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ENHANCING SUSTAINABLE COMMUNITIES WITH GREEN INFRASTRUCTURE

A GUIDE TO HELP COMMUNITIES BETTER MANAGE STORMWATER WHILE ACHIEVING OTHER ENVIRONMENTAL, PUBLIC HEALTH, SOCIAL, AND ECONOMIC BENEFITS

Office of Sustainable Communities
Smart Growth Program

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Executive Summary

Communities across the country want to protect their water quality while also getting the greatest possible benefit out of every investment they make. Many are conserving, restoring, or enhancing natural areas while incorporating trees, rain gardens, vegetated roofs, and other practices that mimic natural systems into developed areas to manage rainwater where it falls. These types of approaches, known as "green infrastructure," are an integral component of sustainable communities primarily because they can help communities protect the environment and human health while providing other social and economic benefits, allowing communities to achieve more for their money. Using green infrastructure strategies to reduce stormwater runoff can strengthen efforts to preserve open space and natural areas and encourage development in existing communities. Green infrastructure elements help make neighborhood streets and greenways pleasant and safe for walking and biking and reinforce a sense of place. Integrating green infrastructure and sustainable communities encourages collaboration in development decisions and promotes green building practices.

Engaging the entire community creates a vision for the future based on people's and businesses' needs, desires, and aspirations. This vision guides the plan and ultimately implementation. A sustainable communities and green infrastructure plan will touch nearly every aspect of a community's design. Involving a wide range of community members in developing both the vision and the plan creates broad support and encourages multiple champions to emerge to handle different aspects of implementation. Such broad-based involvement also helps ensure people from all walks of life, including vulnerable and disadvantaged populations, can share in the benefits that come from implementing a green infrastructure plan.

Successful plans include clear goals, an assessment of assets and opportunities, a comprehensive look at how to achieve implementation, a means for funding implementation, a way to monitor and measure progress toward achieving the community's goals, and a strategy for long-term operations and maintenance. With such a plan in place, a community will be well on its way to improving quality of life, protecting the environment, improving public health, becoming economically stronger, and preparing for climate change impacts.

I. Introduction

Communities across the country want to protect their water quality while also getting the greatest possible benefit out of every investment they make. Many are conserving, restoring, or enhancing natural areas while incorporating trees, rain gardens, vegetated roofs, and other practices that mimic natural systems into developed areas to manage rainwater where it falls. Using these types of approaches, known as "green infrastructure," to reduce stormwater and pollution runoff is a way of protecting water quality while achieving cobenefits that can include improved public health, better quality of life, and economic development.

Green infrastructure can improve water quality, attract investment, revive distressed neighborhoods, encourage redevelopment, and provide recreational opportunities.

In eastern Los Angeles County, California, the organization Amigos de los Rios is working with a coalition of 62 government agencies and other organizations to implement the Emerald Necklace Vision, a plan to integrate green infrastructure throughout a new 17-mile loop of interconnected parks and greenways.[1] Each park serves multiple purposes, including improving public health by encouraging use of the trail system, providing recreation opportunities in underserved communities, supporting biodiversity and creating habitat, providing job training for young people, encouraging walking and bicycling, and reducing ambient air temperatures. For example, the organization created Lashbrook Park along an existing bike trail by constructing a bioswale filled with native, drought-tolerant plants along the park's length to infiltrate stormwater, adding picnic areas and benches, and installing interpretive signage in the Tongva Indian language.[2]

Green infrastructure can not only help improve water quality by better managing stormwater—sometimes even at a lower cost than conventional alternatives—but also can attract investment; help revive distressed neighborhoods; encourage redevelopment; provide recreational opportunities; and help achieve other social, economic, public health, and environmental goals. This document aims to help local governments, water utilities, nonprofit organizations,

[1] Amigos de los Rios. "Emerald Necklace Forest to Ocean Expanded Vision Plan." http://www.amigosdelosrios.org/the-emerald-necklace-vision-plan. Accessed May 28, 2014.
[2] Amigos de los Rios. "Multi-Objective Park Projects." http://www.amigosdelosrios.org/multi-benefit-projects. Accessed May 28, 2014.

neighborhood groups, and other stakeholders integrate green infrastructure strategies into plans that can transform their communities. Many communities that want to use green infrastructure approaches face technical, regulatory, financial, and institutional obstacles that limit widespread implementation.[3] This document serves as a guide to develop a plan that can overcome these obstacles for neighborhoods, towns, cities, and regions of all sizes. It helps stakeholders create a vision for how green infrastructure can enhance their communities—a vision that engages residents and inspires them to take action. It also directs readers to other resources that provide more detailed information that can be tailored to communities' particular climate, goals, and circumstances. This introductory section describes:

A. What green infrastructure is.
B. What sustainable communities are.
C. Why green infrastructure is an integral component of sustainable communities.

Following the introduction,

- Section II describes strategies that support both sustainable communities and green infrastructure.
- Section III explains how to organize stakeholders.
- Section IV outlines the different activities that are part of developing a sustainable communities and green infrastructure plan.
- Section V concludes with a review of best practices for creating a sustainable communities and green infrastructure plan.

A. Green Infrastructure

In developed areas, much of the land is covered by buildings, pavement, and other impermeable surfaces that prevent rain and snowmelt from soaking into the ground. Instead, this water runs off, often flowing directly to streams, rivers, and other water bodies. It can carry pollutants such as oil, chemicals, and lawn fertilizers. In addition, the quantity and speed of flow can cause erosion, flooding, and damage to aquatic habitat, property, and infrastructure.

Green infrastructure includes a range of approaches for managing stormwater near where it falls. Most green infrastructure uses the natural processes of soils and vegetation to capture, slow down, and filter runoff, often allowing it to recharge ground water, but some practices

[3] U.S. Water Alliance. *Barriers and Gateways to Green Infrastructure*. 2011. http://www.uswateralliance.org/news-media/alliance-publications/barriers-and-gateways-to-green-infrastructure.

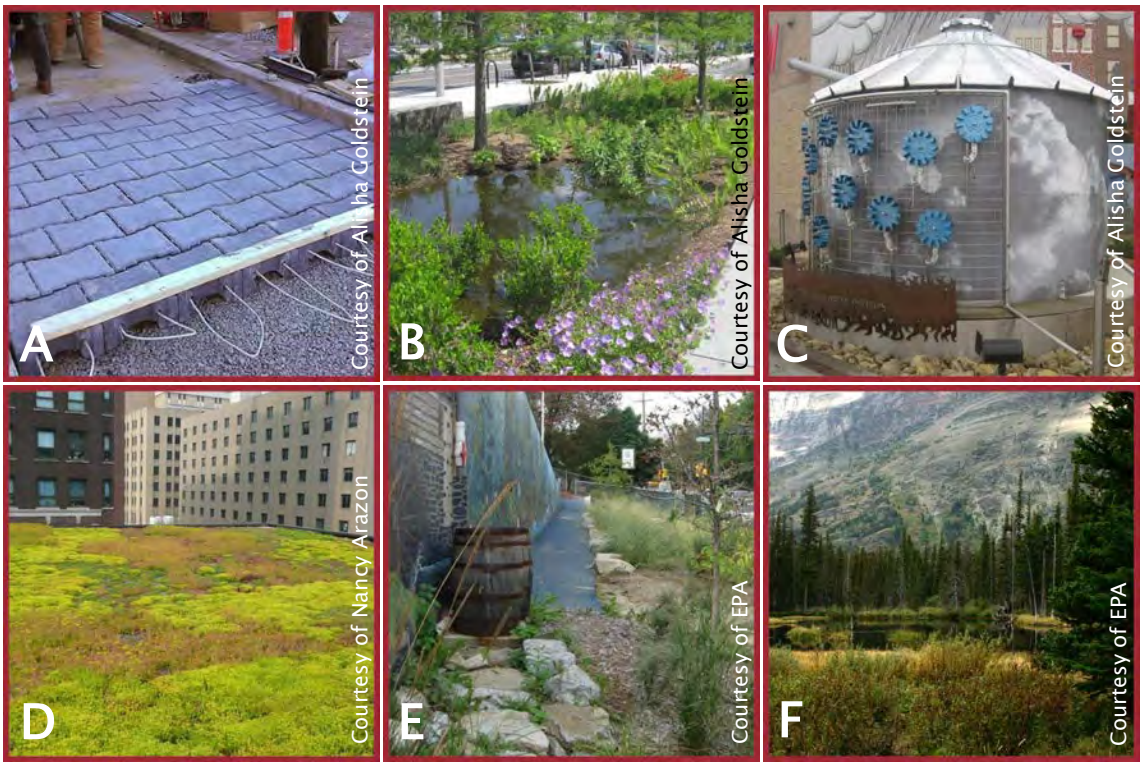

Exhibit 1. Green Infrastructure Approaches. Green infrastructure approaches range from site-scale practices, including (A) permeable pavement, (B) rain gardens, (C) cisterns, (D) green roofs, and (E) rain barrels, to watershed-level approaches such as (F) wetland preservation.

collect and store rain water for future use. Some techniques, including using permeable pavements, bioswales, rain gardens, vegetated or "green" roofs, rain barrels, and cisterns, work at the site scale and can fit into individual development, redevelopment, or retrofit projects. Larger-scale management strategies, including preserving or restoring flood plains, open space, wetlands, and forests, can be used at the watershed level.[4]

In contrast to green infrastructure, stormwater in cities has historically been managed by expansive and capital-intensive underground storm sewer systems. This "gray infrastructure" has the single purpose to collect and carry runoff from city streets, parking lots, and other impervious surfaces as quickly as possible. Many communities are now looking to combine gray and green infrastructure approaches to manage stormwater to achieve multiple community goals. The most appropriate techniques in a given location will depend on goals, budget, and other context-specific factors, but green infrastructure can be designed to work in nearly all

[4] For a complete description of different green infrastructure approaches, see: EPA. "What is Green Infrastructure?" http://water.epa.gov/infrastructure/greeninfrastructure/gi_what.cfm. Accessed May 7, 2014.

Exhibit 2. Green infrastructure in arid climates, Tuscon, Arizona.
Curb extensions with inlets to collect rainwater from the street show how even arid climates can use green infrastructure to manage stormwater and make neighborhoods more attractive.

areas. For example, many people think of green infrastructure as an approach only for wet climates. However, it can also manage stormwater and conserve water resources in arid regions if designers select plants for their drought tolerance and use other landscaping techniques that reduce the need for irrigation.[5]

B. Sustainable Communities

Sustainable communities are places that balance their economic assets, natural resources, and social priorities so that residents' diverse needs can be met now and in the future. These communities prosper by attracting and retaining businesses and people and offering individuals of all incomes, races, and ethnicities access to the opportunities, services, and amenities they need to thrive. To become more environmentally and economically sustainable, many communities use smart growth approaches—a range of strategies that cities, suburbs, towns, and rural areas can use to protect the environment and public health, support economic development, create strong neighborhoods with diverse housing and transportation options, and improve residents' quality of life. Exhibit 3 lists the principles that underlie smart growth strategies.[6]

[5] For more information about adapting green infrastructure techniques to water-limited regions, see: EPA. *Green Infrastructure in Arid and Semi-Arid Climates.* 2010. http://www.epa.gov/npdes/pubs/arid_climates_casestudy.pdf.
[6] For more information about sustainable communities and smart growth approaches, see: EPA. "Smart Growth." http://www.epa.gov/smartgrowth/index.htm. Accessed May 7, 2014.

Exhibit 3: Smart Growth Principles

In 1996, the Smart Growth Network—a group of more than 30 national organizations representing a range of interests including real estate; the environment; community development; affordable housing; and local, state, and federal government—developed 10 smart growth principles:

- Mix land uses.
- Take advantage of compact building design.
- Create a range of housing opportunities and choices.
- Create walkable neighborhoods.
- Foster distinctive, attractive communities with a strong sense of place.
- Preserve open space, farmland, natural beauty, and critical environmental areas.
- Strengthen and direct development towards existing communities.
- Provide a variety of transportation choices.
- Make development decisions predictable, fair, and cost effective.
- Encourage community and stakeholder collaboration in development decisions.

Source: Smart Growth Network. "Why Smart Growth?" http://www.smartgrowth.org/why.php. Accessed November 26, 2013.

C. Green Infrastructure Is an Integral Component of Sustainable Communities

Green infrastructure is an integral component of sustainable communities primarily because it can help communities protect the environment and human health while providing other social and economic benefits. In addition, green infrastructure and sustainable communities approaches can help local governments that are struggling to pay for needed upgrades to stormwater and wastewater infrastructure that is beyond its intended lifespan. These challenges are likely to grow as a changing climate further strains public infrastructure and municipal finances. For example, the projected increase in extreme weather events will likely increase service disruptions in some locations, particularly those near climate-sensitive environmental features like coastlines, rivers, storm paths, and vegetation in arid regions.[7] Adapting infrastructure so that it is more resilient to these types of changes will be expensive.

