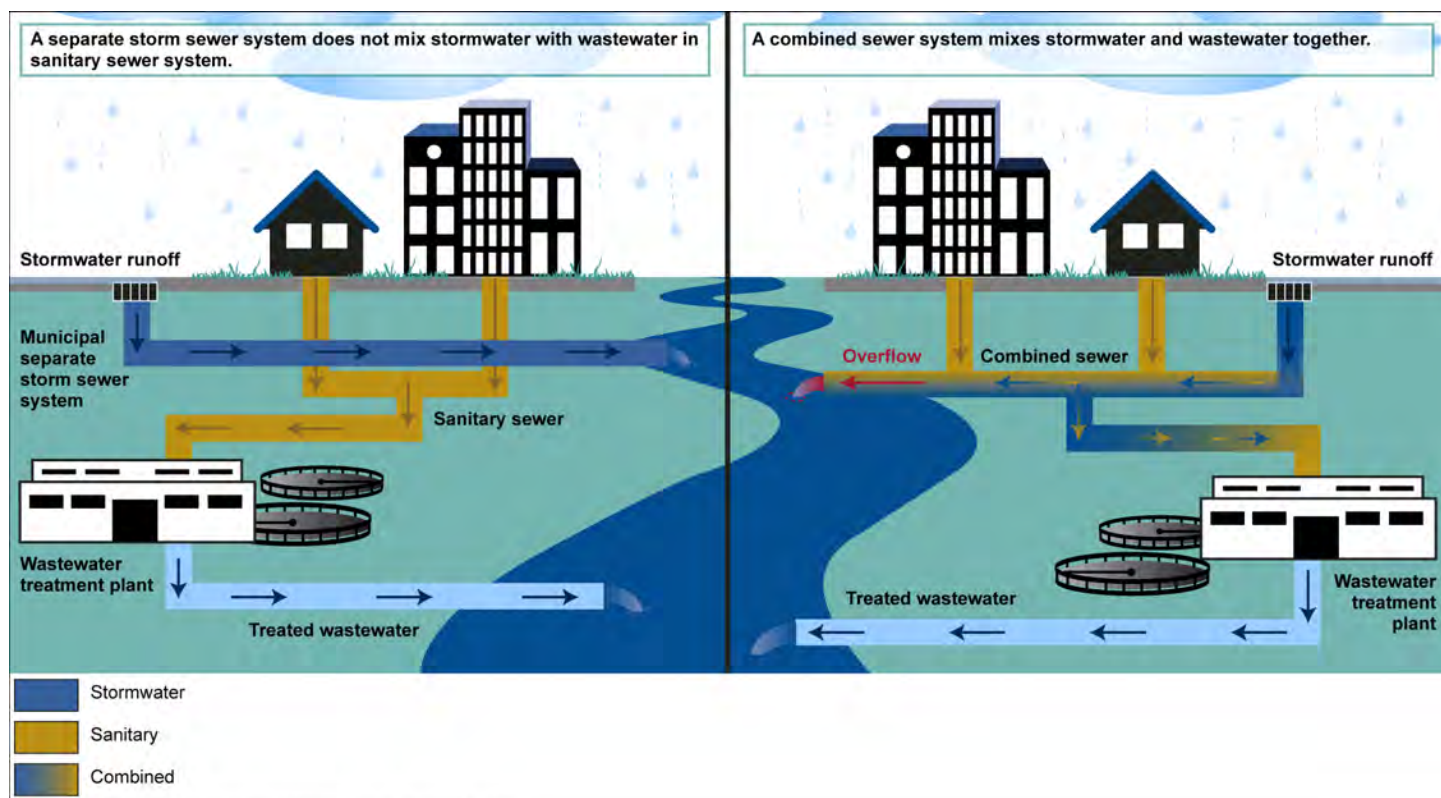
---

<sup>7</sup>The Federal Water Pollution Control Act Amendments of 1972, Pub. L. No. 92-500, § 2, 86 Stat. 816, codified as amended at 33 U.S.C. §§ 1251-1387 (2016) (commonly referred to as the Clean Water Act). For the purposes of this report, we refer to the statute and its amendments as the Clean Water Act.

<sup>8</sup>In this report, we refer to all permits for discharging pollutants from point sources as NPDES permits, including permits issued by states under their own EPA-approved clean water programs.

can have one or both types of stormwater systems, a municipal separate storm sewer system or a combined sewer system. Figure 2 illustrates the components of the two types of systems and how a CSO occurs.

**Figure 2: Types of Municipal Sewer Systems**



Source: D.C. Department of Energy and Environment. | GAO-17-750

In 1990, EPA issued a regulation implementing the first phase of the stormwater program, requiring municipalities serving populations of 100,000 or more to obtain permits for stormwater discharges.<sup>9</sup> In 1999, EPA implemented the second phase by expanding NPDES permit requirements to smaller municipalities.<sup>10</sup> Generally, permits effectively prohibit non-stormwater discharges into storm sewers, and require

<sup>9</sup>55 Fed. Reg. 47,990 (Nov. 16, 1990). The regulation also required industrial facilities and construction sites greater than 5 acres to obtain permits for stormwater discharges.

<sup>10</sup>64 Fed. Reg. 68,722 (Dec. 8, 1999). The regulation also required construction sites from 1 to 5 acres to obtain permits for stormwater discharges.

---

controls to reduce pollutant discharges to the maximum extent practicable, including the use of best management practices. These practices generally include identifying and eliminating illicit discharges; preventing construction site runoff and post-construction site runoff; and preventing pollution from certain commercial, industrial, and residential areas.<sup>11</sup> Such practices could also include distributing materials with utility bills to help educate the public on activities like cleaning up pet waste and household chemicals, implementing street sweeping to eliminate trash and debris, and training and certifying construction contractors.

To manage CSO pollution, in 1994, EPA issued its Combined Sewer Overflow Control Policy, which provides guidance on how to meet the Clean Water Act's pollution control goals through NPDES permits issued to municipalities with combined sewer systems.<sup>12</sup> Specifically, the policy provides guidance on coordinating the planning, selection, and implementation of CSO controls that meet the requirements of the Clean Water Act. In 2000, Congress amended the Clean Water Act to require that NPDES permits for discharges from combined sewer systems comply with EPA's Combined Sewer Overflow Control Policy.<sup>13</sup> Actions that can be taken to reduce the number and volume of discharges from a combined sewer system can include separating storm sewer and sanitary sewer systems and building larger tunnels to hold stormwater runoff until it can be treated and discharged by a wastewater treatment plant.

When Clean Water Act requirements are violated—for example, when a municipality has an unauthorized CSO event—EPA and states may, among other things, bring suit in court. These suits can result in consent decrees under which a municipality agrees, for example, to take corrective actions to reduce the number and volume of CSO events. In 1998, EPA's Office of Enforcement and Compliance Assurance began a National Enforcement Initiative to focus enforcement action on keeping raw sewage and contaminated stormwater out of the nation's waters. According to an EPA official, the agency has addressed noncompliance

---

<sup>11</sup> Illicit discharges can enter a stormwater sewer through piping that is mistakenly or purposefully connected to the sewer or infiltration from cracked pipes in the system, spills, or dumping.

<sup>12</sup> 59 Fed. Reg. 18,688 (Apr. 19, 1994).

<sup>13</sup> 33 U.S.C. §1342(q) (2006) (adopting as law the Combined Sewer Overflow Control Policy signed by the Administrator on April 11, 1994; see 59 Fed. Reg. 18688 (Apr. 19, 1994)).

---

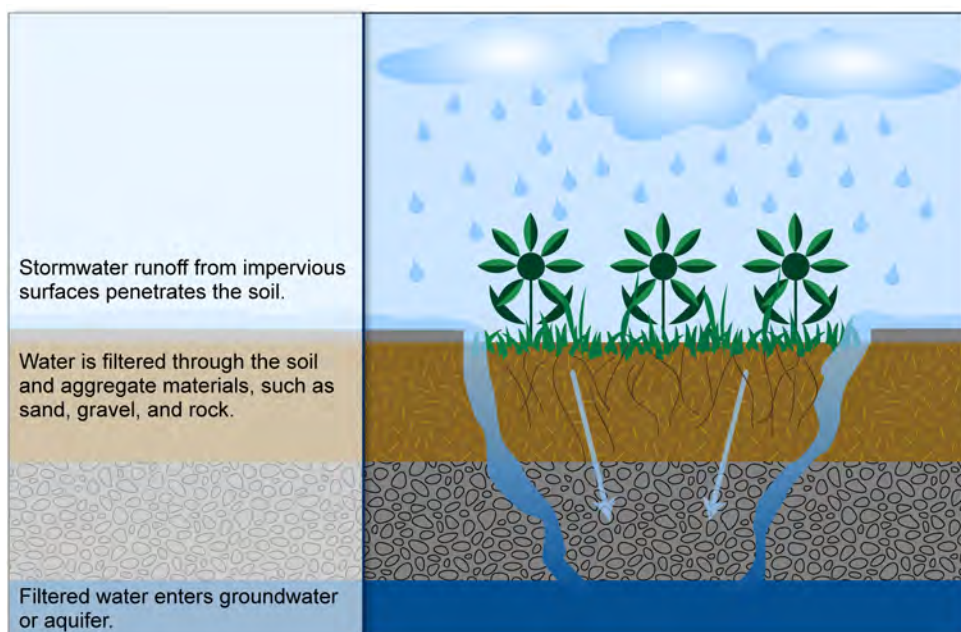
with stormwater and wastewater requirements of the Clean Water Act by entering into consent decrees with over 50 municipalities from 1998 through 2016.

---

## Green Infrastructure

Municipalities use green and gray infrastructure to manage stormwater and meet the requirements of permits and consent decrees. Gray infrastructure refers to sewer structures that are typically made of materials, such as concrete or metal, designed to collect and channel stormwater runoff from impervious surfaces, such as city streets and parking lots, to a wastewater treatment plant or nearby creeks, lakes, and rivers. Green infrastructure includes practices and structures to manage stormwater that use or mimic natural processes to slow stormwater runoff, filter pollutants from the runoff, and facilitate stormwater storage for future use or replenishing groundwater and aquifers. Figure 3 illustrates how green infrastructure allows stormwater to penetrate (seep into) the soil and replenish groundwater and aquifers.

**Figure 3: How Green Infrastructure Allows Stormwater to Replenish Groundwater**



Source: GAO. | GAO-17-750

Municipalities can meet permit and CSO consent decree requirements using either green or gray infrastructure, or a combination of both. For

---

example, both types of infrastructure can limit the amount of pollutants that stormwater washes into nearby water bodies. Green infrastructure can filter out the pollutants, and gray infrastructure can convey the combined stormwater and wastewater to a wastewater treatment plant. Similarly, both types of infrastructure can prevent CSO events. Green infrastructure can reduce the volume of stormwater entering a combined sewer, and if gray infrastructure has sufficient capacity, the combined sewer will not be overwhelmed during storm events.

Since 2007, EPA has encouraged municipalities to use green infrastructure to help meet the requirements of permits and CSO consent decrees. In April 2007, the EPA Administrator entered into an agreement with state, environmental, and wastewater utility groups to promote the use of green infrastructure in reducing stormwater pollution and mitigating CSOs.<sup>14</sup> In August 2007, EPA issued a memorandum stating that EPA regional offices and states may encourage the use of green infrastructure, where appropriate, in meeting permit requirements and CSO consent decrees. According to EPA officials we interviewed, the agency worked with a number of partners, including other federal agencies and nonprofit groups involved in water management, conservation, and housing and development, to promote the use of green infrastructure. EPA developed a strategic plan to help communities use green infrastructure in 2008 and updated it in 2011 and again in 2013. EPA's latest plan, the 2013 *Green Infrastructure Strategic Agenda*, includes five goals:

- Green infrastructure practices are embedded in federal agency programs.
- Green infrastructure language in permitting and enforcement actions is common practice.
- Data on the design, performance, costs, and benefits of green infrastructure is known and readily available.
- Decrease the financial burden to communities of installing and maintaining green infrastructure.
- Communities across the country are networking and exchanging information on the best green infrastructure approaches.

---

<sup>14</sup>Green Infrastructure Statement of Intent (Apr. 19, 2007), signed by Environmental Protection Agency, National Association of Clean Water Agencies, Natural Resources Defense Council, Low Impact Development Center, and Association of State and Interstate Water Pollution Control Administrators.

---

EPA's website illustrates different types of green infrastructure, with 11 examples.<sup>15</sup> Figure 4 shows the 11 examples of green infrastructure listed on EPA's website.

---

<sup>15</sup>Environmental Protection Agency, *Green Infrastructure*, accessed July 12, 2017, <https://www.epa.gov/green-infrastructure>.

**Figure 4: Types of Green Infrastructure Illustrated on the Environmental Protection Agency's Website**



**Bioswale**



**Downspout disconnection**



**Green parking**



**Green roof**



**Green street**



**Land conservation**



**Permeable pavement**



**Planter box**



**Rain garden**



**Rainwater harvesting**



**Urban tree canopy**

Source: Environmental Protection Agency. | GAO-17-750



---

## Surveyed Municipalities Use of Green Infrastructure to Manage Stormwater Is Limited and Funded through General Revenues and Fees Charged to Utility Customers

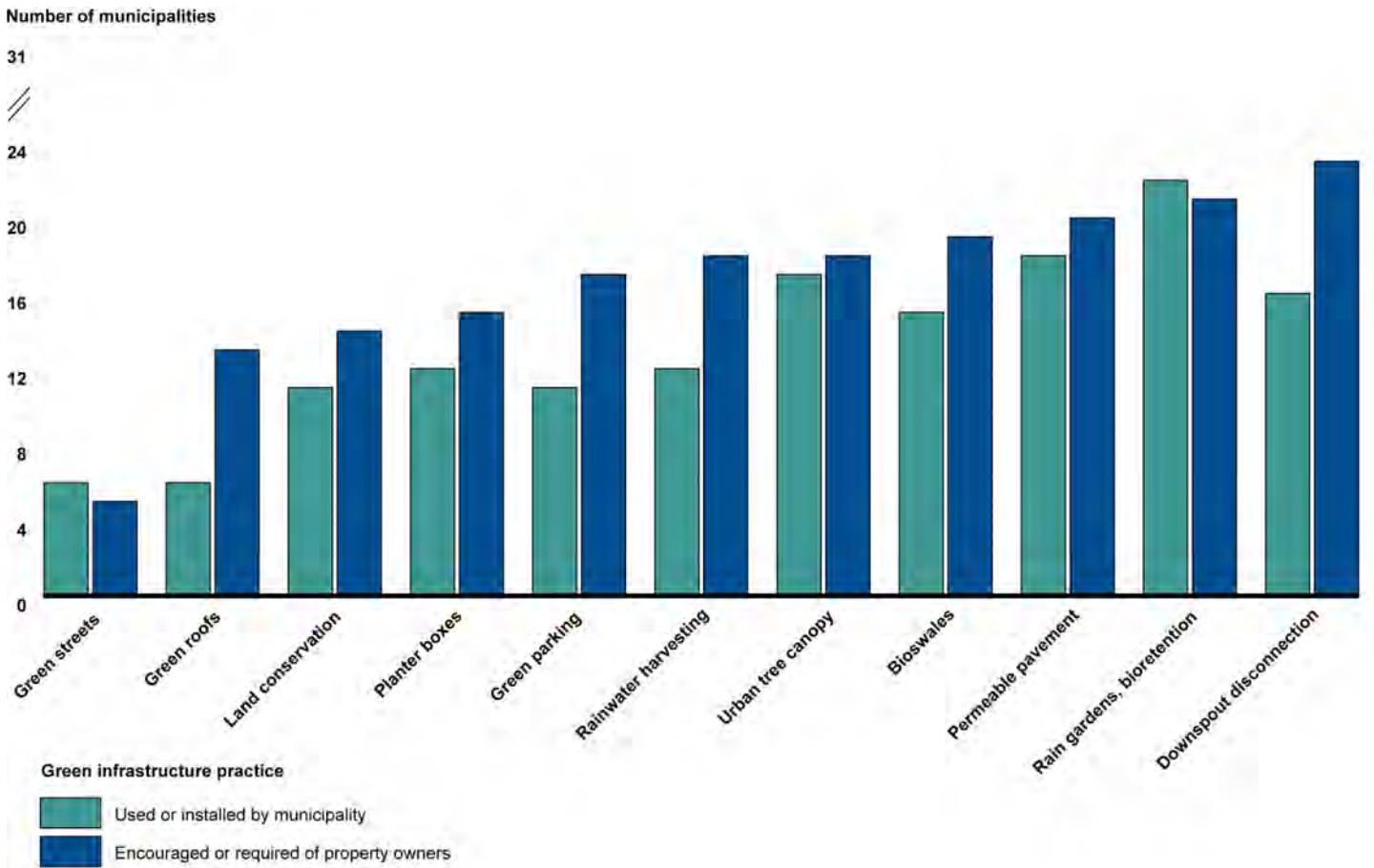
Most of the 31 municipalities we surveyed use green infrastructure to comply with NPDES permits or CSO consent decrees, but almost half said that less than 5 percent of the area covered by their permits or consent decrees drains into green infrastructure. About three-quarters of the municipalities said that they fund green infrastructure through general revenues and stormwater fees charged to utility customers or residents of the municipality.