1. Benefits

Many communities need significant investments to upgrade existing water infrastructure and prefer solutions that are not only cost effective but also provide additional benefits. Many property owners see their role in stormwater management as solely to ensure that it flows from

[7] Wilbanks, Thomas J., and Steven J. Fernandez. *Climate Change and Infrastructure, Urban Systems, and Vulnerabilities*. U.S. Department of Energy. 2014. http://www.eenews.net/assets/2014/03/06/document_cw_01.pdf.

their property as quickly as possible to prevent flooding—property owners have largely not had to concern themselves with where stormwater goes. Now, as communities are facing mounting bills for safely dealing with that stormwater, they are hoping to shift public understanding so property owners recognize stormwater as something they should either manage on site or pay to have removed, much as they have long been used to paying for snow removal and municipal trash service. Green infrastructure offers a way to address this challenge: it provides tools for property owners to manage stormwater themselves, and it offers additional tangible environmental, economic, public health, and social benefits (Exhibit 4).

Exhibit 4: Potential Green Infrastructure Benefits

- Improved water quality.
- Reduced municipal water use.
- Ground water recharge.
- Flood risk mitigation.
- Increased resilience to climate change impacts such as heavier rainfalls, hotter temperatures, and higher storm surges.
- Reduced ground-level ozone.
- Reduced particulate pollution.
- Reduced air temperatures in developed areas.
- Reduced energy use and associated greenhouse gas emissions.
- Increased or improved wildlife habitat.
- Improved public health from reduced air pollution and increased physical activity.
- Increased recreation space.
- Improved community aesthetics.
- Cost savings.
- Green jobs.
- Increased property values.

For example, green infrastructure and sustainable communities strategies can help communities adapt to climate change. Many communities are not adequately prepared for current weather extremes, much less projected future impacts. Depending on the region, these changes could include higher temperatures, more extreme weather events, changes in precipitation patterns, and sea-level rise. These changes can strain water infrastructure, reduce water supplies, worsen water and air pollution, and increase flooding because of more intense downpours and higher storm surges.[8] Sustainable communities strategies can help communities become more resilient to these challenges by encouraging development in safer locations, promoting water- and energy-efficient buildings and neighborhoods, providing transportation options that people can use every day as well as in an emergency, and helping protect the populations most vulnerable to climate change impacts—the very old and very young; people with chronic health problems; non-English speakers; and residents of low-

[8] For assessments of regional climate change impacts, see: Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds. *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program. 2014. http://nca2014.globalchange.gov.

income, minority, and overburdened communities.[9] Incorporating green infrastructure can further increase community resilience by filtering polluted stormwater, recharging ground water supplies, reducing ambient air temperatures by adding greenery, and providing retention areas that slow runoff.[10,11]

Recognizing such benefits, the city of Chicago's Climate Action Plan calls for 6,000 new green roofs, more than a million new trees, a watershed plan that factors in changes expected due to climate change, and other actions.[12] In the first two years after implementation, more than 4 million square feet of green roofs were completed or planned, and 32,000 square feet of Chicago alleyways were reconstructed with permeable materials.[13]

Exhibit 5. Green roof on City Hall, Chicago, Illinois. The city of Chicago created a green roof on its city hall to test the performance of the technology and understand how green roofs could help the city achieve its climate action goals. The roof can be as much as 30 degrees cooler than surrounding roofs in the summer. It reduces the use of air conditioning in the building while absorbing rainfall that would otherwise run into storm sewers.

Unlike gray infrastructure, which serves only to manage stormwater, green infrastructure allows a local government to make the most of limited public dollars and achieve multiple goals with a single investment. Many cities already take advantage of the multiple benefits of green infrastructure. The watershed management plan of Portland, Oregon, for example, prioritizes areas ripe for redevelopment and infill when deciding where to make green infrastructure

[9] For more information on how sustainable communities strategies can help communities prepare for climate change, see: EPA. *Using Smart Growth Strategies to Create More Resilient Communities in the Washington, D.C., Region*. 2013. http://www.epa.gov/smartgrowth/sgia_communities.htm#dc.

[10] Garrison, Noah, Robert C. Wilkinson, and Richard Horner. *A Clear Blue Future.* Natural Resources Defense Council and the University of California, Santa Barbara. 2009. http://www.nrdc.org/water/lid.

[11] For more information on how green infrastructure can create communities more resilient to climate change, see: EPA. *Green Infrastructure for Climate Resiliency*. 2014. http://water.epa.gov/infrastructure/greeninfrastructure/upload/climate_res_fs.pdf.

[12] City of Chicago. *Chicago Climate Action Plan.* Undated. http://www.chicagoclimateaction.org.

[13] City of Chicago. *Chicago Climate Action Plan Progress Report 2008–2009: The First Two Years*. 2010. http://www.chicagoclimateaction.org/pages/ccap_progress_report/81.php.

investments to simultaneously encourage economic activity and improve watershed health in ways that are cost effective and equitable.[14] Grand Rapids, Michigan's master plan update recognizes that green infrastructure could solve several community challenges, including loss of tree canopy and park space, the demand for more walking and biking trails, and limited availability of fresh, local food.[15] It recommends strategies to acquire additional parkland in underserved neighborhoods, expand the off-street bicycle network, and remove barriers to the expansion of community gardening.

Green infrastructure allows a local government to make the most of limited public dollars and achieve multiple goals with a single investment.

2. Potential Cost Savings Compared to Gray Infrastructure

Every 4 years, the U.S. Environmental Protection Agency (EPA) prepares a report to Congress, based on a survey of states, on the unfunded capital costs for projects to address water quality or water quality-related health problems.[16] As of 2008, states had identified the need for $63.6 billion to address combined sewer system overflows[17] and $42.3 billion for stormwater management.

One approach to address combined sewer overflows is to replace a single combined sewer system with separate storm and sanitary sewer systems. Directing storm sewer flows directly to waterways and sanitary sewer flows to treatment plants can ensure that the sanitary sewer system does not exceed capacity during periods of heavy rain or snowmelt. However, system separation is expensive and leaves untreated stormwater flowing directly to rivers, lakes, and estuaries. Another approach is to construct underground facilities that can hold excess wastewater from combined sewer systems until a treatment plant has the capacity to handle it. However, underground storage facilities are expensive and take many years to construct. By contrast, cities can implement green infrastructure solutions over time and produce incremental results towards achieving their long-term goals.

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[14] City of Portland. *Actions for Watershed Health: Portland Watershed Management Plan.* 2005. http://www.portlandoregon.gov/bes/38965.
[15] City of Grand Rapids. *Green Grand Rapids.* 2011. http://grcity.us/design-and-development-services/Planning-Department/Green-Grand-Rapids/Pages/default.aspx.
[16] EPA. *Clean Watersheds Needs Survey.* 2008. http://water.epa.gov/scitech/datait/databases/cwns.
[17] Combined sewer systems collect stormwater runoff, domestic sewage, and industrial wastewater in the same pipe. Most of the time, combined sewer systems transport all of their wastewater to a sewage treatment plant. During periods of heavy rainfall or snowmelt, however, the wastewater volume can exceed the system's capacity resulting in an overflow to nearby streams, rivers, or other water bodies.

In some cases, green infrastructure can reduce costs by decreasing the amount of stormwater gray infrastructure systems must be designed to manage. For example, in 2013, EPA approved a plan by the Metropolitan Sewer District of Greater Cincinnati to control combined sewer overflows stemming from the Lower Mill Creek service area using green infrastructure, along with strategic sewer separation and other methods.[18] This approach using both gray and green infrastructure is projected to save $150 million compared to the city's original plan to construct a deep tunnel stormwater storage area—even before considering other potential economic benefits.[19]

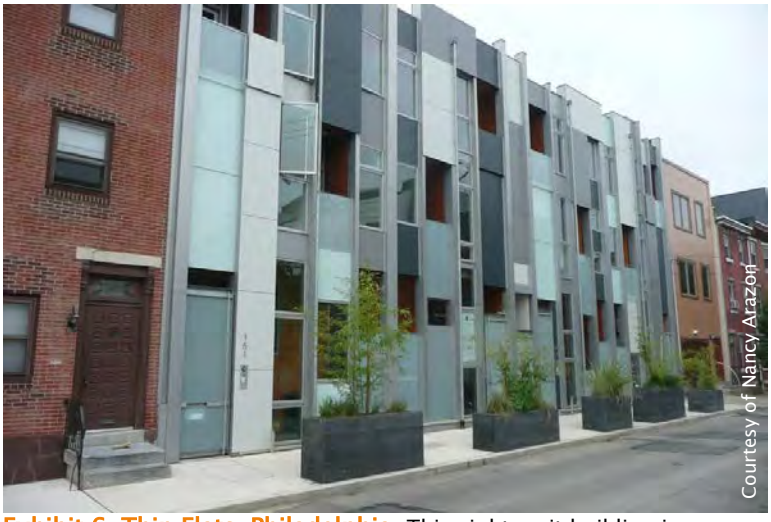

Exhibit 6. Thin Flats, Philadelphia. This eight-unit building in Philadelphia's Northern Liberties neighborhood achieved LEED Platinum certification for its environmentally sustainable features that include a green roof and underground cisterns that store rainwater to irrigate backyard gardens.

The Philadelphia Water Department commissioned a study comparing alternatives for controlling its combined sewer overflows that measured the value of various environmental, social, public health, and other benefits.[20] Across all city watersheds, the total net benefits over 40 years ranged from $1.9 billion (in 2009 dollars) for an option that included managing 25 percent of impervious surfaces in the city through green infrastructure to $4.5 billion for an option that included managing 100 percent of impervious surfaces through green infrastructure. The total net benefits for options that included managing stormwater through a system of storage

[18] EPA. "Hamilton County, Ohio — Revised Original Lower Mill Creek Sewer Overflow Partial Remedy." http://www.epa.gov/Region5/water/lowermillcreek/. Accessed Mar. 11, 2014.
[19] New public investments that make surrounding real estate more desirable and raise property values can result in unintended adverse consequences for low-income residents without strong community engagement with affected residents and careful planning to avoid displacement. For information on strategies and tools to help communities achieve more equitable development, see: EPA. "Smart Growth and Equitable Development." http://www.epa.gov/smartgrowth/equitabledev.htm.
[20] City of Philadelphia Water Department. *Philadelphia Combined Sewer Overflow Long Term Control Plan Update: Triple Bottom Line Analysis.* 2009. http://www.phillywatersheds.org/ltcpu/Vol02_TBL.pdf.

tunnels ranged from just $61.6 to $140 million over the same period, depending on the size of the tunnel system.

Green infrastructure can also save money for places that do not have combined sewer systems needing upgrades. An EPA report on 17 projects using site-scale green infrastructure found that in most cases, green infrastructure was cheaper and performed better environmentally than conventional stormwater management.[21] A report by the Natural Resources Defense Council reviewing published research on the benefits to owners of commercial buildings that incorporate well-designed green infrastructure found that they can command higher rents and property values, increase retail sales, save energy, reduce maintenance costs, reduce flood damage costs, reduce water bills, lower crime, and improve health and job satisfaction for employees.[22]

Maintenance cost comparisons have also shown that green infrastructure practices can be less expensive than conventional gray infrastructure, although more research is needed to help communities make informed decisions based on their particular context and the types of green infrastructure approaches used.[23] Green infrastructure approaches have not been used as extensively or as long as gray infrastructure for stormwater management, so actual operations and maintenance costs are not as well documented. However, EPA and the Water Environment Research Foundation developed a set of spreadsheet tools to help users calculate capital and long-term maintenance costs for several green infrastructure practices, including retention ponds, permeable pavement, and green roofs.[24]

Tools are also available to help communities evaluate the potential cost savings and economic benefits of green infrastructure. For example, the Center for Neighborhood Technology and American Rivers developed a method to evaluate the economic, environmental, and social benefits of green infrastructure.[25] Their guide includes examples illustrating the potential economic and nonmonetary value of multiple benefits, including reduced water treatment needs, increased ground water recharge, and improved neighborhood aesthetics. The Center for

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[21] EPA. *Reducing Stormwater Costs Through Low-Impact Development (LID) Strategies and Practices.* 2007. http://water.epa.gov/polwaste/green/costs07_index.cfm.
[22] Natural Resources Defense Council. *The Green Edge: How Commercial Property Investment in Green Infrastructure Creates Value*. 2013. http://www.nrdc.org/water/commercial-value-green-infrastructure.asp.
[23] American Rivers and Green for All. *Staying Green: Strategies to Improve Operations and Maintenance of Green Infrastructure in the Chesapeake Bay Watershed.* 2013. http://greenforall.org/focus/water/staying-green-strategies-to-improve-operations-and-maintenance-of-green-infrastructure-in-the-chesapeake-bay-watershed.
[24] Pomeroy, Christine and Jeff Moeller. *BMP and LID Whole Life Cost Models: Version 2.0*. Water Environment Research Federation. 2009. http://www.werf.org/i/a/Ka/Search/ResearchProfile.aspx?ReportId=SW2R08.
[25] Center for Neighborhood Technology and American Rivers. *The Value of Green Infrastructure: A Guide to Recognizing Its Economic, Environmental and Social Benefits*. 2010. http://www.americanrivers.org/newsroom/resources/the-value-of-green-infrastructure.

Neighborhood Technology also developed a National Green Values™ calculator to quickly estimate the performance, costs, and benefits of green infrastructure compared to conventional stormwater management practices.[26] Other resources for estimating the costs and benefits of alternative approaches to stormwater management are available on EPA's Green Infrastructure website.[27]

[26] Center for Neighborhood Technology. "Green Values® National Stormwater Management Calculator." http://greenvalues.cnt.org/national/calculator.php. Accessed Jan. 27, 2014.
[27] EPA. "Green Infrastructure Cost-Benefit Resources." http://water.epa.gov/infrastructure/greeninfrastructure/gi_costbenefits.cfm. Accessed Jan. 27, 2014.

II. Strategies That Support Sustainable Communities and Green Infrastructure

While storm sewers and other types of gray infrastructure are built below ground, much of green infrastructure is visible at the ground level. Sustainable communities that fully integrate green infrastructure approaches use community design to help simultaneously achieve environmental, economic, and social goals. These goals include improving water quality, revitalizing neighborhoods, reducing flood risk, and providing recreational areas that encourage physical activity. Community planners can enhance these and other benefits by selecting the types and locations of green infrastructure approaches that best support their goals.

Communities need to be particularly thoughtful when applying green infrastructure in areas where space is most valuable, such as in compact neighborhoods—the very places where past development has contributed to serious water quality problems. Many older cities and towns face serious challenges in better managing stormwater to improve water quality, address overflows from combined storm and sanitary sewer systems, and reduce flooding. Green infrastructure could help address these problems, but the cobenefits would be greatest if designers selected practices that also achieve other community goals. For example, wide sidewalks with space for outdoor cafes, bike racks, benches, and other amenities attract people to a neighborhood, bringing customers to businesses. Downtowns might, therefore, look for green infrastructure practices that do not compete with these amenities for valuable sidewalk space. For example, street trees can be planted in tree boxes that hold soil and water underneath sidewalks made with permeable paving, allowing stormwater to infiltrate and keeping the trees healthy without encroaching on the area where people walk. Designers can often accommodate green infrastructure in the existing street width by, for example, extending curbs into the no-parking zone at intersections to both create space for a rain garden to absorb stormwater and shorten the distance needed to walk across the street (see Exhibit 14). These curb extensions also help calm traffic and protect walkers and bicyclists. Other factors for designers to consider when selecting green infrastructure practices to support sustainable communities include how well they enhance the aesthetics of public spaces and create a sense of place and whether they are compatible with compact development that puts homes and workplaces near transit stations.

Fort Collins, Colorado, tackled this issue by developing a series of prototypes to explore options for addressing flooding and water quality problems in a nearly 100 percent impervious commercial corridor where development activity is concentrated.[28] The city's evaluation revealed that if individual property owners were responsible for managing their stormwater on-site, development density would tend to decrease. Further, the city found that dispersed management responsibilities could jeopardize the long-term effectiveness of this approach. However, a regional facility located in a low-value area could treat stormwater using bioinfiltration and detain storm events to reduce downstream flooding while leaving 100 percent of the commercial district available for redevelopment. The city could acquire land for the facility by establishing a stormwater district through which property owners would be able to spread out the costs of constructing the facility.

The following strategies illustrate how green infrastructure can enhance sustainable communities' approaches and help achieve a wide range of goals, including to:

A. Preserve and Restore Open Space, Natural Beauty, and Critical Environmental Areas.
B. Create Parks, Community Gardens, and Other Public Green Spaces.
C. Direct Development Toward Existing Communities.
D. Create Compact, Mixed-Use Development.
E. Build Neighborhood Streets and Trails That Encourage Walking and Biking.
F. Cultivate Communities with a Strong Sense of Place.
G. Encourage Community and Stakeholder Collaboration in Development Decisions.
H. Promote Green Building Practices.

A. Preserve and Restore Open Space, Natural Beauty, and Critical Environmental Areas

Forests, wetlands, and other natural areas provide recreational space, shape regional identity, and support regional economies through tourism, agriculture, and other activities. In addition, protecting natural areas is often the least expensive, most efficient way to keep stormwater pollution from further degrading waterways. Natural areas serve a wealth of ecological functions that cannot be easily replaced. For example, wetlands can absorb floodwaters and buffer storm surges, protecting communities from flooding while performing ecological

[28] City of Fort Collins. *City Plan Fort Collins: Stormwater Report*. 2011. http://www.fcgov.com/planfortcollins/pdf/stormwater-report.pdf.

services like providing wildlife habitat and filtering excess nutrients and contaminants from stormwater. During Hurricane Sandy, communities with healthy dune systems had natural buffers that protected adjacent neighborhoods, while communities without healthy dunes generally suffered more damage.[29] The city of Crystal Lake, Illinois, created a green infrastructure plan that established the priority areas of the city for protection, including highly important resource areas such as river corridors and watersheds that are critical for the city's environmental health and economic vitality and secondary resource areas that could serve as important connectors in a green network.[30] The plan's benefits include reduced flooding, conservation of wildlife habitat and biodiversity, reduced infrastructure costs, and a stronger sense of place and community identity. Saratoga PLAN, a nonprofit land trust in Saratoga Springs, New York, created a toolkit for municipalities considering voluntary, incentive-based, and regulatory strategies to preserve open lands, including conservation easements, the purchase of development rights, and zoning.[31]

B. Create Parks, Community Gardens, and Other Public Green Spaces

Parks, community gardens, and other public green spaces create opportunities in built-up areas for people to gather, exercise, and connect with nature. These spaces are particularly important in low-income and disadvantaged neighborhoods because they provide critical health, social, and environmental benefits. These types of places can also readily incorporate green infrastructure into their design.

The Chicago region's comprehensive plan *GO TO 2040* recommends investing in increasing the supply of urban parks, protecting the region's most critical natural areas, and creating a network that links the region's green spaces.[32] The Chicago Metropolitan Agency for Planning, the regional planning organization, recognized that having these places helps make the Chicago area a healthier and better place to live and work, attracting residents and employees and improving economic competitiveness. Low-income communities in the region do not have enough parks for their residents, and one of *GO TO 2040's* recommendations was for the

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[29] The City of New York. *A Stronger, More Resilient New York.* 2013. http://www.nyc.gov/html/sirr/html/report/report.shtml.
[30] City of Crystal Lake and Cowhey, Gudmundson & Leder. *Green Infrastructure Vision.* 2012. http://www.chicagowilderness.org/files/4713/6854/3682/Crystal_Lake_GreenInfrastructureVision.pdf.
[31] Saratoga PLAN. "Tools for Community Planning and Conservation." http://www.saratogaplan.org/communityplanning.html. Accessed Jun. 20, 2014.
[32] Chicago Metropolitan Agency for Planning. *GO TO 2040: Comprehensive Regional Plan*. 2010. http://www.cmap.illinois.gov/about/2040.

Illinois legislature to reduce the required local match for state funds to acquire land for parks and open space for these communities. In 2013, the Illinois legislature reduced the local match from 50 percent to 10 percent for distressed communities, which should help distribute open space in the region more equitably.[33]

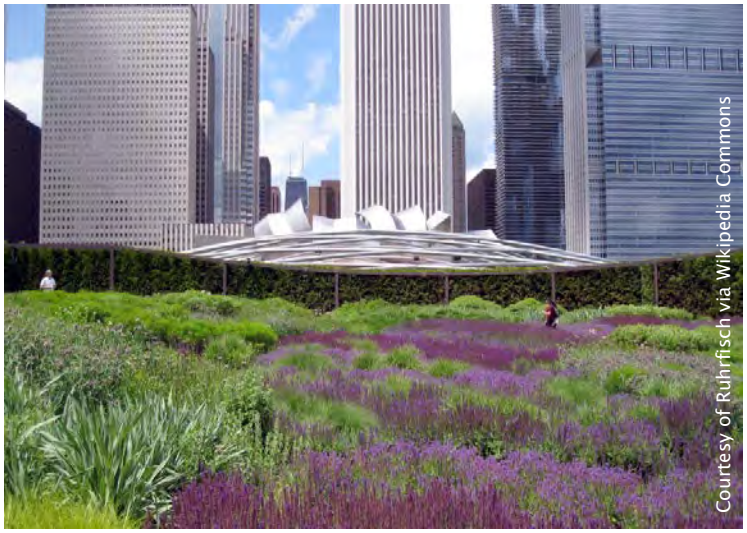

Exhibit 7. Lurie Garden, Chicago, Illinois. Lurie Garden in Millennium Park is a 2.5-acre rooftop garden on top of a parking garage. Native plants provide critical wildlife habitat while creating an urban oasis for residents and visitors.

C. Direct Development Toward Existing Communities

Investing in existing communities brings jobs and services for residents and takes advantage of past infrastructure investments. Redevelopment also spurs cleanup of historical environmental and health hazards at contaminated properties that often disproportionately affect disadvantaged populations. These actions can revitalize areas that have suffered from disinvestment, replacing underused or vacant lands with productive businesses, parks, and other community amenities. Very low levels of impervious cover have been shown to degrade watershed health.[34] Developing compactly on a redevelopment site can avoid creating new impervious surfaces that could further degrade water quality.

For example, the city of Buffalo, New York, started a program through which the city clears vacant lots to make way for rain gardens and other green infrastructure that can help improve property values and provide neighborhood parks and green space while helping the city meet

[33] Chicago Metropolitan Agency for Planning. *Moving Forward 2013.* 2014. http://www.cmap.illinois.gov/documents/10180/112663/FY14-0047%202013%20CMAP%20IMPLEMENTATION%20POSTER_FINAL.pdf/2a2f4ee3-1f36-4113-91ed-2f48f4686ee0.

[34] For a review of research on the levels of impervious cover at which watershed effects are apparent, see: EPA. *Our Built and Natural Environments.* 2013. http://www.epa.gov/smartgrowth/built.htm.

its goal of reducing the number of combined sewer overflow discharges.[35] In its 2012 comprehensive plan, Ranson, West Virginia, encourages selecting green infrastructure techniques to manage stormwater that can allow additional development in the city's Old Town while preserving its character.[36] Improving Old Town's infrastructure will ensure that the city can accommodate development downtown where it has the least impact on natural areas and the greatest economic benefits.

Exhibit 8. University Heights Collaborative Community Garden, Buffalo, New York. This newly planted community garden in Buffalo was built with the help of Grassroots Gardens, an organization dedicated to helping residents create and sustain community gardens on vacant properties in the city. Several entities, including churches, community centers, and nonprofit organizations, help maintain it.

D. Create Compact, Mixed-Use Development

Compact, mixed-use development puts buildings close together, creating neighborhoods where residents are near shops, restaurants, and services; public transit, walking, and biking are viable transportation options; and jobs are easily accessible. Strategies include constructing buildings with a mix of uses such as retail on the ground floor and offices or apartments above; reducing (or eliminating) the distance between buildings; positioning buildings closer to the street; rightsizing surface parking to meet demand while minimizing the amount of developable land it uses; and narrowing road lanes where feasible. These approaches help make a neighborhood more walkable by reducing distances between destinations and calming traffic. They also minimize the amount of land and impervious surface that is necessary for a given

[35] Buffalo Sewer Authority. "Ongoing Projects." http://bsacsoimprovements.org/cso-control-plan/ongoing-projects-2. Accessed Mar. 11, 2014.
[36] City of Ranson. *2012 Comprehensive Plan.* 2012. http://ransonrenewed.com/wp-content/uploads/2012/04/RansonCompPlan_2012_Adopted-Reduced.pdf.

unit of development, leaving more land undeveloped and able to continue to absorb rainwater and perform other ecological functions. Compact building design can be one of the most cost-effective ways to prevent additional stormwater pollution because it requires no construction or maintenance beyond what is already occurring.

The city of Chicago's comprehensive plan, *Adding Green to Urban Design*, recognizes that the city's use of resources is much more efficient than would be the case if the population were more spread out, requiring more roads and other impervious area, using more energy to operate water and wastewater infrastructure, and necessitating driving greater distances.[37] In other words, the compactness of the city is a necessary and important strategy for achieving many of its environmental goals, including improving water quality, reducing energy use, and lowering greenhouse gas emissions. Likewise, Ranson, West Virginia, established compact development as a stormwater best management practice in its 2012 comprehensive plan, recognizing that land left undeveloped is one of the most valuable and cost-effective ways to prevent additional stormwater pollution.[38]

E. Build Neighborhood Streets and Trails That Encourage Walking and Biking

Walkable neighborhoods have streets, sidewalks, and paths that are safe and appealing for pedestrians and bicyclists. Streets designed for the safety of all users are also known as "complete streets," which can encourage residents to lead healthier lifestyles. Green infrastructure plays an important role in designing streets to make a neighborhood walkable. Street trees provide shade, filter airborne pollutants, and help reduce ambient air temperatures, making walking outdoors in hot weather more comfortable. In general, adding greenery, such as a vegetated buffer between people and traffic, can also help to make the area feel more inviting. Walking and biking trails can be designed as linear community parks that link destinations, create opportunities to get around without a car, improve public health by encouraging physical activity, integrate green infrastructure throughout a community, and provide green space in underserved neighborhoods.