---

## Most Surveyed Municipalities Are Using Green Infrastructure in Their Efforts to Comply with Permits and CSO Consent Decrees, but About Half Reported Using It to a Limited Extent

Of the 31 municipalities we surveyed, 30 reported using at least 1 of the 11 examples of green infrastructure presented on EPA's website to help meet the provisions of their permits since 2012 or the provisions of their CSO consent decrees. For each of the 11 green infrastructure types, municipalities reported whether to comply, at least in part, with their permit or consent decrees they (1) used or installed the type of green infrastructure themselves or (2) encouraged or required property owners to use or install the type of green infrastructure. Twenty-eight municipalities reported that they used or installed a type of green infrastructure and encouraged or required property owners to use or install a type of green infrastructure. Two municipalities reported that they had not used or installed any green infrastructure themselves but had encouraged or required property owners to use or install a type of green infrastructure. Of the 11 types, the 3 most used or installed by municipalities—or that municipalities encouraged or required their customers to use—were downspout disconnection, rain gardens (also known as bioretention), and permeable pavement. Figure 5 illustrates how many of the 30 municipalities reported using or installing 1 or more of the 11 types of green infrastructure themselves and how many municipalities reported that they encouraged or required private property owners to use or install a type of green infrastructure.

**Figure 5: Types of Green Infrastructure Used or Installed by Selected Municipalities or That These Municipalities Encouraged or Required Private Property Owners to Use to Help Meet Permit or Combined Sewer Overflow Consent Decree Requirements**



Source: GAO. | GAO-17-750

Note: The time frame covered by this figure is November 2011 through April 2017 for the municipalities with National Pollutant Discharge Elimination System permits. We did not specify a time frame for the municipalities with combined sewer overflow (CSO) consent decrees. Responses are from 30 of 31 municipalities in our survey sample. We did not include the 1 municipality with a CSO consent decree that reported not using any green infrastructure.

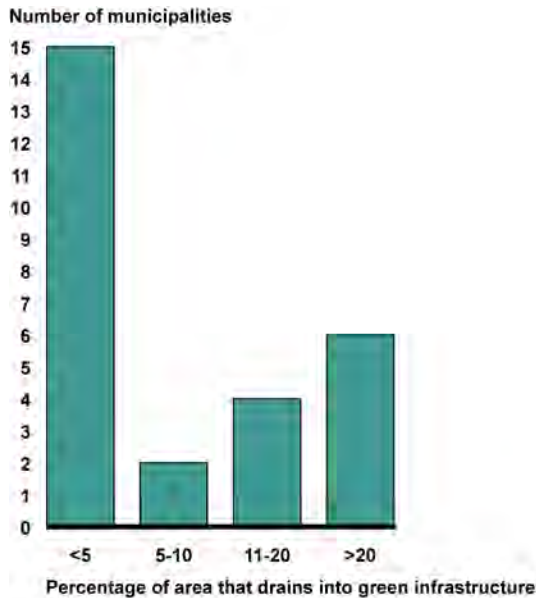
In addition to the green infrastructure types identified in figure 5, the municipalities we surveyed also identified other green infrastructure that they used to help meet permit or consent decree requirements. For example, one municipality said that it used habitat restoration and similar efforts to address stormwater runoff. Another municipality reported using an infrastructure system that collected water underneath a parking lot where it could penetrate the soil below the paved surface.

---

The one municipality that reported not using green infrastructure to help comply with the provisions of its consent decree said that there was insufficient public land on which to install green infrastructure and that the type of soil in the area subject to the decree, blue marine clay, is not permeable enough to allow green infrastructure to filter water through the soil. However, the same municipality said that the community that it served was generally receptive to using green infrastructure to manage stormwater and that it uses green infrastructure in other areas of the community not included in the terms of the consent decree.

Of the 30 municipalities that reported using green infrastructure to help meet the provisions of their permits or CSO consent decrees, many of them also reported on the percentages of the areas subject to permits or consent decrees that drain into green infrastructure, with the remaining areas draining into gray infrastructure or directly into creeks, lakes, or rivers. Twenty-seven municipalities provided us with information about how much of the areas subject to permits or consent decrees drains into green infrastructure and how much drains into gray infrastructure or elsewhere. Of these 27 municipalities, 15 reported that less than 5 percent of the relevant areas drained into green infrastructure, while 6 municipalities reported that more than 20 percent of the area subject to permits or consent decrees drained into green infrastructure. The remaining 6 municipalities reported that from 5 percent to 20 percent of the relevant areas drains into green infrastructure. Figure 6 provides additional information on the percentages of areas subject to municipalities' permits or consent decrees that drain into green infrastructure.

**Figure 6: Percentages of the Areas Subject to Municipalities' Permits or Consent Decrees That Drain into Green Infrastructure, as of April 2017, as Reported by Selected Municipalities**



Source: GAO. | GAO-17-750

Note: Responses are from 27 of 31 municipalities in our survey sample. Six municipalities reported that more than 20 percent of the areas subject to their permits or consent decrees drained into green infrastructure—the percentages these municipalities reported are 24 percent, 25 percent, 40 percent, 50 percent, 80 percent, and 94 percent.

**Most Surveyed Municipalities Are Funding Green Infrastructure through General Revenues or Stormwater Fees Charged to Utility Customers**

Of the 30 municipalities that reported using green infrastructure to help comply with the provisions of their permits or CSO consent decrees, 24 municipalities reported using general revenues or specific fees for stormwater management levied on utility customers or municipal residents to fund capital expenditures for green infrastructure over their last 3 fiscal years. Of the remaining 6 municipalities, 2 reported using sales tax revenues or federal grant funding as the sole source of funding, 2 said that they had no capital expenditures for green infrastructure in the last 3 fiscal years, and 2 did not respond to the question.

Of the 24 municipalities that reported using general revenues or stormwater fees to fund capital expenditures for green infrastructure to help comply with the provisions of permits or CSO consent decrees, 14 reported that they also used funding from one or more additional sources. Six reported that they also used federal grant funding to help pay for capital expenditures on green infrastructure, 5 said that they also used

---

funding from their state's Clean Water State Revolving Fund, and 5 said that other nonfederal grants were a source of funding for their green infrastructure. Some municipalities also identified additional sources of revenue to fund capital expenditures for green infrastructure, including fees on new development.

Of the 30 municipalities that reported using green infrastructure to meet the provisions of their permits or CSO consent decrees, 17 provided information comparing their capital expenditures for green infrastructure to capital expenditures for gray infrastructure.<sup>16</sup> The remaining municipalities either did not have information that distinguished between capital expenditures on green infrastructure and gray infrastructure or they did not provide us with that information. The amount that the 17 municipalities reported spending on capital expenditure for green infrastructure varied from a 3-year average of about \$5,000 to about \$5.9 million. The amount that the municipalities reported spending on capital expenditure for gray infrastructure varied from a 3-year average of about \$18,000 to about \$208.2 million. Of the 17 municipalities that provided data comparing their capital expenditures for green infrastructure to capital expenditures for gray infrastructure, 11 (65 percent) reported spending approximately 20 percent or less of capital expenditures on green infrastructure, including 7 municipalities that reported spending less than approximately 5 percent on green infrastructure. Conversely, 6 of the 17 municipalities reported spending more than approximately 20 percent of capital expenditures on green infrastructure, including 3 municipalities that reported spending more than 60 percent on green infrastructure. Overall, the 17 municipalities reported spending an average of about 24 percent of their capital expenditures for meeting the provisions of their permits or CSO consent decrees on green infrastructure, with the remaining amount spent on gray infrastructure.

---

<sup>16</sup>Sixteen of these municipalities provided data for their last 3 full fiscal years, and 1 municipality provided data for its last full fiscal year.

---

---

## Surveyed Municipalities Reported That Using Green Infrastructure Was More Challenging Than Using Gray Infrastructure but Also Reported Continuing to Use It

Most of the 31 municipalities (26) we surveyed reported that one or more aspects of infrastructure development involved with projects to help meet the provisions of their NPDES permits or CSO consent decrees were usually more challenging when using green infrastructure than when using gray infrastructure. However, the municipalities also reported continuing to use green infrastructure.

In our survey, we asked the 30 municipalities that reported using green infrastructure to help meet the provisions of their permits or CSO consent decrees about eight aspects of infrastructure development that may have challenged municipalities when using green infrastructure. For each aspect, we asked municipalities if the aspect was usually more challenging for green infrastructure, usually less challenging, or about the same when compared to gray infrastructure.<sup>17</sup>

The eight aspects are

1. obtaining land to install green infrastructure,
2. developing capital expenditure estimates for green infrastructure,
3. developing operation and maintenance estimates for green infrastructure,
4. designing and engineering green infrastructure,
5. installing green infrastructure,
6. overall cost of using green infrastructure,
7. confidence in the effectiveness of green infrastructure, and
8. political and public opinions regarding green infrastructure.

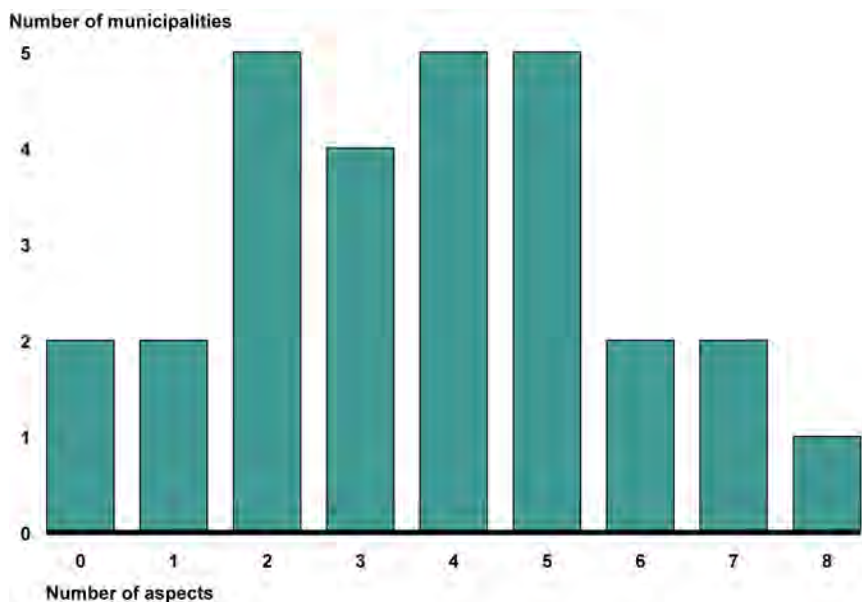
As shown in figure 7, 15 of 30 municipalities reported that four or more of the eight aspects were usually more challenging for green infrastructure

---

<sup>17</sup>We worded the questions differently depending on the aspect. For five of the aspects, we asked municipalities if the aspect was usually more difficult for green infrastructure. For example, we asked municipalities if obtaining land for green infrastructure was usually more difficult than obtaining land for gray infrastructure, usually less difficult, or about the same. For three of the aspects, we worded the question differently. We asked municipalities if (1) the overall cost of green infrastructure was usually higher than the cost of gray infrastructure, usually lower, or usually about the same; (2) confidence in the effectiveness of green infrastructure was usually higher than confidence in the effectiveness of gray infrastructure, usually lower, or about the same; and (3) political and public opinion regarding green infrastructure was usually more positive than political and public opinion regarding gray infrastructure, usually less positive, or about the same.

than for gray infrastructure. One municipality said that all eight of the aspects were usually more challenging for green infrastructure than for gray infrastructure. Two municipalities reported that no aspects were usually more challenging for green infrastructure than for gray infrastructure.

**Figure 7: Number of Aspects That Selected Municipalities Reported Were Usually More Challenging for Green Infrastructure Than for Gray Infrastructure, as of April 2017**



Source: GAO. | GAO-17-750

Note: Twenty-eight of the 31 municipalities that we surveyed responded to the survey questions about whether the aspects were usually more challenging for green infrastructure than for gray infrastructure. Two municipalities with National Pollutant Discharge Elimination System permits did not respond to the questions because they did not have any capital expenditures on green infrastructure in the 5 years prior to our survey, although they reported encouraging or requiring private property owners to use or install green infrastructure during that time frame. We did not ask these questions of the one municipality with a combined sewer overflow consent decree that reported not using any green infrastructure.