Roads designed primarily for automobiles are wider and tend to encourage single-story development with large areas of surface parking. All of this impervious area creates more

[37] City of Chicago. *Adding Green to Urban Design: A City for Us and Future Generations*. 2008. http://www.cityofchicago.org/city/en/depts/dcd/supp_info/green_urban_design.html.
[38] City of Ranson. Op. cit.

stormwater runoff. Although site-scale green infrastructure practices can help such places improve stormwater management, they cannot readily replace the full range of ecological functions provided by natural areas. Taking into consideration opportunities to limit impervious surfaces and preserve or restore natural areas by planning for green infrastructure across an entire neighborhood, town, or city can lead to more effective stormwater management and help maximize the other benefits of green infrastructure.

Exhibit 9. Green Street, Maplewood, Minnesota. Rain gardens along the curb capture stormwater from the street and make the neighborhood a more enjoyable place to walk.

The city of Maplewood, Minnesota, adopted a living streets policy framework, under which the city will rebuild streets after infrastructure upgrades to better accommodate walkers, bikers, and transit users while incorporating green infrastructure such as trees and rain gardens on street edges.[39] The plan helps the city turn the need to replace aging drinking water and wastewater infrastructure into an opportunity to improve streets. The city can save money by achieving multiple goals, including improving safety and environmental quality, with a single project.

F. Cultivate Communities with a Strong Sense of Place

Development that represents the values, history, culture, economy, and geography of a community is key to supporting a strong economy, vibrant neighborhoods, and a high quality of life. Green infrastructure approaches can help create vibrant, interesting neighborhoods with a strong sense of place—a unique combination of characteristics that makes a place special. Many green infrastructure approaches use plants adapted to each region's climate, helping to create a distinct identity and contribute to a neighborhood's overall aesthetic appeal, while gray

[39] Environmental Initiative. "Maplewood Living Streets Policy and Demonstration Project." http://www.environmental-initiative.org/projects/environmental-initiative-awards/2014-awards-finalists/maplewood-living-streets-policy-and-demonstration-project. Accessed Jun. 23, 2014.

Exhibit 10. Tanner Springs Park, Portland, Oregon. Tanner Springs Park collects rain falling on the park to recreate a portion of the wetland that once surrounded Tanner Creek in Portland's Pearl District. Native plants and art installations that use reclaimed railroad track and glass from a local company contribute to the sense of place.

infrastructure is almost entirely underground where it is out of sight and out of mind. Public art and green infrastructure can be integrated into a single site, each reinforcing the sense of place established by the other. Features such as fountains fed by rain water, living walls, or artist-designed stormwater infrastructure can help enliven a space and educate visitors about ways to protect water quality (see Exhibit 17).

The city of St. Paul, Minnesota, studied how public art could be integrated into green infrastructure along the city's 11-mile light rail line to manage stormwater, catalyze and support transit-oriented development, and provide benefits to all residents. The city collected examples from across the country that demonstrate community enhancements and could serve as models for its own projects (see Exhibit 11).[40]

In rural regions, vegetated areas such as forests, wetlands, grasslands, and working farms often shape the region's sense of place. Protecting and conserving these areas by directing development to existing neighborhoods and employment centers can help maintain the character that attracts tourism and supports the quality of life residents value while protecting valuable water resources. For example, Saratoga County, New York, developed a green infrastructure plan to safeguard and expand its network of parks, recreational trails, open

[40] City of St. Paul. *Strategic Stormwater Solutions for Transit-Oriented Development*. 2013. http://www.corridorsofopportunity.org/sites/default/files/Strategic_Stormwater_Solutions_for_TOD_Final_Report.pdf.

spaces, working lands, and protected areas to maintain the county's character and support its continued economic prosperity.[41]

G. Encourage Community and Stakeholder Collaboration in Development Decisions

Sustainable communities strategies involve residents, business owners, community-based organizations, and other stakeholders early and often to define and implement the community's vision and goals. Likewise, because green infrastructure can help transform how a community looks and functions, public involvement in the planning process is equally important. Community leaders might need to adapt outreach efforts to reach populations that are disadvantaged, vulnerable to displacement, and often left out of development decisions. Engaging all stakeholders early in the planning process can create needed support and help form partnerships that maintain momentum for the plan during a long implementation period.

Watershed Watch in Kentucky, Inc., a statewide organization dedicated to improving water quality, developed a plan to help communities adopt green infrastructure approaches by empowering individuals to take action through "citizen action plan teams."[42] Strategies it suggests to help residents influence local decisions about stormwater management include assessing what information resources are available; identifying applicable laws, ordinances, and regulations; coordinating planning with other interested stakeholders; identifying funding opportunities; and monitoring green infrastructure performance.

H. Promote Green Building Practices

The term "green building" refers to the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation, and deconstruction. An important aspect of green building is designing sites and structures to allow the capture, use, infiltration, or evapotranspiration of stormwater to reduce some of development's negative effects on water quality. Many green building certification programs look beyond the building envelope to techniques for environmentally sustainable stormwater management such as green

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[41] Saratoga County. *Green Infrastructure Plan for Saratoga County*. 2006. http://www.saratogaplan.org/cp_GreenInfrastructure.html.
[42] Watershed Watch in Kentucky, Inc. *The Kentucky Green Infrastructure Action Plan for Stormwater & Wet Weather Sewage Management*. 2012. http://kwalliance.org/wp-content/uploads/2013/01/ky_green_infrstruc_action_plan.pdf.

roofs, cisterns, and site-scale green infrastructure.[43] These approaches can have many benefits, including reducing stormwater runoff and storing water for landscaping and other nonpotable uses, which is particularly important in regions where water is scarce or is projected to become scarcer due to climate change.

In Redmond, Washington, the Green Building and Green Infrastructure Incentive Program encourages developers and homebuilders to incorporate green building and site-scale green infrastructure techniques into new residential developments. Techniques include retaining native vegetation, reducing impervious surface area, collecting rainwater from roofs for nonpotable uses, using pervious materials, and installing green roofs. Incentives include priority building permit processing, reductions in the required minimum lot size, and additions to allowed density.[44]

[43] To learn about the major green building certification programs, see: EPA. "Green Building Standards." http://www.epa.gov/greenbuilding/standards/index.html.
[44] City of Redmond. "Green Building Program." http://www.redmond.gov/BusinessDevelopment/DeveloperServicesCenter/GreenBuildingProgram. Accessed Mar. 12, 2014.

III. Organizing Stakeholders

The strategies that support sustainable communities and green infrastructure are diverse and touch on many aspects of a community. A variety of stakeholders can directly implement or indirectly support these strategies, and organizing these stakeholders is an important step for an organized and inclusive process. This section discusses:

A. Who can take the lead?
B. Which government entities need to be involved?
C. Which community members need to be involved?
D. How can the federal government help?

A. Identifying Lead Stakeholders

Every community needs an individual, organization, or entity to take the lead in developing a sustainable communities and green infrastructure plan—a local champion committed to improving a neighborhood, city, or region's quality of life and sustainability. Most successful plans involve many stakeholders, and coordination is important so that everyone understands how individual activities fit into the overall framework that moves the community forward. In many communities, a local government agency takes the lead in organizing stakeholders and developing the green infrastructure plan because it will help that agency serve its core mission. Other times, stakeholders have coordinated broad-ranging community visioning exercises and developed plans. For example, in Pittsburgh, Pennsylvania, a nonprofit, community-based development organization took the lead in developing the East Liberty Green Vision, a plan for integrating green features into public and private development in the East Liberty neighborhood. Two private foundations and the Pennsylvania Department of Conservation and Natural Resources funded the effort.[45] In Detroit, the Lower Eastside Action Plan began as a conversation among community development organizations serving neighborhoods in the southeastern part of the city. The organizations collaborated with a diverse group of other stakeholders to develop a 10-year vision for the area that aims to stabilize neighborhood property values, improve stormwater management, and benefit the city as a whole by

[45] East Liberty Development, Inc. *East Liberty's Green Vision.* Undated. http://www.eastliberty.org/community-planning/plans-and-studies/east-liberty-green-vision.

repurposing vacant land for urban gardening, forest regeneration, greenway development, and other uses.[46]

B. Involving Government Entities

Although a variety of entities can spearhead successful sustainable communities and green infrastructure plans, participation and support from local government is crucial. Local governments manage not only publicly owned land but also streets, parking lots, and other places that often accommodate green infrastructure. If local governments lead by example by using green infrastructure approaches on public land, private property owners can see and learn about these techniques and might be more likely to adopt them. Local governments can also ensure that policies and programs are consistent with the community's vision, and the city's demonstrated leadership and commitment to the plan objectives help keep stakeholders engaged. The most appropriate government players will vary but often include:

Exhibit 11. Public art and green infrastructure, Portland, Oregon. The Portland Bureaus of Environmental Services and Transportation worked with the Regional Arts and Culture Council to create new bicycle parking that incorporates public art and green infrastructure. The sculpture by artists Peg Butler and Buster Simpson parks ten bicycles and redirects stormwater from an adjacent brewery's rooftop through a canopy-planter made of repurposed oil barrels into a rain garden filled with native plants.

- The mayor and other elected leaders.
- City departments, including the departments of planning, transportation, housing, public works, parks and recreation, economic development, engineering, and the environment.
- Leadership and staff from adjacent jurisdictions.

[46] LEAP. *Reinventing Detroit's Lower Eastside.* 2012. https://docs.google.com/file/d/0B3Dq7xnK5ajaSF9kZGlvQXdJbWs/edit?usp=drive_web&pli=1.

- State and county government agencies.
- Federal government agencies that control land in the community such as the National Park Service and the U.S. Forest Service.
- Quasi-government partners, for example, water, sewer, and stormwater utilities; regional councils; development authorities; and school districts.

Each of these entities has a different interest and role in the process, and including a broad range of stakeholders will help ensure that the team can get early buy-in from important participants and explore a range of opportunities. For example, school districts might own large properties, including some that are no longer in use, that could be locations for pilot projects to evaluate the effectiveness of different green infrastructure strategies and provide a venue for environmental education. The water utility might be able to help set realistic expectations about service costs under different development scenarios that would provide important information for community planning.

C. Involving Community Members

It might take years for a community to fully implement a sustainable communities and green infrastructure plan, so early and ongoing involvement of stakeholders throughout the community is important to maintain enthusiasm and momentum. In addition, because private property owners are often responsible for maintaining site-scale green infrastructure practices on their sites, they must understand how they work and appreciate their value. Participants will vary, but successful sustainable communities and green infrastructure plans often involve:

- Residents, including people from underserved communities that often have the least green space in their neighborhoods.[47]
- Property owners, developers, and homeowner associations.
- Neighborhood groups such as garden clubs and civic improvement organizations.
- Business organizations such as the local chamber of commerce.
- Nonprofit organizations such as watershed groups, environmental justice organizations, and faith-based institutions.
- Academic and health institutions such as universities and hospitals.

[47] To learn about strategies that low-income, minority, tribal, and overburdened communities can use to shape development so it responds to their needs and reflects their values, see: EPA. *Creating Equitable, Healthy, and Sustainable Communities.* 2013. http://www.epa.gov/smartgrowth/equitable_development_report.htm.

New York City formalized its stakeholder engagement through a Green Infrastructure Citizens Group and a Green Infrastructure Steering Committee including representatives from the development community, environmental and other nonprofit groups, academia, and design professionals, to help develop ideas and address concerns about the city's implementation of its green infrastructure initiatives.[48] The Metropolitan Sewer District of Greater Cincinnati used multiple mechanisms to solicit community input when developing a master plan for the Lick Run Watershed, including open houses, design workshops, public tours, meetings with community organizations, a website, outreach at local festivals, and letters mailed to residents of the watershed.[49]

Exhibit 12. Bikeshare and green infrastructure, Brooklyn, New York. A tree pit designed to capture stormwater from the street and a bikeshare station make Dean Street in Brooklyn an appealing place to walk and bike.

Partnerships with the private sector, academic institutions, nonprofit organizations, and private foundations help local government make limited resources go further. These partnerships can help the other organizations in various ways. For example, universities could help with ongoing performance monitoring to improve scientific understanding of best practices for local conditions and provide real-world training for students. The University of Wisconsin-Madison's Department of Urban and Regional Planning offers a course for graduate students that provides practical training in planning. In 2010, the program worked with the city of Freeport, Illinois, to help the city use green infrastructure planning to reduce flooding, make neighborhoods more attractive, revitalize downtown, create jobs, and clean up contaminated properties so they could be developed into assets for the community.[50]

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[48] The City of New York. "Get Involved and Find Resources." http://www.nyc.gov/html/dep/html/stormwater/nyc_green_infrastructure_outreach.shtml. Accessed Dec. 9, 2013.
[49] Project Groundwork. "Lick Run Master Plan—May 2012." http://www.projectgroundwork.org/projects/lowermillcreek/sustainable/lickrun/cdw1.htm. Accessed Mar. 11, 2014.
[50] University of Wisconsin-Madison. *Freeport Revitalization Project*. 2013. http://urpl.wisc.edu/academics/workshop/912_Freeport/index.html.