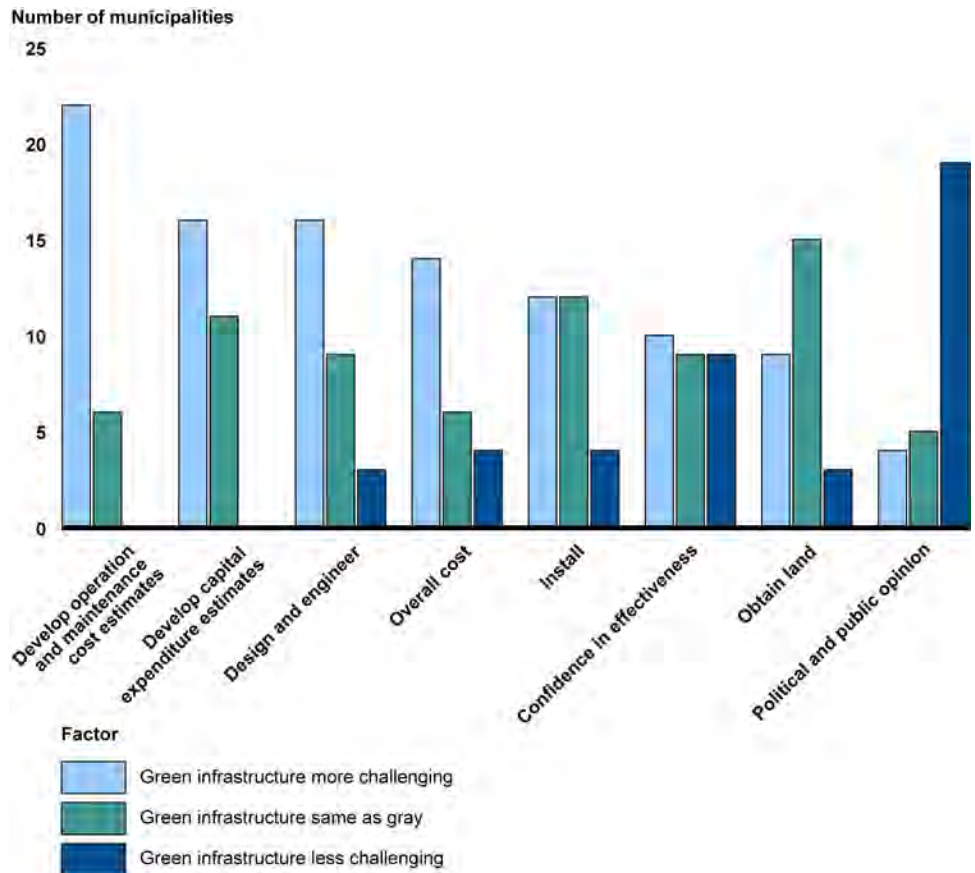
Municipalities most often cited the following aspects of infrastructure development as being more challenging for green infrastructure than for gray infrastructure: developing a capital expenditure estimate, developing an operation and maintenance cost estimate, and designing and engineering a project. Of the 30 municipalities that reported using green infrastructure, 22 reported that developing an operation and maintenance cost estimate was usually more challenging than doing so for gray infrastructure, while none said that it was usually less challenging.

---

Similarly, 16 municipalities reported that developing a capital expenditure estimate for green infrastructure was usually more challenging than doing so for gray infrastructure, while none said that it was less challenging. Finally, 16 municipalities reported that designing and engineering a project was usually more challenging for green infrastructure than for gray infrastructure, while 3 said that it was usually less challenging. Figure 8 shows the number of municipalities that reported for each of the eight aspects whether they were usually more challenging, usually about the same, or usually less challenging when using green infrastructure compared to using gray infrastructure. Figure 8 also shows that political and public opinion regarding green infrastructure was the one aspect that municipalities cited as usually less challenging for green infrastructure than for gray infrastructure.



**Figure 8: Number of Selected Municipalities Citing Aspects That Challenged Their Use of Green Infrastructure Compared to Gray Infrastructure**



Source: GAO. | GAO-17-750

Note: The time frame covered by this figure is November 2011 through April 2017 for the municipalities with National Pollutant Discharge Elimination System (NPDES) permits. We did not specify a time frame for the municipalities with combined sewer overflow (CSO) consent decrees. Twenty-eight of the 31 municipalities we surveyed responded to the survey questions about whether the aspects were usually more challenging for green infrastructure than for gray infrastructure. Two municipalities with NPDES permits did not respond to the questions because they did not have any capital expenditures on green infrastructure in the 5 years prior to our survey, although they reported encouraging or requiring private property owners to use or install green infrastructure during that time frame. We did not ask these questions of the 1 municipality with a CSO consent decree that reported not using any green infrastructure.

In explaining why these aspects of infrastructure were more challenging for green infrastructure, municipalities most commonly reported that they were not familiar with green infrastructure. For example, when describing their unfamiliarity with green infrastructure, representatives of one municipality said that with gray infrastructure, the maintenance activities

---

and costs associated with traditional sewers are known from experience. For green infrastructure, however, they said that they needed to increase cost estimates for maintenance activities to account for unforeseen events. Representatives of another municipality, referring to gray infrastructure, said they know what it costs to put a pipe in the ground but do not have the skill set or experience to estimate the capital costs of green infrastructure. Discussing the costs associated with maintaining green infrastructure, representatives of another municipality said they hired staff with horticultural expertise to maintain rain gardens because they were unsure about the requirements necessary to maintain them. Another municipality said that it had difficulties finding qualified personnel to assist its engineers with green infrastructure.

Of the 26 municipalities that reported that green infrastructure was usually more challenging than gray infrastructure for at least one aspect, 25 reported that there were instances where they used green infrastructure anyway. In describing instances where they used green infrastructure even though it was more challenging, some municipalities reported that they continued to use green infrastructure to help comply with their permits or CSO consent decrees for three primary reasons: they saw using green infrastructure as a learning opportunity, they believed that green infrastructure would perform better or provide additional benefits compared to gray infrastructure, or the community wanted to use green infrastructure. Municipalities expressed a desire to learn from their experiences with green infrastructure. For example, a municipality said that it had to rebuild some green infrastructure—add new soil and replant vegetation—because it let maintenance slide because of budget issues. Representatives of this municipality said that understanding how to plan appropriately for operation and maintenance is part of the learning process associated with using green infrastructure. Another municipality was more specific, with representatives saying that the city had installed permeable pavement on a section of street as an opportunity to learn about permeable materials, especially the maintenance needed to ensure that permeable pavement continues to function properly.

Some municipalities reported that using green infrastructure was a better option than using gray infrastructure to address their stormwater management needs. For example, representatives of one municipality said that although they had less experience with green infrastructure, they used it anyway because it was a better option than using pipes and concrete to reduce the flow of stormwater and the amount of contaminants in stormwater. Representatives of another municipality said that they used green infrastructure because it met other project

---

objectives: it was more aesthetically pleasing, it “fit” into the neighborhood better, and it replenished groundwater. These municipality representatives noted that most of the town’s water comes from groundwater wells.

Some municipalities also reported that they were committed to using green infrastructure even though it was more challenging than using gray infrastructure on one or more aspects. For example, representatives of one municipality said that their city made a pledge to use green infrastructure. They said the city made the investment and set goals for green infrastructure, and although it is more difficult to generate cost estimates, the municipality continues to pursue green infrastructure. Another municipality said that there was not much data on the long-term costs of caring for the plants used in bioswales under the drought conditions that the municipality was currently experiencing. Nevertheless, the officials said the municipality installed the bioswales because doing so was supported by the public and an environmentally conscious city council interested in aesthetics and habitat restoration.

Conversely, of the 26 municipalities that reported that at least one aspect was usually more challenging when using green infrastructure than when using gray infrastructure, 19 reported instances where they were discouraged from using green infrastructure because it was more challenging than using gray infrastructure. We asked municipalities to describe these instances.

Some municipalities reported that they were discouraged from using green infrastructure because they were not familiar with it, because conditions specific to the area under consideration were not conducive to using green infrastructure, and because green infrastructure was more expensive than gray infrastructure. For example, describing their unfamiliarity with green infrastructure, representatives of one municipality said that because they were trying to meet the provisions of their consent decree, they needed an option that they had high confidence would meet the provisions. They believed that green infrastructure was not a proven technology. Representatives from another municipality said that while there had been a high turnover in city engineers and that the newer staff was amenable to using green infrastructure, the longer tenured engineers who were reluctant to use green infrastructure had an outsized influence on whether the engineering department would do so.

Several of the municipalities reported that they were discouraged from choosing green infrastructure because conditions in the area under

---

consideration were not conducive to using green infrastructure, including that there was not enough land in the right place to use green infrastructure or that the area was too arid. For example, representatives from one municipality said that they were considering bioretention measures to reduce CSOs, but there was not enough available land to make this option viable. They said that because of the topography of the town, any bioretention measures would need to be placed near the center of town, but because it was the center of town, there was no room for bioretention measures. Representatives from another municipality said that widening a road to meet fire protection requirements consumed the green space available for green infrastructure and that buying a right of way was cost prohibitive. Representatives from a third municipality said that installing green infrastructure in a city's historic district would change the character of the area and could consume limited parking spaces—thus engendering negative public opinion. Municipalities also said that arid conditions discouraged them from installing green infrastructure in some instances. For example, representatives from one municipality said that because their municipality is in a semiarid climate that makes it difficult to establish grasses, they try to predict whether the upcoming season will be wet or dry and install green infrastructure accordingly. They said that if they do not predict correctly, the plants will die and the funds spent on green infrastructure will have been wasted.

Several municipalities also reported that they were discouraged from using green infrastructure because it was more expensive than using gray infrastructure. For example, representatives from one municipality said that green infrastructure was more costly than gray infrastructure because of the cost of the land that would need to be purchased to install it. Representatives from another municipality said that green infrastructure would need to be installed in a flat area near the river and that in some instances the city did not own the surface area necessary to install green infrastructure but did own an easement to install gray infrastructure underground. The representatives said that the city was unable or unwilling to purchase such surface rights. Representatives from a third municipality said they did not have the in-house expertise to design green infrastructure and were discouraged from using green infrastructure because of the cost to hire outside consultants with that expertise.

---

## EPA Helped to Facilitate Municipalities' Use of Green Infrastructure, but in Launching a New Pilot Project Has Not Yet Developed Collaboration Agreements with Municipalities

Over the last 10 years since EPA began encouraging the use of green infrastructure to manage stormwater, the agency's efforts have provided information, technical assistance, and funding to help municipalities use green infrastructure. In addition, in 2016, EPA began a pilot project to assist five municipalities in developing long-term stormwater plans that would allow more time to incorporate green infrastructure practices but has not yet developed written agreements documenting how they will work together to collaborate.

---

## EPA Has Provided Information, Technical Assistance, and Funding and Launched a Pilot Project to Assist Municipalities in Developing Stormwater Plans That Include Green Infrastructure

Since 2007, when EPA began encouraging the use of green infrastructure to manage stormwater, EPA has provided information, technical assistance, and funding for green infrastructure to help municipalities incorporate green infrastructure into their stormwater systems. The goals of the green infrastructure program, as described in EPA's 2013 *Green Infrastructure Strategic Agenda*, are (1) embedding green infrastructure in federal agencies; (2) making green infrastructure language in permitting and enforcement actions common practice; (3) making data on design, performance, costs, and benefits of green infrastructure known and readily available; (4) decreasing the financial burden to communities of installing and maintaining green infrastructure; and (5) establishing partnerships and capacity building, where communities are networking and exchanging information on the best green infrastructure approaches. The goals most relevant to EPA's providing assistance to municipalities to employ green infrastructure are the latter three, providing information, funding, and partnerships and capacity building.

To address the goal of making information available on the design, performance, costs, and benefits of green infrastructure, EPA has provided extensive information on its website, including sharing its own research and that of academics, nonprofit groups, and other entities on a variety of issues related to green infrastructure. For example, the website contains links to documents and databases from EPA, universities, and others on the performance and benefits of specific green infrastructure technologies, such as a report summarizing results from research conducted by EPA's Office of Research and Development into the

---

performance of several green infrastructure practices.<sup>18</sup> The website also contains links to

- technical webcasts for public officials and green infrastructure practitioners concerning specific green infrastructure practices, such as design, operation, and maintenance, including a webcast addressing strategies on designing, implementing, and maintaining green infrastructure at the local level and a webcast on the cost-savings and benefits of using green infrastructure,<sup>19</sup> and
- fact sheets and supplemental materials that EPA has developed to provide examples of how green infrastructure can be incorporated into permits and other compliance agreements, such as CSO consent decrees.<sup>20</sup>

In addition, since 2012 EPA has provided \$2.8 million in technical assistance to 52 municipalities for planning and implementing green infrastructure. On the basis of this work, EPA has posted on its website case studies focused on the use of green infrastructure options to address a variety of site-specific issues related to green infrastructure, such as flood mitigation, the capture of stormwater for reuse for irrigation of parkland, adaptation to climate change, the integration of green infrastructure into transportation planning, and addressing barriers to using green infrastructure. For example, in one case study, EPA identified green infrastructure options for a low-lying coastal area subject to sea level rise.<sup>21</sup> In another case study, EPA worked with a city to develop a

---

<sup>18</sup>Environmental Protection Agency, Office of Research and Development, *Green Infrastructure for Stormwater Control: Gauging Its Effectiveness with Community Partners*, EPA/600/R-15/219 (Washington, D.C.: October 2015).

<sup>19</sup>EPA webcast presented on November 15, 2016: *Building the Case for Green Infrastructure: Outreach and Education*, <https://www.epa.gov/green-infrastructure/building-case-green-infrastructure-outreach-and-education>. EPA webcast presented on May 5, 2015: *Getting More Green from Your Stormwater Infrastructure*, <https://www.epa.gov/green-infrastructure/getting-more-green-your-stormwater-infrastructure>.

<sup>20</sup>For example, Environmental Protection Agency, *Greening CSO Plans: Planning and Modeling Green Infrastructure for Combined Sewer Overflow (CSO) Control*, EPA 832-R-14-001 (Washington, D.C.; March 2014)..

<sup>21</sup>Environmental Protection Agency, *Restoring Knitting Mill Creek through Green Infrastructure*, EPA 832-R-15-012 (Washington, D.C.: December 2015), accessed July 20, 2017, <https://www.epa.gov/green-infrastructure/restoring-knitting-mill-creek-through-green-infrastructure>.

---

conceptual design for a 100,000-gallon storage tank that the city will use to harvest stormwater from a storm drain system, reducing runoff and using the water to irrigate parkland.<sup>22</sup> In addition, EPA also issued a summary report to convey the overall lessons learned in the technical assistance projects.<sup>23</sup>

To address the goal of decreasing the financial burden to communities of installing green infrastructure, EPA has provided funding for green infrastructure to municipalities. For example, since 2009, the Green Project Reserve (GPR), which is part of the agency's Clean Water State Revolving Fund, has provided \$944 million for green infrastructure project loans to municipalities, according to EPA's website.<sup>24</sup> Green infrastructure projects funded under the GPR have included (1) urban reforestation in one city that has served the dual purpose of reducing stormwater runoff and promoting urban revitalization in an economically distressed area and (2) in another city, a bioengineered stream and constructed wetland that reduced stormwater runoff by enhancing water infiltration into the ground while creating a public gathering space. EPA also provides funding under other programs for green infrastructure, including through Clean Water Act Nonpoint Source Grants and through its Urban Waters Small Grants Program, Five Star and Urban Waters Restoration Grants Program, and Greening America's Communities Program, among others.<sup>25</sup>

---

<sup>22</sup>Environmental Protection Agency, *Building Resilience to Drought in Ozone Park*, EPA 832-R-15-010 (Washington, D.C.: June 2015).

<sup>23</sup>Environmental Protection Agency, *Tools, Strategies and Lessons Learned from EPA Green Infrastructure Technical Assistance Projects*, EPA 832-R-15-016 (Washington, D.C.: December 2015), accessed May 18, 2017, <https://www.epa.gov/green-infrastructure/tools-strategies-and-lessons-learned-epa-green-infrastructure-technical>.