State Farm Insurance and the Surdna Foundation funded the Center for Neighborhood Technology to pilot a "Wetrofit" program that facilitates the retrofit of properties in the Chicago region to better manage stormwater and reduce flooding through green infrastructure.[51] The program coordinates the services of multiple agencies to provide tailored solutions for individual properties. Public-private partnerships like these can help finance, construct, and/or maintain green infrastructure projects in ways that benefit both the public and private participants.

EPA developed a guide for leaders trying to build a stakeholder engagement group around activities to improve watershed health.[52] It includes information on how to build a group and maintain engagement as well as other resources to help with stakeholder involvement and communication.

[51] The Center for Neighborhood Technology. "Neighborhood Flood Reduction." http://www.cnt.org/water/projects/neighborhood-flood-reduction/. Accessed Dec. 9, 2013.
[52] EPA. *Getting in Step: Engaging Stakeholders in your Watershed*. 2nd Edition. 2013. http://cfpub.epa.gov/npstbx/files/stakeholderguide.pdf.

IV. Developing a Sustainable Communities and Green Infrastructure Plan

To most effectively attain the benefits of green infrastructure, it is important for stakeholders to develop a good plan of action that can transform a community vision into reality. Specific components of the plan will vary from place to place, but plan developers should consider several steps that can help the plan succeed in the long term, including:

A. Developing a community vision.
B. Establishing goals.
C. Assessing assets and opportunities.
D. Identifying potential approaches to add green infrastructure and help create sustainable communities.
E. Factoring brownfields and hazardous waste sites into planning.
F. Developing strategies for funding.
G. Monitoring and measuring progress.
H. Planning for long-term operations and maintenance.
I. Identifying federal government resources.

A. Developing a Community Vision

Green infrastructure is an important component of many types of local plans at the neighborhood, city, and regional levels, including those for water resource management, hazard mitigation, climate adaptation and resilience, sustainability, environmental justice, and economic development. However, many communities are also developing stand-alone green infrastructure plans that complement other efforts. Whether green infrastructure is one aspect of a broader plan or is the central purpose of a plan, and whether the plan focuses on a neighborhood or an entire region, the first step in a planning effort is typically developing a vision for what the community will look like once the plan is fully implemented. The vision brings people together to determine a common view of the future and guides the plan and its implementation.

One benefit of green infrastructure is that people can usually see and enjoy it, often right in their front yard, on their building's roof, and in their neighborhood streets and parks. Green infrastructure affects the look and feel of a neighborhood—usually for the better—but people are more likely to be happy with the results if they had a hand in deciding where it will be and what it will look like.

Exhibit 13. Design concept for Second Street, Frankfort, Kentucky. The city of Frankfort hosted a public design workshop as part of EPA's Greening America's Capitals Program to develop a vision for a historic commercial corridor. The city wanted to help the community visualize how design improvements could improve pedestrian and bicycle safety, reduce stormwater runoff, and encourage economic revitalization in the area. For more information on The Greening America's Capitals program see: EPA. "Greening America's Capitals." http://epa.gov/smartgrowth/greencapitals.htm.

Community goals and values can affect the alternatives that property owners or local governments consider and influence how they weigh factors for selecting among options. For example, a neighborhood with a strong artist community could have artist-designed downspouts, rain barrels, or planter boxes, which can foster support for green infrastructure and long-term stewardship among residents. The Whitefish Bay Civic Foundation in Whitefish Bay, Wisconsin, sponsored a rain barrel art project in which local businesses exhibited artist-designed rain barrels that were then auctioned off to residents.[53]

Meaningful stakeholder involvement from the outset will help ensure that the community's vision effectively incorporates local knowledge, experience, and insight. Developing a vision for widespread implementation of sustainable communities approaches and green infrastructure has other benefits, including:

- **Encourages private investment consistent with the vision.** Private-sector entities that initiate and finance the bulk of new investment in the community, including property owners, developers, investors, and businesses, will have a guide to understand the community's expectations and preferences for future development.
- **Garners broad-based support.** Individuals, businesses, and organizations such as neighborhood groups, nonprofits, schools, health care institutions, and foundations can

[53] Whitefish Bay Civic Foundation. "Rain Barrel Street Art Project." http://wfbcivicfoundation.org/index.php?option=com_content&view=article&id=18&Itemid=26. Accessed Apr. 4, 2014.

be inspired and encouraged to participate in implementing the vision when the community can clearly demonstrate its support.

- **Leads to supportive policies and programs.** Local governments can use the vision to guide development of policies, regulations, capital improvement plans, incentive structures, city department budget priorities, development review and approval procedures, and other programs that help implement the vision.
- **Builds support for public expenditures to manage stormwater.** Educating the community about the cost of needed infrastructure repairs or upgrades requires significant, ongoing public engagement. The public is more likely to support government spending on green infrastructure, as well as possible tax increases or higher utility rates and fees should they be necessary, if they understand and support the longer-term investment plan and its benefits. Once plan implementation begins, the green infrastructure itself allows property owners to see the benefits of the investment of public money.
- **Enables better coordination of efforts.** Articulating how the vision supports multiple community goals can encourage collaboration across organizations and local government agencies with different missions. The most successful green infrastructure plans identify connections to other ongoing efforts, such as those promoting economic development, preparation for climate change impacts, and environmental sustainability, to help identify the most impactful projects.[54]

B. Establishing Goals

In many communities, the initial impetus for developing a sustainable communities and green infrastructure plan might be to manage stormwater and improve water quality, and the plan's goals would naturally include improvement in indicators of watershed health. For example, the primary goal might be to eliminate combined sewer overflows or to have water clean enough to allow fishing or swimming in the community's rivers, lakes, and beaches.

However, regardless of the initial reason for developing a sustainable communities and green infrastructure plan, one of its main advantages is that implementation can achieve a diverse array of community goals, such as improving the local economy, revitalizing struggling neighborhoods and commercial corridors, improving quality of life for residents, reducing flooding, and protecting the environment for generations to come (see Section I.C.1). Plans

[54] EPA. *Green Infrastructure Case Studies: Municipal Policies for Managing Stormwater with Green Infrastructure.* 2010. http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100FTEM.TXT.

might also explicitly set goals like fostering community pride through signs of new investment in the community—visible results that can make community members want to join in the revitalization. Goals will vary depending on the community's characteristics, such as whether it is growing or losing population; whether it has combined or separate storm and sanitary sewers; and whether it is rural, suburban, or urban. This community context helps create specific, feasible strategies to implement the plan.

Fort Campbell, Kentucky, created a green infrastructure plan with the primary goal of improving the personal resiliency and health of soldiers and their families.[55] The plan aims to ensure that residents can get to community facilities without having to use a car so they can get the physical and mental health benefits associated with exercise and time spent outdoors. The plan recognizes improved stormwater management and environmental sustainability as valuable cobenefits.

The Wasatch Front Regional Council in Utah led a collaborative effort to create *(Re)Connect*, a green infrastructure plan to complement its regional plan for development and transportation, *Wasatch Choice for 2040*. One of the first steps in developing *(Re)Connect* was to identify goals for the process itself, including:

- "Increase public support and awareness regarding the benefits of a green infrastructure approach and an interconnected green infrastructure network.
- Collaboratively map an interconnected network by identifying and prioritizing the region's existing green infrastructure assets and resources.
- Identify existing green infrastructure lands and propose objectives and strategies to plan, design, and manage the region's green infrastructure network.
- Bring together local and regional stakeholders that play a part in planning, engineering, studying, managing, and maintaining green infrastructure.
- Support an interconnected green infrastructure network in order to provide environmental, social, recreational, psychological, public health, and economic benefits.
- Encourage the incorporation of green infrastructure planning and implementation strategies into existing plans and studies."[56]

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[55] Fort Campbell, Kentucky. *Fort Campbell Green Infrastructure Plan*. 2014. http://www.campbell.army.mil/campbell/directorates/DPW/Documents/Green%20Infrastructure%20and%20Recreation%20Connectivity%20Plan%2012%20May%2014.pdf.

[56] Wasatch Front Regional Council. *(Re)Connect: The Wasatch Front Green Infrastructure Plan*. Undated. http://wfrc.org/new_wfrc/Green_Infrastructure/%28Re%29Connect%20The%20Wasatch%20Front%20Green%20Infrastructure%20Plan.pdf.

For many communities, green infrastructure will be a complement to, not a replacement for, gray infrastructure. Integrated planning for gray and green infrastructure can allow communities to select the most cost-effective solutions by using green infrastructure where it can reduce the size and cost of needed gray infrastructure. By considering both approaches together from the beginning, communities can incorporate green infrastructure early enough to potentially reduce the amount of gray infrastructure needed to meet water quality objectives cost-effectively and on schedule. EPA compiled case studies of public entities that have evaluated the economic impacts of their green infrastructure programs to help communities understand the potential benefits of their own programs, and it highlights several cases where green infrastructure, in combination with gray infrastructure, can reduce costs.[57]

Integrated planning for gray and green infrastructure can allow communities to select the most cost-effective solutions.

C. Assessing Assets and Opportunities

Planning for sustainable communities and green infrastructure involves assessing the community's existing assets and opportunities. The features the community inventories and maps will vary depending on the community's goals, but many communities collect data on:

- The amount of impervious surface.
- The number and/or amount of roads, parking lots, and buildings that could incorporate green infrastructure.
- Land ownership and use, including vacant and contaminated properties.
- Existing green space and trails.
- Watershed boundaries.
- Condition of water bodies.
- Areas at risk of flooding.
- Rainfall amounts and patterns, soil type, topography, depth to ground water, and other factors that affect green infrastructure design and functionality.

This information can help communities select the most appropriate sites for green infrastructure and design the most effective green infrastructure solutions for particular sites.

[57] EPA. *Case Studies Analyzing the Economic Benefits of Low Impact Development and Green Infrastructure Programs.* 2013. http://water.epa.gov/polwaste/green/upload/lid-gi-programs_report_8-6-13_combined.pdf.

One useful tool for analysis is EPA's National Stormwater Calculator, which estimates the amount of stormwater runoff from a site and how runoff volumes could change with the use of a given site-scale green infrastructure technique based on local soil conditions, land use, and historical and projected precipitation patterns.[58]

Analysis of economic conditions and population demographics can help identify areas where the economic and social benefits of sustainable community and green infrastructure approaches could have the most impact, including areas where residents might be vulnerable to displacement. This information can help community planners address the specific needs of vulnerable populations as areas are revitalized. It can also serve as a baseline against which the community can measure changes over time.

The development of the Milwaukee Metropolitan Sewerage District's *Regional Green Infrastructure Plan* involved analysis of impervious area, soils, land use, property ownership, ground water, topography, separate and combined sewer areas, tree canopy, and other data. This analysis allowed the district to estimate the storage volume that new green infrastructure could accommodate and how much it would cost to install and maintain.[59]

D. Identifying Potential Approaches to Add Green Infrastructure

In developing an overall plan, stakeholders need to identify a variety of approaches and opportunities to incorporate green infrastructure into their community—on both public and private land, using both incentives and requirements. These approaches can fall into one of four categories:

1. Use existing public land.
2. Acquire additional public land.
3. Provide incentives for implementing green infrastructure on private land.
4. Require green infrastructure on private land.

1. Use Existing Public Land

Local governments can build support for a green infrastructure plan when they lead by example. For example, at the larger scale, local governments sometimes control sizable, contiguous areas of natural land whose preservation maintains community character and sustains vital

[58] EPA. "National Stormwater Calculator." http://www.epa.gov/nrmrl/wswrd/wq/models/swc. Accessed Feb. 5, 2014.
[59] Milwaukee Metropolitan Sewerage District. *Regional Green Infrastructure Plan.* 2013. http://www.freshcoast740.com/en/GI-Plan.aspx.

ecological functions. At the site scale, green infrastructure projects in public spaces can achieve multiple benefits, including:

- Providing opportunities to educate people about the problems of poorly managed stormwater and potential solutions.
- Demonstrating the aesthetic and other values of green infrastructure to build public support.
- Providing opportunities to collect performance and cost data and learn about local challenges to implementation.
- Developing maintenance schedules and protocols that private property owners can use.
- Creating a demand for workers who can install and maintain green infrastructure.

Most importantly, green infrastructure on public land sends a clear message to other community stakeholders that the local government is committed to the green infrastructure plan. A demonstrated commitment by the local government is often critical to getting the private sector to invest in the plan as well.

Green infrastructure on public land sends a message to stakeholders that the local government is committed to the green infrastructure vision.

Many routine local government activities could integrate site-scale green infrastructure practices. For example, a community could plan to incorporate green infrastructure during underground utility work or road maintenance and repair projects and when government facilities are built or renovated. Adding green infrastructure elements to these projects during project planning would have little or even no additional cost. The city of Tucson, Arizona, created a green streets policy that requires all publicly funded road construction and reconstruction projects to incorporate green infrastructure that can capture and absorb the first quarter-inch of rain.[60] The city is applying this policy not just for water quality benefits, but also to ensure that trees are added to streets in lower-income communities. Milwaukee's *Green Streets Stormwater Management Plan* helps the city select appropriate strategies for planned

[60] City of Tucson. "Green Streets." 2013. http://www.tucsonaz.gov/files/transportation/Green_Streets_APG_Signed_by_Director.pdf.

repaving or reconstruction projects to ensure that green infrastructure is factored into the project design from the start to minimize costs.[61]

Exhibit 14. Broadway Boulevard, Tucson, Arizona. Broadway Boulevard's redesigned streetscape includes sidewalk extensions at intersections to reduce the distance pedestrians need to cross, planters that incorporate drought-tolerant trees that will provide much-needed shade, curb cuts to allow stormwater from the street to enter planting beds, and space for bike parking.

Similarly, the Chicago Department of Transportation has policies and guidelines for integrating environmental performance goals into planning for all of its transportation projects.[62] Under these guidelines, all projects, from routine resurfacing to alley improvements to major roadway realignments, must consider water quality objectives and opportunities for site-scale green infrastructure. Such advance planning for retrofits can make green infrastructure a small additional cost in a capital improvement project.

In 2010, New York City's Department of Environmental Protection established a Green Infrastructure Task Force of commissioners from various city agencies to identify capital projects that could incorporate site-scale green infrastructure.[63] The task force also developed standard design and siting guidelines and established maintenance procedures for some types of green infrastructure. In addition, the New York City Departments of Environmental Protection, Transportation, and Parks and Recreation signed a memorandum of understanding in 2011 to establish responsibilities and improve coordination for site-scale green infrastructure in public rights of way.[64]

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[61] CH2MHill. *Green Streets Stormwater Management Plan*. City of Milwaukee. 2013. http://city.milwaukee.gov/ImageLibrary/Groups/cityGreenTeam/documents/2013/Green_Streets_Stormwater_Manag.pdf.
[62] Chicago Department of Transportation. *Sustainable Urban Infrastructure.* 2013. http://www.cityofchicago.org/city/en/depts/cdot/supp_info/sustainable_urbaninfrastucturequidelines.html.
[63] The City of New York. *NYC Green Infrastructure Plan*. 2011. http://www.nyc.gov/html/dep/pdf/green_infrastructure/gi_annual_report_2012.pdf.
[64] The City of New York. *Memorandum of Understanding.* 2011. http://www.nyc.gov/html/dep/pdf/mou/11092011_re-DEP-DOT-DPR-MOU_GreenInfrastructureConstructionandMaintenance.pdf.

Exhibit 15: Using Vacant Property for Green Infrastructure

Some communities are struggling to manage a large number of vacant lots and abandoned buildings that are waiting for demolition because the market currently does not support redeveloping the land. Some of these communities have recognized that if they use a vacant property for green infrastructure, they could remove a source of blight, reduce stormwater pollution, provide a community amenity, and spur interest in redevelopment. In short, green infrastructure could help convert vacant property from a liability to an asset.

The obstacles to creating a vacant lot program for green infrastructure can be difficult for municipalities to overcome. Many vacant properties are privately owned, so local governments have to acquire them outright or acquire an easement for their use. However, land banks or other mechanisms for acquiring and holding property are often not available or can be time consuming and labor intensive to use. The community needs to determine which properties it should acquire to get the size and location of green infrastructure that will produce the most public benefit, an approach that generally requires a public process and engineering consultations. Property might also be contaminated with hazardous substances and need to be evaluated and/or cleaned up. Finally, the community will need a strategy to fund and maintain the green infrastructure. Although all green infrastructure on public land needs funding and maintenance, the costs can be a particular burden in a distressed community struggling with a vacant property problem.

The New York City Soil & Water Conservation District evaluated several successful and early-stage programs. They found several lessons for communities hoping to remedy a vacant lot problem through green infrastructure, including:

- Water agencies can be valuable long-term partners because programs often address stormwater management.
- Successful programs have multiple goals in addition to stormwater management. Sometimes the design and use of new green space is a compromise between what is ideal for stormwater management and what the community will embrace and support.
- Spatial analysis on the regional, watershed, and subwatershed scales; stakeholder input; and site visits are all important when selecting properties to acquire.
- Communities often establish a separate program for green infrastructure on vacant property because the goals of the program often span multiple agencies or offices without fitting neatly into any one, and the programs generally require a unique combination of expertise and dedicated staff.
- Programs have different acquisition strategies, financing tools, ownership structures, and maintenance programs (often a combination of them). No one approach works best in all circumstances.

Source: New York City Soil & Water Conservation District. *Greening Vacant Lots: Planning and Implementation Strategies.* 2012. http://docs.nrdc.org/water/wat_13022701.asp.

Incorporating green infrastructure into sustainable communities approaches can transform neighborhoods. In Nashville, Tennessee, the city remade the street connecting the Metro Courthouse and the state capitol using a variety of green infrastructure practices, including shade trees, bioswales, and permeable sidewalk paving. The city's efforts not only reduced stormwater runoff by more than 1 million gallons per year but also revitalized a formerly dilapidated part of the city, attracting more pedestrians and investment in new businesses and restaurants.[65,66] In Minneapolis, the redevelopment of former public housing projects into a 900-unit, mixed-use neighborhood used open spaces and site-scale green infrastructure woven throughout a series of parks to manage stormwater and create attractive new recreational amenities for residents.[67,68]

2. Acquire Additional Public Land

The local government could strategically acquire land in areas where green infrastructure could provide the greatest benefits for water quality, community revitalization, or other goals. In some cases, particularly in communities that have seen significant population declines, acquiring vacant land for green infrastructure can stabilize property values and allow the local government to assemble land best suited for open space or green infrastructure approaches that can manage stormwater from several surrounding properties. Given the power of such efforts to transform entire communities, early and ongoing engagement of residents in affected neighborhoods is critical.

Milwaukee developed the Greenseams Program to acquire outright or purchase conservation easements[69] for the conservation or restoration of land along streams, shorelines, and wetlands and in areas that serve critical water storage functions and are subject to development pressure.[70] Between 2001 and 2012, the program purchased 2,500 acres of land and restored

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[65] Metropolitan Government of Nashville and Davidson County, Tennessee. "Accomplishments." http://www.nashville.gov/Mayors-Office/Priorities/Environment-and-Sustainability/Accomplishments.aspx. Accessed Dec. 9, 2013.
[66] Johnson, Elizabeth. "Renovated Deaderick Street Enhances Nashville's City Core." *The Tennessean*. Jun. 15, 2010. http://www.tennessean.com/article/20100615/DAVIDSON/100615071.
[67] City of Minneapolis. "Heritage Park." http://www.ci.minneapolis.mn.us/cped/projects/cped_heritage_park. Accessed Dec. 9, 2013.
[68] City of Minneapolis. "Heritage Park Stormwater Brochure." Undated. http://www.ci.minneapolis.mn.us/www/groups/public/@cped/documents/webcontent/convert_286760.pdf.
[69] Conservation easements limit the type or amount of development that can occur on property that remains under private ownership.
[70] The Conservation Fund. "Greenseams: Milwaukee Flood Management." http://www.conservationfund.org/projects/greenseams-green-infrastructure-milwaukee/. Accessed May 16, 2014.

500 acres of forest, prairie, or wetlands.[71] In 2010, the mayor of Detroit assembled a steering committee consisting of business, nonprofit, government, and philanthropic stakeholders for long-range planning. The committee developed a vision for the city's future that recommended assembling large, contiguous tracts of land for new public open space that could manage stormwater and provide other community amenities like parks and community gardens.[72] In addition, the steering committee recommended that the city acquire some vacant lots to provide open space for parks, forest, and greenways to help stabilize neighborhood property values and encourage redevelopment. One community plan the city is considering to inform citywide planning efforts is the Lower Eastside Action Plan, which was put together by a group of individuals and organizations in the neighborhood. The plan identifies larger, contiguous, and ecologically valuable areas that could be managed as natural lands; areas that could be used for large-scale stormwater facilities; and areas that would benefit from additional parkland.[73]

3. Provide Incentives for Implementing Green Infrastructure on Private Land

Many strategic locations for green infrastructure will be on privately owned land, so private-sector involvement will be necessary to implement an effective, comprehensive green infrastructure plan. Communities can encourage private property owners to participate in the community visioning process so they have a stake in its implementation. Beyond that critical step, communities across the country have developed many innovative programs to encourage private-sector participation.[74]

Beginning in 2006, the city of Portland, Oregon, allowed developers to build higher-density buildings in the central city area than otherwise allowed under zoning codes if they installed a green roof. The amount of additional developed space allowed on a building's footprint is determined by the percentage of the footprint that the green roof covers.[75,76] As of 2008, developers participating in the program had installed 260,000 square feet (6 acres) of green

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[71] The Conservation Fund and the Milwaukee Metropolitan Sewer District. *Greenseams 2012 Year in Review.* http://www.conservationfund.org/wp-content/uploads/2012/08/Greenseams-2012-Year-in-Review.pdf.

[72] City of Detroit. *Detroit Future City.* 2012. http://detroitfuturecity.com/wp-content/uploads/2014/02/DFC_Full_2ndEd.pdf.

[73] Leap. Op. cit.

[74] For more information on incentive mechanisms to encourage the use of green infrastructure on private property, see: EPA. *Managing Wet Weather with Green Infrastructure Municipal Handbook: Incentive Mechanisms*. 2009. http://water.epa.gov/infrastructure/greeninfrastructure/upload/gi_munichandbook_incentives.pdf.

[75] Garrison, Noah, and Karen Hobbs. *Rooftops toRivers II: Green Strategies for Controlling Stormwater and Combined Sewer Overflows.* Natural Resources Defense Council. 2011. http://www.nrdc.org/water/pollution/rooftopsii.

[76] City of Portland. "Ecoroof Floor Area Ratio Bonus Option." 2009. https://www.portlandoregon.gov/bes/article/474490.

roofs, creating an additional 600,000 square feet of development that would not have been otherwise permitted.[77] The city of Chicago offers another type of incentive, offering developers an expedited permit process and reductions in building permit fees if they include site-scale green infrastructure and other environmentally sustainable building designs, including solar panels and geothermal systems.[78]

Exhibit 16. The Louisa, Portland, Oregon. This LEED Gold-certified, mixed-use building in Portland's Pearl District has a green roof that serves as a private outdoor gathering place for residents while reducing stormwater runoff and helping to cool the city.

Many municipalities discount stormwater utility fees as an incentive to install certain green infrastructure practices. Minneapolis offers a credit of up to 50 percent off the stormwater utility fee for practices that reduce stormwater volume or filter out pollutants, such as rain gardens, vegetated swales, and green roofs. The city offers credits of up to 100 percent for practices that can accommodate on-site stormwater from a 100-year storm event.[79,80]

Communities also use other types of financial incentives. In 2008, New York City passed a measure to allow a one-year property tax abatement of up to $4.50 per square foot for buildings with green roofs.[81] Philadelphia's Stormwater Management Incentives Program offers low-interest loans of $75,000 to $1 million to non-residential property owners to implement certain green infrastructure practices.[82]

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[77] David Evans and Associates, Inc. and ECONorthwest. *Cost Benefit Evaluation of Ecoroofs.* City of Portland. 2008. https://www.portlandoregon.gov/bes/article/261053.
[78] City of Chicago. "Overview of the Green Permit Program." http://www.cityofchicago.org/city/en/depts/bldgs/supp_info/overview_of_the_greenpermitprogram.html. Accessed Jan. 7, 2014.
[79] A 100-year storm event is a storm that has a 1 percent probability of occurring in any given year.
[80] City of Minneapolis. "How Can You Reduce Your Stormwater Fee?" http://www.minneapolismn.gov/publicworks/stormwater/fee/stormwater_fee_stormwater_mngmnt_feecredits. Accessed Jan. 7, 2014.
[81] City of New York. "Green Roof Tax Abatement." http://www.nyc.gov/html/gbee/html/incentives/roof.shtml. Accessed Jan. 7, 2014.
[82] Philadelphia Water Department. "Green Infrastructure Projects." http://www.phillywatersheds.org/whats_in_it_for_you/businesses/green-infrastructure-projects. Accessed Jan. 7, 2014.

Education can also encourage property owners to use green infrastructure approaches. Education can include creating demonstration projects, publishing technical design materials, creating outreach materials, and offering technical assistance programs. Communities should make sure that their educational materials are understandable to people of all education levels and backgrounds, which generally means using plain language and perhaps translating materials into multiple languages.[83] Oklahoma City developed a Green Infrastructure Education Program that created opportunities for local professionals to share their expertise with others in the community through a speaker series.[84]

EPA and academic researchers studied the potential to reduce stormwater volume using a reverse auction, in which homeowners are asked to bid for the amount they would need to be paid to participate in the program and install stormwater controls on their property. The study found that 55 percent of homeowners that participated in the program were willing to do so without any financial incentive, demonstrating the potential for an education campaign to encourage action.[85] In addition, it found that compared to paying homeowners a flat fee for installing stormwater controls on their property, a reverse auction mechanism was a more cost-effective way to reduce stormwater volume. Communities might want to experiment with innovative programs like this one to see what works best to encourage private landowners to participate.