<sup>24</sup>The American Recovery and Reinvestment Act provided that, to the extent there were sufficient eligible project applications, not less than 20 percent of the funds appropriated for state revolving funds were for projects to address green infrastructure, water or energy efficiency improvements or other environmentally innovative activities. According to EPA's website, the GPR includes the following annual funding amounts (in nominal fiscal year dollars): 2009, \$13.7 million; 2010, \$204.0 million; 2011, \$109.7 million; 2012, \$83.7 million; 2013, \$115.0 million; 2014, \$75.7 million; 2015, \$226.5 million; and 2016, \$116.0 million.

<sup>25</sup>See <https://www.epa.gov/urbanwaters/urban-waters-small-grants>, <https://www.epa.gov/urbanwaterspartners/five-star-and-urban-waters-restoration-grant-program-2017>, and <https://www.epa.gov/smartgrowth/greening-americas-communitie> (last accessed 9/21/17).

---

To address the goal of establishing partnerships and capacity, EPA officials said that they held a series of national community summits to encourage peer-to-peer exchange for better stormwater management from 2013 to 2015. The agency now works with a network of municipalities, which was created in 2015, focused on effectively using green infrastructure. The network brings together green infrastructure practitioners from different communities to help them learn from each other as they use green infrastructure. In addition to collaborating with this network, EPA developed a web application called the Green Infrastructure Wizard to connect communities to EPA green infrastructure tools and resources and maintains an electronic mailing list called GreenStream to help share publications, training, and funding opportunities. EPA officials said that they also sponsored efforts to educate students in the use of green infrastructure. Since 2012, EPA has held the Campus RainWorks Challenge, an annual competition for college students, with the intention of exposing future engineers and designers to green infrastructure concepts. In these challenges, college students form teams, each with a faculty sponsor, and design innovative green infrastructure projects for their campuses to effectively manage stormwater. In 2016, according to EPA's website, student teams from 30 states submitted designs that were judged by representatives from EPA and its cooperating organizations—the American Society of Landscape Architects, the American Society of Civil Engineers, and the Water Environment Federation.

In 2016, EPA conducted an informal assessment of its progress in advancing the use of green infrastructure and determined that the information, assistance, and funding that the agency provided had not resulted in communities institutionalizing green infrastructure in a similar fashion to gray infrastructure. EPA officials we interviewed said that they regarded the early years of the agency's green infrastructure program as an educational phase that increased awareness of the use of green infrastructure in managing stormwater. However, these officials said that they have found that while municipalities are now generally aware of green infrastructure, they are not using it extensively to manage stormwater, and the officials identified challenges for the municipalities in installing green infrastructure. The officials said that fully integrating stormwater management into other community planning efforts requires a sufficiently long time horizon to help maximize environmental benefits and provide cost efficiencies by synchronizing a community's plans with its stormwater management and any Clean Water Act obligations; this horizon is likely longer than the current 5-year permit window and the agency is exploring how to incorporate long-term planning approaches



---

into permit conditions. EPA officials said that while it is possible to implement many practices on an ad hoc basis, comprehensive implementation across a municipality's stormwater area can take multiple permit cycles. The EPA officials said that the agency would like communities to be more easily able to integrate green infrastructure into capital improvement plans and other municipal plans to realize the most effective environmental benefits and cost savings. In addition, EPA officials said that since green infrastructure is relatively new, municipalities do not know if using green infrastructure will meet the requirements of their permits and thus may be discouraged from using it.

To address these challenges to installing green infrastructure, EPA officials said that they would develop a new focus on helping municipalities find ways to incorporate green infrastructure into stormwater systems over a longer period of time while still meeting permit requirements. The officials said that beginning in 2016, they launched a pilot project to work with 5 municipalities to develop long-term stormwater plans that incorporate green infrastructure. The officials said that they plan to work with these municipalities to identify projects to address stormwater management, including meeting permit requirements, while developing and implementing larger infrastructure and community plans that address other needs, such as transportation or recreation. According to EPA officials, the long-term stormwater plans will include projects that will be implemented over the course of multiple permit cycles—perhaps as long as 20 to 30 years. The long-term stormwater plans will be incorporated into permits, to show how the permits' requirements to limit or eliminate stormwater pollution will be met. According to an EPA official, a municipality's long-term stormwater plan would be reevaluated when its stormwater permit is renewed. EPA officials said that one purpose of the pilot project will be to help integrate a municipality's long-range stormwater plan into its shorter-term permits.

EPA officials also said that the idea of the pilot project is to demonstrate to other municipalities the benefits of using a long-term approach to planning for green infrastructure and stormwater management. According to the officials, this long-term approach can be more cost-effective for municipalities installing green infrastructure and can help reduce the costs of complying with permit requirements. More specifically, agency officials we interviewed said that by incorporating stormwater management at the same time as other infrastructure projects, such as transportation projects, the costs of implementing green infrastructure could be reduced while balancing other community priorities. For example, a park that includes green infrastructure features, such as

---

bioswales, will serve two purposes, providing both recreational area and stormwater drainage, and the costs to install permeable pavement are not as high if the work is synchronized with other repaving projects, such as adding bike lanes.

---

### EPA Plans to Establish Five Collaborative Groups with Municipalities but Has Not Yet Developed Written Agreements on Collaborating with Them

EPA officials we interviewed said that through the pilot project, the agency plans to establish groups in five municipalities to work collaboratively on developing long-term stormwater plans. By working with each municipality for at least 12 to 18 months, EPA officials said that they intend for each municipality to form a group of stakeholders that will collaborate to integrate green infrastructure into long-range plans that may include other municipal infrastructure elements, such as parks or streets. The participants for each of the five municipalities will include EPA; its consultants; the municipal department responsible for stormwater; potentially state NPDES permitting authorities; other municipal departments, such as for roads or parks; interest groups; and members of the general public. The participants may vary, depending on the municipality and other potential infrastructure improvements the municipality may be planning, and EPA officials said that they will work with stormwater officials in each municipality to identify the appropriate local agencies and other stakeholders that need to be involved in developing the stormwater management plan.

The use of such a collaborative group is consistent with one of the mechanisms to implement interagency collaborative efforts that we identified in a 2012 report on key considerations for implementing interagency collaborative mechanisms.<sup>26</sup> That report discusses different types of collaborative mechanisms, such as a coordinator appointed by the President or an interagency task force. In that report, we also identified that all collaborative mechanisms benefit from certain key features, which raise issues to consider when implementing these mechanisms. These issues are shown in table 1.

---

<sup>26</sup>GAO, *Managing for Results: Key Considerations for Implementing Interagency Collaborative Mechanisms*, [GAO-12-1022](#) (Washington, D.C.: Sept. 27, 2012).

**Table 1: Key Issues to Consider for Implementing Interagency Collaborative Mechanisms**

<b>Key issues</b>	<b>Key considerations</b>
Outcomes and accountability	Have short-term and long-term outcomes been clearly defined? Is there a way to track and monitor their progress?
Bridging organizational cultures	What are the missions and organizational cultures of the participating agencies? Have agencies agreed on common terminology and definitions?
Leadership	How will leadership be sustained over the long term? If leadership is shared, have roles and responsibilities been clearly identified and agreed upon?
Clarity of roles and responsibilities	Have participating agencies clarified roles and responsibilities?
Participants	Have all relevant participants been included? Do they have the ability to commit resources for their agency?
Resources	How will the collaborative mechanism be funded and staffed? Have online collaboration tools been developed?
Written guidance and agreements	If appropriate, have participating agencies documented their agreement regarding how they will be collaborating? Have they developed ways to continually update and monitor these agreements?

Source: GAO. | GAO-17-750

EPA officials said that they have agreements with each municipality that the agency will provide each group with technical assistance. EPA officials also said that they would provide \$150,000 to each municipality, for a total of \$750,000 for the pilot. When we asked about what resources or documents EPA would use to guide the pilot project and the work with the five municipal groups, EPA officials referred us to the following agency resources that provide guidance to communities and wastewater utilities for planning for sustainability and managing stormwater planning more generally.

- *Community Solutions for Stormwater Management: A Guide for Voluntary Long-term Planning* (2016).<sup>27</sup> According to the guide, it describes how to develop a comprehensive long-term community stormwater plan that integrates stormwater management with a municipality's broader plans for economic development, infrastructure investment, and environmental compliance. The document says that when developing a plan, a community should determine and define the scope of the integration effort, ensure the active participation of entities that are needed to implement the plan, and identify the role each entity will have in implementing the plan. EPA officials said that this document outlines the approach they will use for the pilot projects.

<sup>27</sup>Environmental Protection Agency, *Community Solutions for Stormwater Management: A Guide for Voluntary Long-term Planning*, Draft (October 2016).

---

EPA is also developing a web-based Toolkit that will include technical and financing resources to walk communities through the long-term stormwater planning process provided in the Community Solutions for Stormwater Management guide

- *Integrated Municipal Stormwater and Wastewater Planning Approach Framework* (2012).<sup>28</sup> According to the document, it is for use by EPA, states, and local governments to develop and implement integrated plans under the Clean Water Act. Steps for developing a plan include defining the scope of the integration effort, ensuring participation of the entities needed to implement the integrated plan, and identifying the role each entity will have in implementing the plan. EPA officials said that the pilot project's approach to long-term planning reflects EPA's Integrated Planning Framework.

In addition, we identified other EPA resources which include some features that we have identified as being helpful for collaborative groups. These documents include the following information:

- *Green Infrastructure in Parks: A Guide to Collaboration, Funding, and Community Engagement* (2017).<sup>29</sup> According to the guide, it is intended to encourage partnerships between park agencies and stormwater agencies aimed at promoting the use of green infrastructure on park lands. It identifies steps to facilitate the implementation of green infrastructure in parks, including identifying and engaging stakeholders; building relationships; leveraging funding opportunities; and undertaking high-visibility pilot projects, which it says helps gain support for more green practices.
- *Planning for Sustainability: Handbook for Water and Wastewater Utilities* (2012).<sup>30</sup> According to the handbook, it is intended to provide information about how to enhance current planning processes by building in sustainability considerations. It is designed to be useful for various types and scales of planning efforts, such as long-range integrated water resources planning. The steps include the utility

---

<sup>28</sup>Environmental Protection Agency, *Integrated Municipal Stormwater and Wastewater Planning Approach Framework* (Washington, D.C.: June 5, 2012).

<sup>29</sup>Environmental Protection Agency, *Green Infrastructure in Parks: A Guide to Collaboration, Funding, and Community Engagement*, EPA 841-R-16-112 (Washington, D.C.: May 2017).

<sup>30</sup>Environmental Protection Agency, *Planning for Sustainability: A Handbook for Water and Wastewater Utilities*, EPA-832-R-12-001 (February 2012).

---

internally identifying sustainability priorities and potential opportunities and engaging the community about its sustainability priorities.

Key to the success of the five groups is collaboration among the participants as they develop their long-range stormwater plans. Although EPA officials said that the documents they provided were not intended to include how EPA, municipal departments, and other stakeholders are to collaborate, they reflect some of the key considerations for implementing interagency collaborative mechanisms that we identified in our past work. For example, the two 2012 documents identify the need for appropriate participants to be involved in a collaborative group, and the 2016 document discusses the need to identify the roles that each entity will have in implementing a plan and to define the scope of the effort. In addition, the 2017 park planning document states that identifying opportunities to provide resources through leveraging funds can help incorporate green infrastructure features into a park, while at the same time accomplishing other purposes, such as providing trails and irrigation for sports fields.

EPA officials we interviewed said that the efforts with the five municipal groups have just started and that they have not developed further guidance for how to collaborate with the municipalities and relevant stakeholders. In particular, EPA officials said that the five groups have not yet developed agreements on how they will work together to collaborate. According to the officials, they are working on additional resources to provide further details about options to engage communities, promote accountability, prioritize goals and actions, and identify financing options. Our prior work has found that agencies that articulate their agreements in formal documents, such as memorandums of understanding, can strengthen their commitment to working collaboratively.<sup>31</sup> A written document can incorporate agreements reached among participants in any or all of the following areas: leadership, accountability, roles and responsibilities, and resources. When working with the five groups in the pilot project, EPA could better assure that they will successfully develop long-term stormwater plans if they document their agreement on how they will collaborate, such as in a memorandum of understanding, aligned with our key considerations for implementing interagency collaborative mechanisms. Similarly, any other efforts to develop long-term stormwater plans after the pilot project would benefit from the groups documenting their agreement on how they will collaborate.

---

<sup>31</sup>[GAO-12-1022](#).

---

## Conclusions

In the last 10 years, EPA's green infrastructure program has focused on educating municipalities by providing information, technical assistance, and funding and, as our survey results show, has helped municipalities achieve familiarity with the general concept of green infrastructure. Yet EPA officials we interviewed believe that they are now at a turning point in this program, noting that green infrastructure is still not a prominent component of most municipal stormwater programs. EPA's pilot project with five municipalities is a good way to focus on developing long-term stormwater plans. However, the success of EPA's pilot project—and any other efforts to develop long-term stormwater plans after the pilot project—depends on successful collaboration among wide-ranging groups of participants. Our previous work on key considerations for implementing interagency collaborative mechanisms, such as the municipal groups proposed by EPA, provides more specific ways for groups to work together than what is currently contained in EPA documents. That work has also found that agencies that articulate their agreements in formal documents, such as memorandums of understanding, can strengthen their commitment to working collaboratively. When working with the municipal departments and other stakeholders, such as those in each of the five groups in the pilot project, EPA could have a better assurance that the groups will successfully develop long-term stormwater plans if they document their agreement on how they will collaborate, such as in a memorandum of understanding, aligned with our key considerations for implementing interagency collaborative mechanisms.

---

## Recommendation for Executive Action

The Director of EPA's Office of Wastewater Management should, when working with municipalities and other stakeholders to develop long-term stormwater plans, document agreements on how they will collaborate, such as in a memorandum of understanding, aligned with our key considerations for implementing interagency collaborative mechanisms. (Recommendation 1)

---

## Agency Comments

We provided a draft of this report to EPA for review and comment. In its written comments, reproduced in appendix III, EPA generally agreed with our findings, conclusions, and recommendation. EPA stated that it is in the early stages of the pilot project to assist municipalities in developing long-term stormwater plans and will utilize the collaborative practices recommended by GAO as it implements the project over the next 12 to 18 months. EPA's plans, if implemented as described, would address our

---

recommendation. EPA also provided technical comments, which we incorporated as appropriate.

---

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies of this report to the appropriate congressional committees; the Administrator of the Environmental Protection Agency; the Director, Office of Management and Budget; and other interested parties. In addition, this report will be available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff members have any questions about this report, please contact me at (202) 512-3841 or [gomezj@gao.gov](mailto:gomezj@gao.gov). Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are listed in appendix IV.

Sincerely yours,

A handwritten signature in black ink that reads "Alfredo Gómez". The signature is written in a cursive style with a large, stylized initial "A" and "G".

J. Alfredo Gómez  
Director, Natural Resources and Environment

---

# Appendix I: Objectives, Scope, and Methodology

---

In this report, we (1) describe to what extent selected municipalities are incorporating green infrastructure into their efforts to comply with National Pollutant Discharge Elimination System (NPDES) permits and consent decrees that address combined sewer overflows (CSO), and what is known about funding for such efforts; (2) describe what challenges, if any, these municipalities reported facing to incorporate green infrastructure into their efforts to comply with those permits and consent decrees; and (3) examine efforts the Environmental Protection Agency (EPA) is taking to help municipalities use green infrastructure.<sup>1</sup>

To describe how selected municipalities are incorporating green infrastructure into their efforts to comply with NPDES permits and consent decrees that address CSOs, what is known about funding for such efforts, and any challenges municipalities reported facing in incorporating green infrastructure into these efforts, we conducted a survey of representatives of 31 municipalities. We selected 20 municipalities that had NPDES permits required of municipalities to discharge stormwater into nearby water bodies, such as creeks, lakes, and rivers. The remaining 11 municipalities had entered into consent decrees with EPA to address CSOs. We restricted our selection of the 31 municipalities to those in the 50 states and Washington, D.C. Although we selected these municipalities at random from a range of geographic locations and a range of sizes, our sample of 31 municipalities cannot be generalized to all municipalities in the United States.

We randomly selected the 20 municipalities with NPDES permits from the list of more than 5,000 municipalities that EPA identified in its 1999 rule extending the NPDES program to smaller municipalities.<sup>2</sup> By using the 1999 list, which is almost 18 years old, we enhanced the likelihood that survey respondents would have experience conducting work to comply with their permits. We stratified our sample by size and location. Specifically, we randomly selected 10 municipalities with phase I permits—generally required for municipalities with populations of 100,000 or more—from each of EPA's 10 regions. We also randomly selected 10 municipalities with phase II permits—generally required for governmental entities with populations of fewer than 100,000 from each of EPA's 10 regions. Six of the selected municipalities were not available to participate

---

<sup>1</sup>For the purposes of this report, we use the term municipalities to include cities, towns, and other public entities that operate sewer systems.

<sup>2</sup>64 Fed. Reg. 68,722 (Dec. 8, 1999).



in our survey; in each case, we randomly selected a municipality with the same type of permit from the same EPA region to take its place. Table 2 lists the 20 municipalities with permits that we surveyed, the EPA region in which it is located, and the size of population it serves.

**Table 2: Location and Population Served by Municipalities with Permits Included in Our Survey**

Location of municipality	EPA region	Population served
Bellevue, WA	10	140,000
Carpentaria, CA	9	13,500
Eugene, OR	10	159,190
Farr West, UT	8	6,600
Florence, SC	4	37,000
Hillsborough County, FL	4	840,438
Independence, MO	7	117,000
Jamestown, RI	1	5,400
Laredo, TX	6	267,500
Midway Township, MN	5	1,500
Minneapolis, MN	5	514,000
New Castle, NY	2	17,500
Ohio Township, PA	3	5,000
Prince William County, VA	3	440,000
Providence, RI	1	100,000
Rochester, NY	2	210,000
Salt Lake City, UT	8	191,000
San Angelo, TX	6	97,492
San Jose, CA	9	1,000,000
St. Louis, MO	7	1,300,000

Source: GAO. | GAO-17-750

We randomly selected the 11 municipalities that have entered into consent decrees with EPA to address CSOs from a list of 36 such municipalities that EPA provided to us. These were municipalities that entered into consent decrees to address CSOs after August 2007. August 2007 is the date of a memorandum in which EPA states, among other things, that it will consider the feasibility of using green infrastructure in its enforcement activities, for example, consent decrees that address

CSOs.<sup>3</sup> An analysis of the 36 consent decrees showed that they differed in two characteristics—about half had some mention of green infrastructure in the text of the consent decree and about half were entered into with municipalities in EPA’s Region 5 (the Great Lakes region). The consent decrees were roughly distributed evenly among four groups—with and without mention of green infrastructure and either in or not in Region 5. We stratified our sample of 11 municipalities with consent decrees to be proportionally representative of both of these characteristics. In four instances, a municipality was not available to participate in our survey, in which case we randomly selected another municipality with similar characteristics. We selected these municipalities at random from a range of geographic locations and a range of sizes; however, because of the sample size, among other factors, the results are not generalizable to all municipalities in the United States. Table 3 lists the 11 municipalities with CSO consent decrees that we surveyed, the EPA region in which it is located, and population it serves.

**Table 3: Location and Population Served by Municipalities with Consent Decrees Included in Our Survey**

Location of municipality	EPA region	Population served
Anderson, IN	5	55,670
Bangor, ME	1	32,391
Chattanooga, TN	4	400,000
Cincinnati Hamilton County, OH	5	850,000
Lebanon, NH	1	13,000
Elkins, WV	3	8,000
Ironton, OH	5	11,000
Jeffersonville, IN	5	46,950
Oswego, NY	2	10,000
South Bend, IN	5	120,000
Washington, DC	3	2,772,000

Source: GAO. | GAO-17-750

The questions we asked municipalities in our survey focused on (1) the extent to which the municipalities were using green infrastructure to comply, at least in part, with requirements of their permits or consent

<sup>3</sup>Environmental Protection Agency, *Use of Green Infrastructure in NPDES Permits and Enforcement*, Memorandum from Director, Water Permits Divisions, and Director, Water Enforcement Division (Aug. 16, 2007).

decrees; (2) the amount and source of capital expenditures for green infrastructure to comply, at least in part, with requirements of their permits or consent decrees; and (3) the challenges the municipalities may have experienced in using or considering green infrastructure to comply, at least in part, with requirements of their permits or consent decrees.

The time frames for which we asked for information from the survey respondents varied by the questions we asked and whether a municipality was included in our survey because it has an NPDES permit or a consent decree to address CSOs. For questions to municipalities with permits about the extent to which the municipalities were using green infrastructure and questions about the challenges the municipalities may have experienced in using or considering green infrastructure, we asked for information for approximately the 5-year period prior to our survey. For questions to municipalities with consent decrees, we did not specify a time frame. For information on the amount and source of capital expenditure for municipalities with permits and municipalities with consent decrees, we asked survey respondents for the information from the respondents' last 3 completed fiscal years. We limited these questions to 3 fiscal years to reduce the work burden on the respondents.

Our survey questions about the extent to which the municipalities were using green infrastructure included questions about each of the 11 examples of green infrastructure that EPA listed on its website.<sup>4</sup> Our survey questions about the amount and source of capital expenditures for green infrastructure asked about the cost of green infrastructure that was incurred by the permit holder. Seventeen respondents were able to provide us with the information—some provided it during the survey, and others provided it after we concluded the survey. In some instances, the respondents indicated that the expenditure information was an estimate.

Our survey questions about challenges asked about the experiences the municipalities had regarding eight aspects of infrastructure development that may have posed challenges to them in using green infrastructure compared to their experiences in using gray infrastructure. The eight aspects are (1) obtaining land for the infrastructure project, (2) designing and engineering the project, (3) developing estimates for capital expenditures, (4) developing estimates for operation and maintenance

---

<sup>4</sup>Environmental Protection Agency, *Green Infrastructure*, accessed July 12, 2017, <https://www.epa.gov/green-infrastructure>. <https://www.epa.gov/green-infrastructure/what-green-infrastructure>.

---

expenditures, (5) installing the project, (6) the overall cost of the project, (7) confidence in the effectiveness of green infrastructure compared to gray infrastructure, and (8) the political and public opinion of green infrastructure compared to that of gray infrastructure.

For each of these eight aspects, we asked municipalities to describe situations in which the aspect encouraged them to install green infrastructure and situations in which the aspect discouraged them from doing so. We examined each of the responses for each of the aspects to identify broad themes, including being unfamiliar with green infrastructure and being committed to using it. To identify the most common themes, we conducted a content analysis in which one analyst classified each response into one or more of the themes and a second analyst independently verified these classifications. For each aspect, we also asked municipalities if, in general, the aspect made green infrastructure usually more challenging than gray infrastructure, usually less challenging, or about the same.

We conducted the survey by telephone from November 2016 through April 2017, with one analyst asking the questions, a second analyst documenting the responses electronically, and usually a third analyst taking handwritten notes. We reviewed the responses for accuracy and electronically transferred them into an Excel spreadsheet for analysis. For our survey, we used two questionnaires that were similar in content—one was used with municipalities with NPDES permits and the other was used with municipalities with CSO consent decrees. Both questionnaires are presented in appendix II. To help formulate our survey questions, we reviewed EPA documents and other literature describing green infrastructure and how green infrastructure projects are developed. We then met several times with a public interest group that represents municipal utilities and is familiar with green infrastructure and stormwater. We also pretested the survey with three municipalities and adjusted questions to make them more clear and answerable, as appropriate.

To examine efforts EPA is taking to help municipalities use green infrastructure, we reviewed EPA regulations, guidance, and reports, as well as information and tools on EPA's green infrastructure website. In addition, we interviewed officials from EPA's Office of Wastewater Management about their ongoing and proposed efforts to encourage the use of green infrastructure. Specifically, we interviewed them about progress toward the items in the agency's 2013 Strategic Agenda for green infrastructure and efforts they have made to develop a pilot project to collaborate with five communities to incorporate green infrastructure

into long-term infrastructure investment plans and permits. We used key considerations on interagency collaboration identified in our prior work to assess the guidance available to the agency to develop collaborative groups. Specifically, our previous work identifies features of collaborative groups, including defining outcomes and ways to track progress, clarifying roles and responsibilities of participating agencies, ensuring that relevant groups participate, and putting guidance and agreements in writing.<sup>5</sup>

For all three objectives, we interviewed EPA officials in the agency's Office of Wastewater Management, the office responsible for managing the Green Infrastructure Program, and Office of Enforcement and Compliance Assurance, as well as representatives from several public interest groups, about the use of green infrastructure by municipalities.

We conducted this performance audit from February 2016 to September 2017 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

---

<sup>5</sup>GAO, *Managing for Results: Key Considerations for Implementing Interagency Collaborative Mechanisms*, [GAO-12-1022](#) (Washington, D.C.: Sept. 27, 2012).

---

# Appendix II: Questionnaires Used in the Survey

---

GAO used two questionnaires that were similar in content to conduct the survey of municipalities. One questionnaire was used for municipalities with National Pollutant Discharge Elimination System (NPDES) permits, and the other questionnaire was used for municipalities with consent decrees that address combined sewer overflows (CSO). Both questionnaires are presented below.<sup>1</sup>

---

<sup>1</sup> In the questionnaires presented below, we refer to municipalities as utilities.

## Questionnaire Used for Municipalities with NPDES Permits

### Introduction

We have been asked by congress to study the use of green infrastructure to address stormwater issues. As part of our study, we are reaching out to NPDES MS4 stormwater permit holders. We randomly selected your utility from a list of urbanized areas required to have a MS4 permit. Today we will be asking for approximately 90 minutes of your time to answer 20 questions about your experiences with green and grey infrastructure practices in your permit area. Your responses will be used to help us write a report to congress informing them about the use of green infrastructure to address stormwater issues within the continental United States.

### What we mean by green infrastructure

For the purposes of our study, we are making a distinction between green and grey infrastructure. Although there is not a universal definition for green infrastructure, in general, green infrastructure is a set of decentralized practices that minimize stormwater runoff volume and the pollutant load carried by stormwater. Grey infrastructure is the traditional infrastructure used to address stormwater -often made of concrete. It includes everything that is not green infrastructure.

### Background of Permit Holder

1. What is the name of the owner of the permit for this utility system?
2. What is the stormwater permit number?
3. Is the permit an individual or general MS4 permit?
4. What is the total population currently served by this utility system?
5. How many square miles does this utility system currently serve?
6. Please tell us the number of years you have been working in the stormwater program?

**Efforts to Incorporate Green Infrastructure Practices**

The following are questions about the extent that your utility uses green infrastructure. We are interested in green infrastructure that is intended, at least in part, to meet a consent decree requirement or provision.

7. EPA's website provides a description of green infrastructure and includes a list of 11 practices that it provides as examples of green infrastructure.<sup>1</sup> I will read you a list of each of these practices, and for each one, I'd like you to tell me whether your utility has installed the practice itself, or whether it has encouraged or required property owners to do so. The first practice is downspout disconnection.

a. Has your system installed or used downspout disconnection since 2012 to comply with its MS4 permit? (select one response)

- .....Yes
- .....No
- .....Don't know

b. Has your system encouraged or required property owners to install or use downspout disconnection to comply with its MS4 permit? (select one response)

- .....Yes
- .....No
- .....Don't know

c. Has your system installed or used rainwater harvesting since 2012 to comply with its MS4 permit? (select one response)

- .....Yes
- .....No
- .....Don't know

d. Has your system encouraged or required property owners to install or use rainwater harvesting to comply with its MS4 permit? (select one response)

- .....Yes
- .....No
- .....Don't know

e. Has your system installed or used rain gardens (bioretention) since 2012 to comply with its MS4 permit? (select one response)

- .....Yes
- .....No
- .....Don't know

<sup>1</sup> Prior to conducting the survey, we provided each participant a link to EPA's website: What is green infrastructure: <https://www.epa.gov/green-infrastructure/what-green-infrastructure>



---

Appendix II: Questionnaires Used in the Survey

---

- f. Has your system encouraged or required property owners to install or use rain gardens (bioretention) to comply with its MS4 permit? (select one response)
- .....Yes  
.....No  
.....Don't know
- g. Has your system installed or used planter boxes since 2012 to comply with its MS4 permit? (select one response)
- .....Yes  
.....No  
.....Don't know
- h. Has your system encouraged or required property owners to install or use planter boxes to comply with its MS4 permit? (select one response)
- .....Yes  
.....No  
.....Don't know
- i. Has your system installed or used bioswales since 2012 to comply with its MS4 permit? (select one response)
- .....Yes  
.....No  
.....Don't know
- j. Has your system encouraged or required property owners to install or use bioswales to comply with its MS4 permit? (select one response)
- .....Yes  
.....No  
.....Don't know
- k. Has your system installed or used permeable pavement since 2012 to comply with its MS4 permit? (select one response)
- .....Yes  
.....No  
.....Don't know
- l. Has your system encouraged or required property owners to install or use permeable pavement to comply with its MS4 permit? (select one response)
- .....Yes  
.....No  
.....Don't know
- m. Has your system installed or used green streets and alleys since 2012 to comply with its MS4 permit? (select one response)
- .....Yes  
.....No  
.....Don't know

Appendix II: Questionnaires Used in the Survey

- n. Has your system encouraged or required property owners to install or use green streets and alleys to comply with its MS4 permit? (select one response)
- .....Yes  
.....No  
.....Don't know
- o. Has your system installed or used green parking since 2012 to comply with its MS4 permit? (select one response)
- .....Yes  
.....No  
.....Don't know
- p. Has your system encouraged or required property owners to install or use green parking to comply with its MS4 permit? (select one response)
- .....Yes  
.....No  
.....Don't know
- q. Has your system installed or used green roofs since 2012 to comply with its MS4 permit? (select one response)
- .....Yes  
.....No  
.....Don't know
- r. Has your system encouraged or required property owners to install or use green roofs to comply with its MS4 permit? (select one response)
- .....Yes  
.....No  
.....Don't know
- s. Has your system installed or used urban tree canopy since 2012 to comply with its MS4 permit? (select one response)
- .....Yes  
.....No  
.....Don't know
- t. Has your system encouraged or required property owners to install or use urban tree canopy to comply with its MS4 permit? (select one response)
- .....Yes  
.....No  
.....Don't know
- u. Has your system installed or used land conservation since 2012 to comply with its MS4 permit? (select one response)
- .....Yes  
.....No  
.....Don't know

Appendix II: Questionnaires Used in the Survey

v. Has your system encouraged or required property owners to install or use land conservation to comply with its MS4 permit? (select one response)

.....Yes  
 .....No  
 .....Don't know

w. Are there any other green infrastructure practices in use in your service area? (select one response)

.....Yes  
If yes, please tell us more about this other practice.  
 .....No  
 .....Don't know

8. (if applicable) You indicated in each of your responses about green infrastructure that your utility has not installed or used any of the green infrastructure practices we mentioned to comply with their MS4 permit since 2012. Has your utility considered using green infrastructure?