Award and recognition programs are another low-cost way to encourage property owners to implement green infrastructure approaches. For example, the nonprofit organization Lake Champlain International has a certification program for residential properties in the Lake Champlain watershed in Vermont that reduce stormwater runoff.[86] Washington, D.C., sponsored a Green Infrastructure Challenge, inviting applicants to design innovative green infrastructure solutions for selected sites.[87] DC Water awarded $1 million for the design and construction of the winning proposals. To help communities host design competitions, the Water Environment

[83] EPA has outreach materials that state and local governments can customize for use available at: EPA. "Stormwater Outreach Materials and Reference Documents." http://water.epa.gov/polwaste/npdes/stormwater/Stormwater-Outreach-Materials-and-Reference-Documents.cfm. Accessed Aug. 12, 2014.
[84] The City of Oklahoma City. "Green Infrastructure Initiative." http://www.okc.gov/planning/gii/education. Accessed Jan. 7, 2014.
[85] Thurston, Hale W., Michael A. Taylor, William D. Shuster, Allison H. Roy, and Matthew A. Morrison. "Using a Reverse Auction to Promote Household Level Stormwater Control." *Environmental Science & Policy* 13.5 (2010): 405-414.
[86] Lake Champlain International, Inc. "The BLUE Program." http://www.mychamplain.net/blue-program. Accessed Jan. 23, 2014.
[87] DC Water. "Green Infrastructure Challenge." http://www.dcwater.com/greenchallenge. Accessed May 16, 2014.

Federation developed a white paper on effective approaches based on the experiences of multiple cities.[88]

4. Change Requirements for Private Land

Municipalities can change their codes and regulations to require stormwater to be effectively managed on the site where it falls or as near to that site as practical. Stormwater regulations are the most direct means to achieve this goal. In addition, regulations can help make sure that green infrastructure is implemented when it is most cost effective to do so—at the time of initial site planning for both new and redevelopment projects. Many municipalities are investing significant resources to correct existing problems by retrofitting areas to incorporate green infrastructure and reduce the amount of stormwater runoff generated by development (see Exhibits 12, Exhibit 14, and Exhibit 20). If every new development project increases the amount of stormwater that the gray infrastructure system must handle, the community will need more expensive retrofits of existing development to avoid further degrading water quality. Stormwater regulations can, therefore, be an important tool to control overall costs for mitigating stormwater runoff.

Exhibit 17. Roosevelt Community Center, San Jose, California. The community center incorporates green infrastructure throughout the site, including two installations by artist Jackie Brookner that create a lively public space as well as capture and filter stormwater. Developing the center involved cleaning up and repurposing a former brownfield, which has helped catalyze revitalization of the neighborhood.

In 2011, the city of San Jose, California, approved a stormwater management policy that establishes specific requirements to control stormwater runoff from new development and redevelopment projects.[89] The policy requires developers to minimize runoff

[88] Water Environment Federation. *Hosting a Low Impact Development Design Competition.* 2013. http://stormwater.wef.org/2013/06/lid-design-competition/.
[89] City of San Jose. "Post-Construction Urban Runoff Management." 2011. http://www3.sanjoseca.gov/clerk/cp_manual/CPM_6_29.pdf.

through site design decisions that minimize impervious cover and protect natural areas and to treat stormwater with site-scale green infrastructure.

Stormwater regulations generally apply to individual sites, so they cannot address larger land use practices and development patterns. In most communities, other municipal codes and regulations, including parking requirements, street design standards, and zoning ordinances, are important complements to stormwater regulations because they help determine the amount of impervious cover. For example, most communities have minimum parking requirements for development. The more parking required, the more impervious surface is created. Oversupplying parking also often reduces space for pedestrian amenities or forces pedestrians to cross large parking lots, which can discourage walking. By contrast, mixed-use neighborhoods generally need less parking because facilities that have different peak usage patterns can share parking spaces, and people can get around easily without a personal vehicle. As a result, these neighborhoods can often reduce or even eliminate parking minimums, which can reduce the amount of impervious surface—and give developers more flexibility in how they use their land.[90]

EPA developed a *Water Quality Scorecard* to help local governments identify opportunities to remove barriers and revise or create codes, ordinances, and incentives to better protect water quality.[91] The tool covers ways to protect natural resources (including trees) and open space; promote efficient, compact development patterns and infill; design streets that reduce overall imperviousness and create safer conditions for walkers and bicyclists; encourage efficient parking; and adopt green infrastructure stormwater management provisions. EPA also has a *Sustainable Design and Green Building Toolkit for Local Governments* that helps local governments evaluate codes and ordinances that affect the design, construction, renovation, and operation and maintenance of a building and its immediate site to ensure that they allow sustainable design and green building practices.[92]

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[90] For more information on parking strategies that reduce impervious surface and provide other community benefits, see: EPA. *Parking Spaces / Community Places: Finding the Balance Through Smart Growth Solutions*. 2006. http://www.epa.gov/smartgrowth/parking.htm.
[91] EPA. *Water Quality Scorecard: Incorporating Green Infrastructure Practices at the Municipal, Neighborhood, and Site Scale.* 2009. http://www.epa.gov/smartgrowth/water_scorecard.htm.
[92] EPA. *Sustainable Design and Green Building Toolkit for Local Governments*. 2013. http://www.epa.gov/region4/recycle/green-building-toolkit.pdf.

E. Factoring Brownfields and Hazardous Waste Sites Into Planning

Past industrial and commercial activity has left a legacy of soil and water pollution at sites across the country. Thousands of potentially contaminated properties, or brownfields, are located in densely populated neighborhoods, often near places where residents gather and children play. When cleaned up, brownfields and hazardous waste sites can become attractive locations for green infrastructure, which can help convert a neighborhood liability into an asset for the community. Repurposed, cleaned up brownfields and hazardous waste sites improve the value of neighboring properties,[93] help to revitalize entire neighborhoods, and take advantage of the surrounding development's existing infrastructure. Nevertheless, using green infrastructure on potentially contaminated sites requires careful planning to avoid contaminating ground water.

Exhibit 18. EmeryStation East, Emeryville, California. This 20,000-square-foot office building next to the Amtrak Intermodal Transit Center in Emeryville uses bioswales along the side of the building to capture and filter rainwater from the roof while adding greenery to the neighborhood.

The city of Emeryville, California, is located on formerly industrial land along the San Francisco Bay. The area is densely developed with relatively little open space and has contaminated soils in many areas. The city needed to carefully consider how best to implement green infrastructure approaches to ensure that infiltration of stormwater would not contaminate ground water with pollutants picked up as water percolates through contaminated soils. EPA funded a grant to develop *Stormwater Guidelines for Dense, Green Redevelopment* that the Emeryville City Council adopted in 2005 and that could help other cities facing similar challenges.[94] Green

[93] Haninger, Kevin, Lala Ma, and Christopher Timmins. "Estimating the Impacts of Brownfield Remediation on Housing Property Values." Duke University Working Paper EE 12-08. 2012. http://sites.nicholasinstitute.duke.edu/environmentaleconomics/files/2013/01/WP-EE-12-08.pdf.
[94] EPA. *Stormwater Guidelines for Green, Dense Redevelopment*. 2005. http://www.epa.gov/smartgrowth/emeryville.htm.

infrastructure solutions in this context included tree preservation, green roofs, permeable pavement, and stormwater storage and use. These strategies help the city manage stormwater while continuing to attract residents and businesses and improve the overall quality of life.[95]

Green infrastructure planning on a brownfield site should begin early, ideally at the time of site assessment and cleanup so site planners can avoid techniques that might mobilize contaminants. Information about the location and concentration of contaminants is critical for the design, engineering, and placement of remediation measures and green infrastructure in a new development. Often only part of a site is contaminated, and site planners can design the layout of the development to ensure that green infrastructure practices will not mobilize contaminants and pollute ground water. Stormwater infiltration should generally not be considered in areas with certain types of contaminants—e.g., those that are independently mobile, water soluble, or biodegradable. However, many green infrastructure techniques do not require the infiltration of stormwater into the soil to function, including green roofs and cisterns. Alternatively, on many brownfield sites, designers place an impervious barrier or cap over contaminated soil. This cap is then covered with clean soil and vegetation that filter and evapotranspire stormwater before it reaches an underdrain (located above the cap) that is connected to the stormwater system.[96]

Incorporating brownfield sites into an overall green infrastructure plan can help ensure that these properties return to productive use. Revitalization of the area surrounding a brownfield site is as critical to the successful reuse of the property as its assessment, cleanup, and redevelopment. Green infrastructure can play an important role in revitalization by helping remedy brownfields-related environmental and public health problems while encouraging new development and creating job opportunities for site-scale green infrastructure installation and maintenance. These efforts can build on the work of community-based partnerships, particularly in underserved or economically disadvantaged neighborhoods. Several approaches can help ensure that low- and moderate-income families are not displaced following redevelopment and that communities historically plagued with blighted properties and environmental contamination reap the benefits of environmental cleanup and new green infrastructure initiatives. These approaches include:

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[95] EPA. *Case Studies for Stormwater Management on Compacted, Contaminated Soils in Dense Urban Areas*. 2008. http://www.epa.gov/brownfields/tools/swcs0408.pdf.

[96] For more information on considerations when planning green infrastructure on brownfields, see: EPA. *Implementing Stormwater Infiltration Practices at Vacant Parcels and Brownfield Sites.* 2013. http://water.epa.gov/infrastructure/greeninfrastructure/upload/brownfield_infiltration_decision_tool.pdf.

- Creating affordable housing in revitalizing neighborhoods.
- Working with minority- and women-owned businesses for environmental remediation services and site-scale green infrastructure installation and maintenance.
- Partnering with local land trusts.
- Redeveloping brownfield sites for civic purposes such as parks.[97]

The city of Milwaukee worked with partner agencies and organizations to develop a plan to revitalize the 30th Street Industrial Corridor. The plan incorporates green infrastructure to manage stormwater to improve water quality and promote economic development. Because the area is a former industrial corridor with more than 200 brownfield sites in or adjacent to the corridor, the city had to consider the potential for environmental contamination when developing a plan for the area. The city planned for the corridor as a whole, which enabled it to prioritize sites for redevelopment and cleanup to achieve its vision of creating a new job center and economic engine in the region.[98]

Exhibit 19. The Hank Aaron State Trail, Milwaukee, Wisconsin. Redevelopment of a former 1,200-acre brownfield in the Menomonee River Valley incorporates a stormwater park with a multi-use trail. The area now houses the Harley Davidson Museum and more than a dozen other businesses that have created roughly 4,200 jobs since 1998.

EPA's Brownfields Program has a variety of funding sources that local governments can use for brownfields assessment, cleanup, and associated job training programs.[99] EPA also has a guide of all federal programs that can help repurpose brownfield sites.[100]

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[97] EPA. *Addressing Environmental Justice in EPA Brownfields Communities*. 2009. http://www.epa.gov/brownfields/policy/ej_brochure_2009.pdf.

[98] City of Milwaukee and Wisconsin Department of Natural Resources. *30th Street Industrial Corridor EPA Assessment Funding Final Report.* 2012. http://city.milwaukee.gov/ImageLibrary/Groups/cityDCD/30thStreet/documents/Final30thStreetReportRR928.pdf.

[99] EPA. "Grants & Funding." http://www.epa.gov/brownfields/grant_info. Accessed. Jul. 31, 2014.

F. Developing Strategies for Local Funding

To fulfill its sustainable communities and green infrastructure vision, a community needs to have a way to pay for implementing the plan. A plan based on a community-wide vision can generate enthusiasm from funders and/or reduce opposition to new fees or taxes.