.....Yes  
If yes, please explain why your utility hasn't installed or used any green infrastructure.

..... No  
If not, please explain why your utility has not considered installing or using green infrastructure.

.....Don't know  
If they indicate they did not know, please ask them to explain why they did not know.

9. In the past five years, has any decision to use green infrastructure instead of grey infrastructure been influenced by other types of benefits that green infrastructure can provide? For example, green infrastructure might provide aesthetic, economic, or other environmental benefits not directly related to permit compliance.

.....Yes  
If yes, please provide examples.

.....No  
 .....Don't know

10. In the past five years, which three green infrastructure practices used by your utility retain the greatest amount of stormwater in the area covered by your permit?

Response 1

Why was this green infrastructure practice selected over grey infrastructure?

Response 2

Why was this green infrastructure practice selected over grey infrastructure?

Response 3

Why was this green infrastructure practice selected over grey infrastructure?

---

Appendix II: Questionnaires Used in the Survey

---

11. Earlier (question 5) you told us the size of the area covered by the permit. Do you have information on approximately how much of the area covered by your permit drains to green infrastructure and approximately how much drains to grey infrastructure?

- .....Yes
- .....No  
If "No" skip to question 12.
- .....Don't know  
If "Don't know" skip to question 12.

a. What percentage of the permit area drains to green infrastructure?

- .....Less than 5 percent
- .....Between 5 percent and 10 percent
- .....Between 11 percent and 20 percent
- .....Greater than 20 percent  
If they respond greater than 20 percent, ask them to specify how much.

b. Does the remaining permit area drain to grey infrastructure?

- .....Yes
- .....No  
If they respond "No" ask them to please explain.
- .....Don't know  
If they respond "Don't know" ask them to please explain.

c. What is the basis of this estimate? For example, professional judgement, estimate based on model, field measurements, GIS layer, other.

12. During the last five years, has your utility sought assistance with green infrastructure from the US EPA?

- .....Yes
- .....No    If "No" skip to question 14.
- .....Don't know    If "Don't know" skip to question 14.

13. Has your utility received any of the following types of assistance from the US EPA during this period?

a. Planning or designing green infrastructure?

.....Yes

If yes, please describe.

.....No

b. Building or installing green infrastructure?

.....Yes

If yes, please describe.

.....No

c. Funding green infrastructure?

.....Yes

If yes, please describe.

.....No

d. Did the US EPA provide your utility with any other form of assistance regarding green infrastructure?

.....Yes

If yes, please describe.

.....No

Appendix II: Questionnaires Used in the Survey

**Challenges in Using Green Infrastructure to Meet MS4 Permit Requirements Since January 2012**

*Thank you for providing us with information about how your utility is using green infrastructure practices to meet MS4 permit requirements. I am now going to ask you a series of questions about possible challenges you may have experienced while installing and using green infrastructure practices within your permit area.*

*Similar to the previous set of questions, we are interested in green infrastructure practices that were intended, at least in part, to meet a MS4 permit requirement. When answering these questions, please think about the green infrastructure practices you told me about earlier that your utility installed, or considered installing –AT THE PERMIT HOLDER'S EXPENSE, within the last five years.*

**14. Regarding your experiences in obtaining land to install green infrastructure to meet MS4 permit requirements:**

- a. In the last five years, were there situations where obtaining land for green infrastructure was more difficult than obtaining land for grey infrastructure?
  - .....Yes, there were situations where it was more difficult
  - .....No, there were not situations where it was more difficult (Skip to c)
  - .....Don't know (Skip to c)
  
- b. In these situations, did the difficulty in obtaining land discourage your utility from installing green infrastructure?
  - .....Yes, these situations discouraged my utility from installing green infrastructure.  
If so, please describe
  - .....No, these situations did not discourage my utility from installing green infrastructure. (If not, please describe)
  - .....Don't know
  
- c. In the last five years, were there situations where obtaining land for green infrastructure was easier than obtaining land for grey infrastructure?
  - .....Yes, there were situations where it was easier
  - .....No, there were not situations where it was easier (Skip to e)
  - .....Don't know (Skip to e)
  
- d. In these situations, did the ease in obtaining land encourage your utility to install green infrastructure?
  - .....Yes, these situations encouraged my utility to install green infrastructure. (If so, please describe)
  - .....No, these situations did not encourage my utility to install green infrastructure. (If not, please describe)
  - .....Don't know
  
- e. In general, would you say that obtaining land for green infrastructure was usually more difficult than obtaining land for grey infrastructure, usually less difficult, or about the same?
  - .....Usually more difficult
  - .....About the same
  - .....Usually less difficult

15. Regarding your experiences in developing capital expenditure estimates to install green infrastructure to meet MS4 permit requirements:

a. In the last five years, were there situations where developing capital expenditure estimates for green infrastructure was more difficult than developing capital expenditure estimates for grey infrastructure?

- .....Yes, there were situations where it was more difficult
- .....No, there were not situations where it was more difficult (Skip to c)
- .....Don't know (Skip to c)

b. In these situations, did the difficulties developing capital expenditure estimates discourage your utility from installing green infrastructure?

- .....Yes, these situations discouraged my utility from installing green infrastructure.(If so, please describe)
- .....No, these situations did not discourage my utility from installing green infrastructure.(If not, please describe)
- .....Don't know

c. In the last five years, were there situations where developing capital expenditure estimates for green infrastructure was easier than developing capital expenditure estimates for grey infrastructure?

- .....Yes, there were situations where it was easier
- .....No, there were not situations where it was easier (Skip to e)
- .....Don't know (Skip to e)

d. In these situations, did the ease of developing capital expenditure estimates encourage your utility to install green infrastructure?

- .....Yes, these situations encouraged my utility to install green infrastructure. (If so, please describe)
- .....No, these situations did not encourage my utility to install green infrastructure.(If not, please describe)
- .....Don't know

e. In general, would you say that developing capital expenditure estimates for green infrastructure was more difficult than developing capital expenditures for grey infrastructure, less difficult, or about the same?

- .....Usually more difficult
- .....About the same
- .....Usually less difficult

16. Regarding your experiences in developing operation and maintenance estimates to install green infrastructure to meet MS4 permit requirements:

a. In the last five years, were there situations where developing operation and maintenance estimates for green infrastructure was more difficult than developing operation and maintenance estimates for grey infrastructure?

- .....Yes, there were situations where it was more difficult
- .....No, there were not situations where it was more difficult  
Skip to c if they answered "No" here.
- .....Don't know  
Skip to c if they answered "Don't know" here.

b. In these situations, did the difficulties discourage your utility from installing green infrastructure?

- .....Yes, these situations discouraged my utility from installing green infrastructure.  
If so, please describe
- .....No, these situations did not discourage my utility from installing green infrastructure.  
If not, please describe
- .....Don't know

c. In the last five years, were there situations where developing operation and maintenance estimates for green infrastructure was easier than developing operation and maintenance estimates for grey infrastructure?

- .....Yes, there were situations where it was easier
- .....No, there were not situations where it was easier  
Skip to e if they answered "No" here
- .....Don't know  
Skip to e if they answered "Don't know" here.

d. In these situations, did the ease in developing operation and maintenance estimates encourage your utility to install green infrastructure?

- .....Yes, these situations encouraged my utility to install green infrastructure.  
If so, please describe
- .....No, these situations did not encourage my utility to install green infrastructure.  
If not, please describe
- .....Don't know

e. In general, would you say that developing operation and maintenance estimates was usually more difficult than engineering and designing grey infrastructure, usually less difficult, or about the same?

- .....Usually more difficult
- .....About the same
- .....Usually less difficult



17. Regarding your experiences in engineering and designing green infrastructure to meet MS4 permit requirements:

a. In the last five years, were there situations where engineering and designing green infrastructure was more difficult than engineering and designing grey infrastructure?

- .....Yes, there were situations where it was more difficult
- .....No, there were not situations where it was more difficult  
Skip to c if they answered "No" here.
- .....Don't know  
Skip to c if they answered "Don't know" here.

b. In these situations, did the difficulties discourage your utility from installing green infrastructure?

- .....Yes, these situations discouraged my utility from installing green infrastructure.  
If so, please describe
- .....No, these situations did not discourage my utility from installing green infrastructure.  
If not, please describe
- .....Don't know

c. In the last five years, were there situations where engineering and designing for green infrastructure was easier than engineering and designing for grey infrastructure?

- .....Yes, there were situations where it was easier
- .....No, there were not situations where it was easier  
Skip to e if they answered "No" here.
- .....Don't know  
Skip to e if they answered "Don't know" here.

d. In these situations, did the ease in engineering and designing encourage your utility to install green infrastructure?

- .....Yes, these situations encouraged my utility to install green infrastructure.  
If so, please describe
- .....No, these situations did not encourage my utility to install green infrastructure.  
If not, please describe
- .....Don't know

e. In general, would you say that engineering and designing green infrastructure was usually more difficult than engineering and designing grey infrastructure, usually less difficult, or about the same?

- .....Usually more difficult
- .....About the same
- .....Usually less difficult

Appendix II: Questionnaires Used in the Survey

18. Regarding your experiences in installing green infrastructure to meet MS4 permit requirements:

a. In the last five years, were there situations where installing green infrastructure was more difficult than installing grey infrastructure?

- .....Yes, there were situations where it was more difficult
- .....No, there were not situations where it was more difficult  
Skip to c if they answered "No" here.
- .....Don't know  
Skip to c if they answered "Don't know" here.

b. In these situations, did the difficulties discourage your utility from installing green infrastructure?

- .....Yes, these situations discouraged my utility from installing green infrastructure.  
If so, please describe
- .....No, these situations did not discourage my utility from installing green infrastructure.  
If not, please describe
- .....Don't know

c. In the last five years, were there situations where installing green infrastructure was easier than installing grey infrastructure?

- .....Yes, there were situations where it was easier
- .....No, there were not situations where it was easier  
Skip to e if they answered "No" here.
- .....Don't know  
Skip to e if they answered "Don't know" here.

d. In these situations, did the ease in installing green infrastructure encourage your utility to install green infrastructure?

- .....Yes, these situations encouraged my utility to install green infrastructure.  
If so, please describe
- .....No, these situations did not encourage my utility to install green infrastructure.  
If not, please describe
- .....Don't know

e. In general, would you say that installing green infrastructure was usually more difficult than installing grey infrastructure, usually less difficult, or about the same?

- .....Usually more difficult
- .....About the same
- .....Usually less difficult

19. Regarding your experiences with the overall cost of green infrastructure to meet MS4 permit requirements:

- a. In the last five years, were there situations where the overall cost of green infrastructure was higher than the overall cost of grey infrastructure?
  - .....Yes, there were situations where it was higher
  - .....No, there were not situations where it was higher  
Skip to c if they answered "No" here.
  - .....Don't know  
Skip to c if they answered "Don't know" here.
- b. In these situations, did the overall cost discourage your utility from installing green infrastructure?
  - .....Yes, these situations discouraged my utility from installing green infrastructure.  
If so, please describe
  - .....No, these situations did not discourage my utility from installing green infrastructure.  
If not, please describe
  - .....Don't know
- c. In the last five years, were there situations where the overall cost of green infrastructure was lower than the overall cost of grey infrastructure?
  - .....Yes, there were situations where it was lower
  - .....No, there were not situations where it was lower  
Skip to e if they answered "No" here.
  - .....Don't know  
Skip to e if they answered "Don't know" here.
- d. In these situations, did the lower overall costs of green infrastructure encourage your utility to install green infrastructure?
  - .....Yes, these situations encouraged my utility to install green infrastructure.  
If so, please describe
  - .....No, these situations did not encourage my utility to install green infrastructure.
  - .....Don't know
- e. In general, would you say the overall cost of green infrastructure was usually higher than the cost of grey infrastructure, usually lower, or about the same?
  - .....Usually higher
  - .....About the same
  - .....Usually lower

Appendix II: Questionnaires Used in the Survey

20. Now we would like to ask about your experiences regarding confidence in the effectiveness of green infrastructure used to meet MS4 permit requirements:

a. In the last 5 years, were there situations where confidence in the effectiveness of green infrastructure was lower than confidence in the effectiveness of grey infrastructure?

- .....Yes, there were situations where confidence was lower
- .....No, there were not situations where confidence was lower  
Skip to c if they answered "No" here.
- .....Don't know  
Skip to c if they answered "Don't know" here.

b. In these situations, did the lower confidence discourage your utility from installing green infrastructure?

- .....Yes, these situations discouraged my utility from installing green infrastructure.  
If so, please describe
- .....No, these situations did not discourage my utility from installing green infrastructure.  
If not, please describe
- .....Don't know

c. In the last 5 years, were there situations where confidence in the effectiveness of green infrastructure was higher than confidence in the effectiveness of grey infrastructure?

- .....Yes, there were situations where confidence was higher
- .....No, there were not situations where confidence was higher  
Skip to e if they answered "No" here.
- .....Don't know  
Skip to e if they answered "Don't know" here.

d. In these situations, did the higher confidence encourage your utility to install green infrastructure?

- .....Yes, these situations encouraged my utility to install green infrastructure.  
If so, please describe
- .....No, these situations did not encourage my utility to install green infrastructure.  
If not, please describe
- .....Don't know

e. In general, would you say confidence in the effectiveness of green infrastructure was usually higher than confidence in the effectiveness of grey infrastructure, usually lower, or about the same?

- .....Usually higher
- .....About the same
- .....Usually lower

21. Now we would like to ask about your experiences with political and public opinion regarding green infrastructure used to meet MS4 permit requirements:

a. In the past five years, were there situations where political and public opinion regarding green infrastructure was more negative than political and public opinion regarding grey infrastructure?

- .....Yes, there were situations where opinion was more negative
- .....No, there were not situations where it was higher  
Skip to c if they answered "No" here.
- .....Don't know  
Skip to c if they answered "Don't know" here.

b. In these situations, did the negative political and public opinion discourage your utility from installing green infrastructure?

- .....Yes, these situations discouraged my utility from installing green infrastructure. If so, please describe
- .....No, these situations did not discourage my utility from installing green infrastructure. If not, please describe
- .....Don't know

c. In the last 5 years, were there situations where political and public opinion regarding green infrastructure was more positive than political and public opinion regarding grey infrastructure?

- .....Yes, there were situations where opinion was more positive
- .....No, there were not situations where opinion was more positive  
Skip to e if they answered "No" here.
- .....Don't know  
Skip to e if they answered "Don't know" here.

d. In these situations, did the positive public opinion regarding green infrastructure encourage your utility to install green infrastructure?

- .....Yes, these situations encouraged my utility to install green infrastructure. If so, please describe
- .....No, these situations did not encourage my utility to install green infrastructure. If not, please describe
- .....Don't know

e. In general, would you say political and public opinion regarding green infrastructure was usually more positive than political and public opinion regarding grey infrastructure, usually less positive, or about the same?

- .....Usually more positive
- .....About the same
- .....Usually less positive

**Spending to Incorporate Green Infrastructure Practices over the Last 3 Fiscal Years**

Similar to the previous set of questions, we are interested in green infrastructure intended, at least in part, to meet an MS4 permit requirement. However, for this set of questions, we are interested in the cost of green infrastructure that was incurred by the permit holder (NOT by others). We are asking for data for the permit holder's last 3 full fiscal years.

22. Now we would like to ask you questions about the last 3 full fiscal years. When answering these questions we would like for you to be thinking about your total capital expenditures to meet the requirements of the MS4 permit:

a. Does your utility have documentation that distinguishes between the amount of capital expenditures that your utility spent on green infrastructure versus the amount that it spent on gray infrastructure?

.....Yes

.....No

If no, then conclude the interview.

b. What are the dates of your fiscal year?

c. How much did your system spend on capital expenditure for green infrastructure for each of the last 3 FYs?

Green FY  
Amount

Green FY  
Amount

Green FY  
Amount

d. How much did your system spend on capital expenditure for grey infrastructure for each of the last 3 FYs?

Grey FY  
Amount

Grey FY  
Amount

Grey FY  
Amount

e. What is the source of this information? If there is documentation, please provide us with that documentation and guidance on where in the documentation we can find the capital expenditures for green infrastructure and grey infrastructure.

---

Appendix II: Questionnaires Used in the Survey

---

23. Did your utility find the green infrastructure capital expenditure you told us about from any of the following sources?

a. Clean Water State Revolving Fund (CWSRF)

.....Yes

.....No

.....Don't know

b. Public-private funding

.....Yes

.....No

.....Don't know

c. Federal grants

.....Yes

.....No

.....Don't know

d. Other grants

.....Yes

.....No

.....Don't know

e. Bonds, general revenue

.....Yes

.....No

.....Don't know

f. Stormwater Fee

.....Yes

.....No

.....Don't know

g. Other sources

.....Yes

If yes, please explain

.....No

.....Don't know

## Questionnaire Used for Municipalities with CSO Consent Decrees

### Introduction

We have been asked by congress to study the use of green infrastructure to address stormwater issues. As part of our study, we are reaching out to utilities that are subject to EPA consent decrees that address Combined Sewer overflows (CSO). We randomly selected you from a list of these utilities. Today we will be asking for approximately 60-90 minutes of your time to answer about 20 questions about your experiences with green and grey infrastructure practices in the area covered by your consent decree. The survey is not focused on compliance with the consent decree.

### What we mean by green infrastructure

For the purposes of our study, we are making a distinction between green and grey infrastructure. Although there is not a precise definition for green infrastructure, in general, green infrastructure is a set of decentralized practices that minimize stormwater runoff volume and the pollutant load carried by stormwater. Grey infrastructure is the traditional infrastructure used to address stormwater—often made of concrete. It includes everything that is not green infrastructure.

### Background on Utility with a Consent Decree

Before we begin asking about your experiences with green and grey infrastructure, we would like to ask you a few background questions.

1. What is the total population currently served by this utility system?
2. How many square miles does this utility system currently serve?
3. Please tell us the number of years you have been working in this stormwater program.



---

Appendix II: Questionnaires Used in the Survey

---

**Efforts to Incorporate Green Infrastructure Practices**

The following are questions about the extent that your utility uses green infrastructure. We are interested in green infrastructure that is intended, at least in part, to meet a consent decree requirement or provision.

4. EPA's website provides a description of green infrastructure and includes a list of 11 practices that it provides as examples of green infrastructure.<sup>1</sup> I will read you a list of each of these practices, and for each one, I'd like you to tell me whether your utility has installed the practice itself or whether it has encouraged or required property owners to do so. The first practice is downspout disconnection.

a) Has your system installed or used downspout disconnection to comply with its consent decree? (Select one response)

- .....Yes  
 .....No  
 .....Don't know

b) Has your system encouraged or required property owners to install or use downspout disconnection to comply with its consent decree? (Select one response)

- .....Yes  
 .....No  
 .....Don't know

c) Has your system installed or used rainwater harvesting to comply with its consent decree? (Select one response)

- .....Yes  
 .....No  
 .....Don't know

d) Has your system encouraged or required property owners to install or use rainwater harvesting to comply with its consent decree? (Select one response)

- .....Yes  
 .....No  
 .....Don't know

e) Has your system installed or used rain gardens or bioretention to comply with its consent decree? (Select one response)

- .....Yes  
 .....No  
 .....Don't know

<sup>1</sup> Prior to the conducting the survey, we provided each participant a link to EPA's website: What is green infrastructure: <https://www.epa.gov/green-infrastructure/what-green-infrastructure>

Appendix II: Questionnaires Used in the Survey

f) Has your system encouraged or required property owners to install or use rain gardens or bioretention to comply with its consent decree? (Select one response)

- ..... Yes
- ..... No
- ..... Don't know

g) Has your system installed or used planter boxes to comply with its consent decree? (Select one response)

- ..... Yes
- ..... No
- ..... Don't know

h) Has your system encouraged or required property owners to install or use planter boxes to comply with its consent decree? (Select one response)

- ..... Yes
- ..... No
- ..... Don't know

i) Has your system installed or used bioswales to comply with its consent decree? (Select one response)

- ..... Yes
- ..... No
- ..... Don't know

j) Has your system encouraged or required property owners to install or use bioswales to comply with its consent decree? (Select one response)

- ..... Yes
- ..... No
- ..... Don't know

k) Has your system installed or used permeable pavement to comply with its consent decree? (Select one response)

- ..... Yes
- ..... No
- ..... Don't know

l) Has your system encouraged or required property owners to install or use permeable pavement to comply with its consent decree? (Select one response)

- ..... Yes
- ..... No
- ..... Don't know

m) Has your system installed or used green streets and alleys to comply with its consent decree? (Select one response)

- ..... Yes
- ..... No
- ..... Don't know

---

Appendix II: Questionnaires Used in the Survey

---

- n) Has your system encouraged or required property owners to install or use green streets and alleys to comply with its consent decree? (Select one response)
- .....Yes  
.....No  
.....Don't know
- o) Has your system installed or used green parking to comply with its consent decree? (Select one response)
- .....Yes  
.....No  
.....Don't know
- p) Has your system encouraged or required property owners to install or use green parking to comply with its consent decree? (Select one response)
- .....Yes  
.....No  
.....Don't know
- q) Has your system installed or used green roofs to comply with its consent decree? (Select one response)
- .....Yes  
.....No  
.....Don't know
- r) Has your system encouraged or required property owners to install or use green roofs to comply with its consent decree? (Select one response)
- .....Yes  
.....No  
.....Don't know
- s) Has your system installed or used urban tree canopy to comply with its consent decree? (Select one response)
- .....Yes  
.....No  
.....Don't know
- t) Has your system encouraged or required property owners to install or use urban tree canopy to comply with its consent decree? (Select one response)
- .....Yes  
.....No  
.....Don't know
- u) Has your system installed or used land conservation to comply with its consent decree? (Select one response)
- .....Yes  
.....No  
.....Don't know

Appendix II: Questionnaires Used in the Survey

v) Has your system encouraged or required property owners to install or use land conservation to comply with its consent decree? (Select one response)

.....Yes

.....No

.....Don't know

w) Are there any other green infrastructure practices in use in your service area? (If so, record examples of green infrastructure below.)

.....Yes

.....No

.....Don't know

5. (If applicable) You indicated in each of your responses about green infrastructure that your utility has not installed or used any green infrastructure practices to comply with its consent decree. Has your utility considered using green infrastructure?

.....Yes (Please explain why your utility hasn't used any green infrastructure) Conclude interview

.....No (please explain why your utility has not considered green infrastructure). Conclude interview

.....Don't know (please explain why you don't know/ request contact information for someone who does know). Conclude interview

6. Have you conducted studies on the feasibility of using green infrastructure as part of compliance with your consent decree?

.....Yes

.....No (Skip to Q7)

.....Don't know (Skip to Q7)

a) Did the results of the study result in a decision to use green infrastructure?

.....Yes

.....No (Skip to Q7)

.....Don't know (Skip to Q7)

b) Please describe how the study affected your decision to use green infrastructure.

7. In complying with the consent decree, has any decision to use green infrastructure instead of grey infrastructure been influenced by other types of benefits that green infrastructure can provide? For example, green infrastructure might provide aesthetic, economic, or other environmental benefits not directly related to compliance with the consent decree.

.....Yes (If yes, can you provide examples?)

.....No (Skip to Q10)

.....Don't know (Skip to Q10)

8. In complying with the consent decree, which three green infrastructure practices retain

Appendix II: Questionnaires Used in the Survey

the greatest amount of stormwater in your service area (the area covered by your consent decree)?

For each example, can you explain why green infrastructure was selected instead of grey infrastructure?

Example 1

Why green instead of grey?

Example 2

Why green instead of grey?

Example 3

Why green instead of grey?

9. What year was your consent decree signed?

10. In the year your consent decree was signed, what was the area in square miles that drained to the combined sewer system that is subject to the consent decree?

a) Are you able to estimate, as of 2016, what percentage of the area covered by your consent decree drains to green and grey infrastructure?

- .....Yes
- .....No (Skip to Q10)
- .....Don't know (Skip to Q10)

b) What percent of the area covered by your consent decree drains to green infrastructure?

- .....Less than 5 percent
  - .....Between 5 percent and 10 percent
  - .....Between 11 percent and 20 percent
  - .....Greater than 20 percent
- If greater than 20 percent, how much?

c) What percent of the area covered by your consent decree drains to MS4 grey infrastructure?

- .....Less than 5 percent
  - .....Between 5 percent and 10 percent
  - .....Between 11 percent and 20 percent
  - .....Greater than 20 percent
- If greater than 20 percent, how much?

---

Appendix II: Questionnaires Used in the Survey

---

d) Does the remaining area that does not drain to green infrastructure or to MS4 grey infrastructure continue to drain to the combined sewer system?

- .....Yes
- .....No (Please explain)
- .....Don't know (Please explain)

e) What is the basis of this estimate? For example, professional judgement, estimate based on model, field measurements, GIS layer, other.

11. Has your utility sought assistance with green infrastructure from the US EPA in order to comply with your consent decree?

- .....Yes
- .....No (Skip to Q13)
- .....Don't know (Skip to Q13)

12. Has your utility received any of the following types of assistance from US EPA during this period?

a) Planning or designing green infrastructure?

- .....Yes (please describe)
- .....No

b) Building or installing green infrastructure?

- .....Yes (please describe)
- .....No

c) Funding green infrastructure?

- .....Yes (please describe)
- .....No

d) Is there any other way that EPA has provided your utility assistance regarding green infrastructure?

**Challenges in Using Green Infrastructure to Meet Consent Decree Requirements**

*Thanks for providing us with information about how your utility is using green infrastructure. I am now going to ask you about challenges you may have experienced regarding green infrastructure compared to grey infrastructure.*

Similar to the previous set of questions, we are interested in green infrastructure intended, at least in part, to meet a consent decree requirement. For the following questions, please think about the green infrastructure practices that we talked about earlier that your utility installed, or considered installing. I will ask you about eight factors that could potentially have influenced your ability to install green infrastructure. In your responses, please focus on green infrastructure that your system either installed or intended to install at its own expense to comply with the consent decree.

**13. Regarding your experiences in obtaining land to install green infrastructure to meet consent decree requirements:**

a) Were there situations where obtaining land for green infrastructure was more difficult than obtaining land for grey infrastructure?

- .....YES, there were situations where it was more difficult
- .....NO, there were not situations where it was more difficult (SKIP to c)
- .....Don't know

b) In these situations, did the difficulties discourage your utility from installing green infrastructure?

- .....YES, these situations discouraged my utility from installing green infrastructure (please describe)
- .....NO, these situations did not discourage my utility from installing green infrastructure (please describe)
- .....Don't know

c) Were there situations where obtaining land for green infrastructure was easier than obtaining land for grey infrastructure?

- .....YES, there were situations where it was easier
- .....NO, there were not situations where it was easier (SKIP to e)
- .....Don't know

d) In these situations, did the ease in obtaining land encourage your utility to install green infrastructure?

- .....YES, these situations encouraged my utility to install green infrastructure (please describe)
- .....NO, these situations did not encourage my utility to install green infrastructure (please describe)
- .....Don't know

e) Would you say that obtaining land for green infrastructure was usually more difficult than obtaining land for gray infrastructure, usually less difficult, or about the same?

- .....Usually more difficult
- .....About the same
- .....Usually less difficult

14. Regarding your experiences in developing capital expenditure estimates to install green infrastructure to meet consent decree requirements:

a) Were there situations where developing capital expenditure estimates for green infrastructure was more difficult than developing capital expenditure estimates for grey infrastructure?

- .....YES, there were situations where it was more difficult
- .....NO, there were not situations where it was more difficult (SKIP to c)
- .....Don't know

b) In these situations, did the difficulties discourage your utility from installing green infrastructure?

- .....YES, these situations discouraged my utility from installing green infrastructure (please describe)
- .....NO, these situations did not discourage my utility from installing green infrastructure (please describe)
- .....Don't know

c) Were there situations where developing capital expenditure estimates for green infrastructure was easier than developing capital expenditure estimates for grey infrastructure?

- .....YES, there were situations where it was easier
- .....NO, there were not situations where it was easier [SKIP to e]
- .....Don't know

d) In these situations, did the ease in developing capital expenditure estimates encourage your utility to install green infrastructure?

- .....YES, these situations encouraged my utility to install green infrastructure (please describe)
- .....NO, these situations did not encourage my utility to install green infrastructure (please describe)
- .....Don't know

e) Would you say that developing capital expenditure estimates for green infrastructure was usually more difficult than developing capital expenditure estimates for grey infrastructure, usually less difficult, or about the same?

- .....Usually more difficult
- .....About the same
- .....Usually less difficult



15. Regarding your experiences in developing operation and maintenance estimates to install green infrastructure to meet consent decree requirements:

a) Were there situations where developing operation and maintenance estimates for green infrastructure was more difficult than developing operation and maintenance estimates for grey infrastructure?

- .....YES, there were situations where it was more difficult
- .....NO, there were not situations where it was more difficult [SKIP to c]
- .....Don't know

b) In these situations, did the difficulties discourage your utility from installing green infrastructure?

- .....YES, these situations discouraged my utility from installing green infrastructure (please describe)
- .....NO, these situations did not discourage my utility from installing green infrastructure (please describe)
- .....Don't know

c) Were there situations where developing operation and maintenance estimates for green infrastructure was easier than developing operation and maintenance estimates for grey infrastructure?

- .....YES, there were situations where it was easier
- .....NO, there were not situations where it was easier [SKIP to e]
- .....Don't know

d) In these situations, did the ease in developing operation and maintenance estimates encourage your utility to install green infrastructure?

- .....YES, these situations encouraged my utility to install green infrastructure (please describe)
- .....NO, these situations did not encourage my utility to install green infrastructure (please describe)
- .....Don't know

e) Would you say that developing operation and maintenance estimates for green infrastructure was usually more difficult than developing operation and maintenance estimates for gray infrastructure, usually less difficult, or about the same?

- .....Usually more difficult
- .....About the same
- .....Usually less difficult

16. Regarding your experiences in engineering and designing green infrastructure to meet consent decree requirements:

a) Were there situations where engineering and designing green infrastructure was more difficult than engineering and designing grey infrastructure?

- .....YES, there were situations where it was more difficult
- .....NO, there were not situations where it was more difficult (SKIP to c)
- .....Don't know

b) In these situations, did the difficulties discourage your utility from installing green infrastructure?

- .....YES, these situations discouraged my utility from installing green infrastructure (please describe)
- .....NO, these situations did not discourage my utility from installing green infrastructure (please describe)
- .....Don't know

c) Were there situations where engineering and designing green infrastructure was easier than engineering and designing grey infrastructure?

- .....YES, there were situations where it was easier
- .....NO, there were not situations where it was easier (SKIP to e)
- .....Don't know

d) In these situations, did the ease in engineering and designing encourage your utility to install green infrastructure?

- .....YES, these situations encouraged my utility to install green infrastructure (please describe)
- .....NO, these situations did not encourage my utility to install green infrastructure (please describe)
- .....Don't know

e) Would you say that engineering and designing green infrastructure was usually more difficult than engineering and designing grey infrastructure, usually less difficult, or about the same?

- .....Usually more difficult
- .....About the same
- .....Usually less difficult

---

Appendix II: Questionnaires Used in the Survey

---

17. Regarding your experiences in installing green infrastructure to meet consent decree requirements:

a) Were there situations where installing green infrastructure was more difficult than installing grey infrastructure?

- ..... YES, there were situations where it was more difficult
- ..... NO, there were not situations where it was more difficult (SKIP to c)
- ..... Don't know

b) In these situations, did the difficulties discourage your utility from installing green infrastructure?

- ..... YES, these situations discouraged my utility from installing green infrastructure (please describe)
- ..... NO, these situations did not discourage my utility from installing green infrastructure (please describe)
- ..... Don't know

c) Were there situations where installing green infrastructure was easier than installing grey infrastructure?

- ..... YES, there were situations where it was easier
- ..... NO, there were not situations where it was easier (SKIP to e)
- ..... Don't know

d) In these situations, did the ease in installing green infrastructure encourage your utility to install green infrastructure?

- ..... YES, these situations encouraged my utility to install green infrastructure (please describe)
- ..... NO, these situations did not encourage my utility to install green infrastructure (please describe)
- ..... Don't know

e) Would you say that installing green infrastructure was usually more difficult than installing gray infrastructure, usually less difficult, or about the same?

- ..... Usually more difficult
- ..... About the same
- ..... Usually less difficult

Appendix II: Questionnaires Used in the Survey

18. Regarding your experiences with the overall cost of green infrastructure to meet consent decree requirements:

a) Were there situations where the overall cost of green infrastructure was higher than the cost of grey infrastructure?

- .....YES, there were situations where it was higher
- .....NO, there were not situations where it was higher (SKIP to c)
- .....Don't know

b) In these situations, did the higher costs discourage your utility from installing green infrastructure?

- .....YES, these situations discouraged my utility from installing green infrastructure (please describe)
- .....NO, these situations did not discourage my utility from installing green infrastructure (please describe)
- .....Don't know

c) Were there situations where cost of green infrastructure was lower than the cost of grey infrastructure?

- .....YES, there were situations where it was lower
- .....NO, there were not situations where it was lower (SKIP to e)
- .....Don't know

d) In these situations, did the lower costs of green infrastructure encourage your utility to install green infrastructure?

- .....YES, these situations encouraged my utility to install green infrastructure (please describe)
- .....NO, these situations did not encourage my utility to install green infrastructure (please describe)
- .....Don't know

e) Would you say that the cost of green infrastructure was usually higher than the cost of grey infrastructure, usually lower, or about the same?

- .....Usually higher
- .....About the same
- .....Usually lower

Appendix II: Questionnaires Used in the Survey

19. Regarding your experiences regarding the effectiveness of green infrastructure used to meet consent decree requirements:

a) Were there situations where confidence in the effectiveness of green infrastructure was lower than confidence in the effectiveness of grey infrastructure?

- .....YES, there were situations where confidence was lower
- .....NO, there were not situations where confidence was lower (SKIP to c)
- .....Don't know

b) In these situations, did the lower confidence discourage your utility from installing green infrastructure?

- .....YES, these situations discouraged my utility from installing green infrastructure (please describe)
- .....NO, these situations did not discourage my utility from installing green infrastructure (please describe)
- .....Don't know

c) Were there situations where confidence in the effectiveness of green infrastructure was higher than confidence in the effectiveness of grey infrastructure?

- .....YES, there were situations where confidence was higher
- .....NO, there were not situations where confidence was higher (SKIP to e)
- .....Don't know

d) In these situations, did the higher confidence encourage your utility to install green infrastructure?

- .....YES, these situations encouraged my utility to install green infrastructure (please describe)
- .....NO, these situations did not encourage my utility to install green infrastructure (please describe)
- .....Don't know

e) Would you say confidence in the effectiveness of green infrastructure was usually higher than confidence in the effectiveness of grey infrastructure, usually lower, or about the same?

- .....Usually higher
  - .....About the same
  - .....Usually lower
- Regarding your experiences with political and public opinion regarding green infrastructure used to meet consent decree requirements.

20. Were there situations where political and public opinion regarding green infrastructure was more negative than political and public opinion regarding grey infrastructure?

- .....YES, there were situations where opinion was more negative
- .....NO, there were not situations where opinion was more negative (SKIP to c)
- .....Don't know

---

Appendix II: Questionnaires Used in the Survey

---

- a) In these situations, did the negative opinion discourage your utility from installing green infrastructure?
- .....YES, these situations discouraged my utility from installing green infrastructure (please describe)
  - .....NO, these situations did not discourage my utility from installing green infrastructure (please describe)
  - .....Don't know
- b) Were there situations where political and public opinion regarding green infrastructure was more positive than opinions regarding grey infrastructure?
- .....YES, there were situations where opinion was more positive
  - .....NO, there were not situations where opinion was more positive (SKIP to e)
  - .....Don't know
- c) In these situations, did the positive opinion regarding green infrastructure encourage your utility to install green infrastructure?
- .....YES, these situations encouraged my utility to install green infrastructure (please describe)
  - .....NO, these situations did not encourage my utility to install green infrastructure (please describe)
  - .....Don't know
- d) Would you say that political and public opinion regarding green infrastructure was usually more positive than political and public opinion regarding grey infrastructure, usually less positive, or about the same?
- .....Usually more positive
  - .....About the same
  - .....Usually less positive

Appendix II: Questionnaires Used in the Survey

**Spending to Incorporate Green Infrastructure Practices for the last 3 fiscal years**

Note: similar to the previous set of questions, we are interested in green infrastructure intended, at least in part, to meet a consent decree requirement. However, for this set of questions, we are interested in the cost of green infrastructure that was incurred by the utility with the consent decree (NOT by others). We are asking for data for the utility's last 3 full fiscal years.

21. For the last 3 full fiscal years, thinking about the your total capital expenditures to meet the requirements of the consent decree:

a) Does your utility have documentation that distinguishes between the amount of capital expenditures that your utility spent on green infrastructure versus the amount that it spent on gray infrastructure?

- .....YES
- .....NO (Conclude interview)

b. What are the dates of your fiscal year?

c. How much did your system spend on capital expenditure for green infrastructure for each of the last 3 FYs?

Green FY  
Amount

Green FY  
Amount

Green FY  
Amount

d. How much did your system spend on capital expenditure for grey infrastructure for each of the last 3 FYs?

Grey FY  
Amount

Grey FY  
Amount

Grey FY  
Amount

e. What is the source of this information? If there is documentation, please provide us with that documentation and guidance on where in the documentation we can find the capital expenditures for green infrastructure and grey infrastructure.

22. Did your utility fund the green infrastructure capital expenditure you told us about from any of the following sources?

a) Clean Water State Revolving Fund (CWSRF)  
.....Yes  
.....No  
.....Don't know

b) Public-private funding  
.....Yes  
.....No  
.....Don't know

c) Federal grants  
.....Yes  
.....No  
.....Don't know

d) Other grants  
.....Yes  
.....No  
.....Don't know

e) Bonds, general revenue  
.....Yes  
.....No  
.....Don't know

f) Stormwater Fee  
.....Yes  
.....No  
.....Don't know

g) Other sources  
.....Yes  
If yes, please explain below  
.....No  
.....Don't know



# Appendix III: Comments from the Environmental Protection Agency



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON, D.C. 20460

SEP 14 2017

OFFICE OF WATER

Mr. Alfredo Gomez  
Director  
Natural Resources and Environment  
U.S. Government Accountability Office  
Washington, D.C. 20548

Dear Mr. Gomez:

Thank you for the opportunity to review and comment on the Government Accountability Office's (GAO) draft report, *Stormwater Management: EPA Pilot Project to Increase Use of Green Infrastructure Could Benefit from Documenting Collaborative Agreements* (GAO-17-750). The purpose of this letter is to provide the Environmental Protection Agency's (EPA) response to the draft report's findings, conclusions, and recommendation and to convey EPA's technical corrections.

The draft report states that GAO was tasked to (1) describe the extent to which selected municipal utilities are incorporating, and funding, green infrastructure into stormwater management efforts; (2) describe challenges municipal utilities reported facing to incorporate green infrastructure into stormwater management efforts; and (3) examine efforts EPA is taking to help municipal utilities use green infrastructure.

The EPA generally agrees with the GAO's findings, conclusions, and recommendations. Communities cannot afford to wait to address the flooding and public health hazards of stormwater: the curb and gutter (gray infrastructure) approach alone to managing stormwater is not enough to address these risks. In the past several years, many cities have found that an effective, comprehensive, long-term approach to managing stormwater includes green infrastructure practices that manage rain where it falls.

Comprehensive, long-term planning for stormwater management - integrating stormwater with economic development, transportation, recreation and other planning - supports smart investments and new funding sources. Communities are finding the benefits from such long-term approaches go well beyond helping to meet regulatory requirements and turn hazards into opportunities for their communities

While EPA expects its long-term stormwater planning efforts will help increase implementation of green infrastructure, the focus of the initiative is broader - to aid communities in improving stormwater management over the long term and to look for integrated approaches to reduce treatment costs, provide adequate water supplies and protect local waterbodies. EPA is committed to helping communities avoid missed opportunities for better public health and environmental protection.

Internet Address (URL) • <http://www.epa.gov>  
Recycled/Recyclable • Printed with Vegetable Oil Based Inks on 100% Postconsumer Process Chlorine Free Recycled Paper

EPA recommends that the final report include a more detailed and robust discussion of the questionnaire results and site visits in the appendices in order to help EPA continue to focus our robust efforts to help communities more effectively incorporate green infrastructure.

EPA notes that its voluntary long-term stormwater planning efforts launched with the release of its draft guide *Community Solutions for Stormwater Management: A Guide for Voluntary Long-term Planning* is a new project for EPA. Thus, the agency is still in the beginning stages of working with communities on its first pilot projects and is still working to assemble stakeholders. The agency's response to the report's recommendation related to its pilot projects is provided below. We have also provided technical comments as an attachment.

**GAO Recommendation:**

The Director of EPA's Office of Wastewater should, when working with municipal utilities and other stakeholders, document agreements on how they will collaborate, such as in a memorandum of understanding, aligned with our key considerations for implementing interagency collaborative mechanisms.

**EPA Response:**

- EPA generally agrees with the recommendation.
- EPA is still in the early stages of these pilot projects and will utilize the collaborative practices recommended by GAO in these pilot projects which are projected to take place over the next 12-18 months.

Thank you again for the opportunity to review this draft and for the hard work of your staff on this engagement. We would like to acknowledge your staff for their comprehensive contributions to this engagement, especially recognizing their efforts on the in-depth survey of municipalities on their green infrastructure. If you have any questions on this response, please contact Chris Kloss, Chief, Municipal Branch at 202-564-1438.

Sincerely,



Michael H. Shapiro  
Acting Assistant Administrator

Enclosure

cc: EPA GAO Liaison Team

---

# Appendix IV: GAO Contact and Staff Acknowledgments

---

## GAO Contact

J. Alfredo Gómez, (202) 512-3841 or [gomezj@gao.gov](mailto:gomezj@gao.gov)

---

## Staff Acknowledgments

In addition to the contact named above, Susan Iott (Assistant Director), Rodney Bacigalupo, Mark Braza, John W. Delicath, Elizabeth M. Dretsch, Charles Egan, Richard P. Johnson, Ilga Semeiks, and Sarah Veale made key contributions to this report.

---

---

## GAO's Mission

The Government Accountability Office, the audit, evaluation, and investigative arm of Congress, exists to support Congress in meeting its constitutional responsibilities and to help improve the performance and accountability of the federal government for the American people. GAO examines the use of public funds; evaluates federal programs and policies; and provides analyses, recommendations, and other assistance to help Congress make informed oversight, policy, and funding decisions. GAO's commitment to good government is reflected in its core values of accountability, integrity, and reliability.

---

## Obtaining Copies of GAO Reports and Testimony

The fastest and easiest way to obtain copies of GAO documents at no cost is through GAO's website (<http://www.gao.gov>). Each weekday afternoon, GAO posts on its website newly released reports, testimony, and correspondence. To have GAO e-mail you a list of newly posted products, go to <http://www.gao.gov> and select "E-mail Updates."

---

## Order by Phone

The price of each GAO publication reflects GAO's actual cost of production and distribution and depends on the number of pages in the publication and whether the publication is printed in color or black and white. Pricing and ordering information is posted on GAO's website, <http://www.gao.gov/ordering.htm>.

Place orders by calling (202) 512-6000, toll free (866) 801-7077, or TDD (202) 512-2537.

Orders may be paid for using American Express, Discover Card, MasterCard, Visa, check, or money order. Call for additional information.

---

## Connect with GAO

Connect with GAO on [Facebook](#), [Flickr](#), [LinkedIn](#), [Twitter](#), and [YouTube](#). Subscribe to our [RSS Feeds](#) or [E-mail Updates](#). Listen to our [Podcasts](#). Visit GAO on the web at [www.gao.gov](http://www.gao.gov) and read [The Watchblog](#).

---

## To Report Fraud, Waste, and Abuse in Federal Programs

Contact:

Website: <http://www.gao.gov/fraudnet/fraudnet.htm>

E-mail: [fraudnet@gao.gov](mailto:fraudnet@gao.gov)

Automated answering system: (800) 424-5454 or (202) 512-7470

---

## Congressional Relations

Katherine Siggerud, Managing Director, [siggerudk@gao.gov](mailto:siggerudk@gao.gov), (202) 512-4400, U.S. Government Accountability Office, 441 G Street NW, Room 7125, Washington, DC 20548

---

## Public Affairs

Chuck Young, Managing Director, [youngc1@gao.gov](mailto:youngc1@gao.gov), (202) 512-4800, U.S. Government Accountability Office, 441 G Street NW, Room 7149, Washington, DC 20548

---

## Strategic Planning and External Liaison

James-Christian Blockwood, Managing Director, [spel@gao.gov](mailto:spel@gao.gov), (202) 512-4707, U.S. Government Accountability Office, 441 G Street NW, Room 7814, Washington, DC 20548



Please Print on Recycled Paper.