Federal and state funding programs (as discussed in Section IV.I) can seed a local effort but are generally not sufficient to cover all costs for plan implementation. Communities usually need to rely on locally generated money as a long-term funding source. Most successful models for locally funded implementation of a large-scale green infrastructure plan establish a dedicated revenue source for capital projects, operations, and maintenance. Often this source can be a stormwater utility. Property owners pay the utility through a fee on their water bill for the cost of managing stormwater flowing from the property. A survey of states by the Natural Resources Defense Council found that more than half of states have specifically delegated authority to establish a stormwater utility to local governments, although in most states, municipalities do have the legal authority to establish a utility if the rate structure is clearly set up to collect fees for local services rather than taxes.[101] By one estimate, between 1,800 and 2,000 stormwater utilities exist in the United States.[102]

A stormwater utility fee is generally more equitable than other revenue sources because it can be based on the actual cost the city incurs to manage stormwater from each property. How finely the community can calibrate the fees depends on how able it is to implement a more complicated program. Many communities use a flat fee, especially for residential properties, that is based on the average imperviousness of a residence in the locality. A fee structured in this way is much easier to implement than one in which each property's impervious cover is calculated and tracked. However, a system based on actual rather than average impacts might be more legally defensible.[103] Another benefit of stormwater utility fees is that even tax-exempt properties, such as universities and hospitals, can be required to pay their share of the costs incurred by the municipality for stormwater management.[104] Utilities can also encourage

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[100] EPA. *Brownfields Federal Programs Guide.* 2013. http://www.epa.gov/brownfields/partners/brownfields-federal-programs-guide-2013.pdf.
[101] Natural Resources Defense Council. "Funding and Gaining Support for Stormwater Programs." http://www.nrdc.org/water/pollution/storm/chap4.asp. Accessed August 11, 2014.
[102] Western Kentucky University. *Stormwater Utility Survey.* 2013. http://www.wku.edu/engineering/civil/fpm/swusurvey/.
[103] American Rivers and Green for All. Op. cit.
[104] van der Tak, Laurens, Keith Bishton, Bruce Taylor, and Mike Matichich. "Trends in Stormwater Utility Implementation." *Stormwater*. Jun. 27, 2012. http://www.stormh2o.com/SW/Editorial/Trends_in_Stormwater_Utility_Implementation_17636.aspx.

private property owners to use green infrastructure approaches by reducing their fees.[105] When green infrastructure projects benefit just a small number of property owners, e.g., to reduce a localized flooding problem, a local government can create a special assessment district to charge just those property owners a fee that pays for the installation and maintenance of those projects.

In trying to garner support for any new revenue stream, local governments can help property owners recognize that gray infrastructure comes with maintenance costs as well—costs that can sometimes be higher than maintenance for green infrastructure.[106] In addition, costs for site-scale green infrastructure practices will generally come down as the market for new technologies develops. Some communities are reducing costs by developing innovative public-private partnerships to design, build, operate, and maintain green infrastructure retrofits.[107] In a public-private partnership, the municipality contracts with a private firm that gets paid only if it meets established performance goals. Cost savings would come from economies of scale and standardization of practices, scheduling routes, and other maintenance procedures. Prince George's County, Maryland, created a public-private partnership to retrofit about 8,000 acres of existing properties with green infrastructure. The county used the potential cost savings and the jobs the program is expected to create to install and maintain an estimated 40,000 to 50,000 green infrastructure practices as a selling point for the county's retrofit program.[108]

Stormwater utility fees are generally the most effective means to ensure a stable, consistent revenue stream to implement a green infrastructure plan. To be funded through general funds or with bonds (which must be repaid from general funds and contribute to overall debt burdens), green infrastructure would have to compete with schools, public safety, and other public expenditures. In addition, general funds often come from property taxes, which fluctuate, and tax-exempt properties such as churches and schools often have large impervious surfaces, which creates concerns about how equitably the costs are shared among property owners.[109] Some communities have used financing mechanisms such as permit and inspection fees, development impact fees, and a dedicated portion of local tax revenues. However, as with using general funds, with these financing options, green infrastructure has to compete with other

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[105] University of Maryland Environmental Finance Center. *Local Government Stormwater Financing Manual: A Process for Program Reform*. 2014. http://www.efc.umd.edu/assets/publications/2efc_stormwater_financing_manual_final_(1).pdf.
[106] American Rivers and Green for All. Op. cit.
[107] Water Environment Federation. "Financing Urban Retrofits via a Public-Private Partnership." Jul. 31, 2013. http://stormwater.wef.org/2013/07/financing-urban-retrofits-via-a-public-private-partnership.
[108] Ibid.
[109] American Rivers and Green for All. Op. cit.

community priorities, making the revenue stream more uncertain. For more information on stormwater funding mechanisms and types of stormwater programs, see EPA's *Funding Stormwater Programs*.[110]

In 2004, San Mateo County, California, enacted legislation establishing a vehicle registration fee of $4 for the management of traffic congestion and stormwater pollution from vehicles. The county has used the fee to develop a *Sustainable Green Streets and Parking Lots Design Guidebook* and install several demonstration projects.[111]

Exhibit 20. Brisbane City Hall, San Mateo County, California. Redesigning the parking lot for the Brisbane City Hall created space for a rain garden that captures stormwater from the building and parking lot. The redesigned parking lot accommodates the same number of cars. The city also gained an outdoor gathering space, room for bicycle parking, and a safer and more inviting entrance to the building.

In 2008, Minnesota voters voted to increase the state sales tax by 0.375 percent, with one-third of the collected revenues going to a Clean Water Fund that provides grants to local projects.[112] Among the funded projects is one installing rain gardens, stormwater planters, infiltration trenches, and more than 5 miles of tree trenches that support more than 1,000 trees along portions of a light rail line running through St. Paul.[113]

The private sector can fund green infrastructure projects independently or collaboratively through mechanisms such as a business improvement district, in which property owners agree to pay fees to an organization that takes care of various improvements in the area. A local improvement district in Portland, Oregon, installed a green street on Northeast 97th Avenue

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[110] EPA. *Funding Stormwater Programs.* 2009. http://water.epa.gov/infrastructure/greeninfrastructure/upload/FundingStormwater.pdf.
[111] Nevue Ngan Associates and Sherwood Design Engineers. *San Mateo County Sustainable Green Streets and Parking Lots Design Guidebook*. 2009. http://www.flowstobay.org/greenstreets.
[112] The Minnesota State Legislature. "About the Funds." http://www.legacy.leg.mn/about-funds. Accessed Jan. 7, 2014.
[113] Capitol Region Watershed District. "Green Line Green Infrastructure Practices – Water Quality." http://www.capitolregionwd.org/our-work/watershed-planning/cclrt_wq/. Accessed Jan. 7, 2014.

that incorporated vegetated swales and street trees.[114] Local governments can work with the private sector to encourage these types of investment by providing education, technical assistance, and/or partial funding through fee reductions, tax credits, or grants. Greenville County, South Carolina, created a voluntary stormwater banking program that allows developers to increase density in residential developments in exchange for designing projects that better manage stormwater and protect water quality. Developer fees to participate in the program go to a fund used for stormwater retrofits in strategic locations throughout the county.[115]

G. Monitoring and Measuring Progress

A process to measure how well sustainable communities and green infrastructure approaches help the community achieve its environmental, social, and economic goals is an important component of an overall plan. Performance metrics can be used to communicate with stakeholders about progress in implementing the plan, demonstrate ongoing commitment to the community vision, encourage accountability, and suggest course corrections that can help ensure continued progress toward goals. Involving stakeholders in choosing performance metrics and setting up the monitoring process can help ensure that residents and property owners, particularly those in disadvantaged communities, understand and support the goals.

Establishing target dates to achieve needed policy changes helps hold local governments accountable and sends clear signals to the private sector about when local policies and regulations will support their efforts. For example, the city of Chicago developed an implementation roadmap as part of its comprehensive plan to plot out the changes it would need to achieve each key action in the plan. The roadmap specifies target dates for a draft or pilot and for completion. It also lists the lead agency responsible for meeting those targets.[116]

Recognizing the importance of monitoring how well the city's efforts are controlling combined sewer overflows, New York City will use modeling plus three other methods to estimate flow volume to track overflow events at the 422 outfall locations distributed across the city. In addition to tracking stormwater flows, the city is also continuing its water quality monitoring

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[114] City of Portland. "NE 97th Avenue Green Street." http://www.portlandoregon.gov/transportation/article/303101. Accessed Jan. 7, 2014.
[115] Greenville County. *Stormwater Banking Program Manual for Users.* 2012. http://www.greenvillecounty.org/County_Council/_Agenda/Meetings%20of%202013/County%20Council/2013.02.19/Stormwater%20Banking%20Manuel%20WHOLE.pdf.
[116] City of Chicago. *Adding Green to Urban Design: A City for Us and Future Generations.* 2008. http://www.cityofchicago.org/dam/city/depts/zlup/Sustainable_Development/Publications/Green_Urban_Design/GUD_booklet.pdf.

Exhibit 21. High Line, New York City. An elevated former railroad track in New York City has become a linear park more than 20 blocks long. The entire length incorporates native, drought-resistant plants that absorb and filter rainfall. The park provides a place for recreation and cultural events and creates a safe way for bicyclists and pedestrians to travel in the city. Real estate development along the line has skyrocketed, helping to make the popular park a successful economic development project.

program and increasing the number of monitoring stations at the mouths of key tributaries to help track how pathogen levels are affected by reductions in combined sewer overflow events.[117]

The Northeast Ohio Regional Sewer District (covering Cleveland and surrounding counties) plans to monitor not just reductions in stormwater discharges due to green infrastructure approaches, but also cobenefits, including:

- "Life-cycle costs for green infrastructure as compared to gray infrastructure.
- Ecological benefits and ecosystem services, including habitat improvements and the flood and erosion control benefits of green infrastructure.
- Socioeconomic and/or quality of life benefits to low-income or minority populations including improved access to safe and maintained green spaces and recreational opportunities and increased property values due to additional neighborhood amenities.
- Provision of recreational benefits, such as bicycle lanes and walking trails, within underserved communities of the District's combined sewer system area.
- Climate change-related effects, including change in carbon footprint and reduction in the overall carbon impact of the District's implementation of gray infrastructure per the Consent Decree.
- Energy savings as a result of increased green infrastructure implementation.
- Air quality benefits of additional green space, trees, and plantings within neighborhoods.

[117] The City of New York. *NYC Green Infrastructure Plan: A Sustainable Strategy for Green Waterways.* 2010. http://www.nyc.gov/html/dep/pdf/green_infrastructure/NYCGreenInfrastructurePlan_LowRes.pdf.

- Aesthetics and improvements in the look and feel of neighborhoods as a result of green infrastructure implementation.
- Jobs resulting from the deployment of site-based green infrastructure control measures and the growth of local expertise related to green infrastructure.
- Property value increases as a result of the collective impact of green infrastructure projects within a neighborhood."[118]

In a similar approach, the city of Grand Rapids, Michigan, created a series of targets in its *2011-2015 Sustainability Plan*. These targets are benchmarks the city can use to track and measure progress under the *Green Grand Rapids Master Plan* update. These targets include:

- "Achieve 100% compliance with water quality permits annually.
- Eliminate three of the remaining seven combined sewer overflow points by 2015.
- Protect and restore at least three properties identified in the Ecological Framework Plan by 2015.
- Increase the number and square footage of green roofs by 2015.
- Increase the percentage of city tree canopy to at least 35.7% by 2015.
- Achieve 5% pervious pavement in new roads by 2015.
- Increase on-street bike lanes to 100 miles by 2014.
- Increase the number of people living within ¼ mile of a park or open space by 10% by 2015.
- Ensure 100% compliance with stream protection ordinance by 2012.

Exhibit 22. River of Dreams rain garden, Grand Rapids, Michigan. The city of Grand Rapids' Environmental Services Department installed a rain garden on an old tank site that is able to divert 1.5 million gallons of untreated stormwater from the Grand River annually.

[118] Northeast Ohio Regional Sewer District. *Green Infrastructure Plan.* 2012. http://www.neorsd.org/I_Library.php?a=download_file&LIBRARY_RECORD_ID=5526.

- Increase riverfront property available for economic development and people-oriented activities by 2015."[119]

These examples demonstrate some of the ways a local government can monitor and track progress toward implementing a green infrastructure plan. Articulating a clear set of targets developed with input from stakeholders helps ensure that implementation addresses the desires and concerns of residents and stakeholders for a greener, more attractive community.

A clear set of targets developed with input from stakeholders helps ensure that implementation addresses their desires and concerns.

H. Planning for Long-Term Operations and Maintenance

All stormwater infrastructure requires maintenance, including structural repairs and replacement and removal of trash, sediment, and debris. Both gray and green infrastructure require establishment of clear responsibilities for maintenance, a funding mechanism, and an inspection system. Best practices for both types of infrastructure also include having established maintenance and inspection schedules with a system for tracking activities, standard maintenance protocols, an operations and maintenance training program, and a database indicating where infrastructure is located. However, some green infrastructure systems will require different maintenance practices, resources, and expertise to maintain than gray infrastructure, such as those required to properly identify plants and maintain plant health. While the local government agency that traditionally maintains stormwater infrastructure might not have this expertise, it can often be found in other parts of the government, such as the local parks department, state land grant universities, and county extension programs or conservation districts.[120] In addition, green infrastructure is well suited for workforce development programs to create local jobs because of a growing need for employees with skills to install and maintain site-scale practices. Training for these positions generally does not

[119] City of Grand Rapids. *Green Grand Rapids*. 2011. http://grcity.us/design-and-development-services/Planning-Department/Documents/GGR_REPORT_3_1_12_low%20rz.pdf.
[120] American Rivers and Green for All. Op. cit.

require a high level of formal education and can create opportunities for middle-skilled workers.[121]

Operations and maintenance costs will vary based on the particular approaches used and local conditions. Effective green infrastructure plans identify a dedicated source of funding for these activities. Many green infrastructure funding sources like the Clean Water State Revolving Fund programs provide loans for capital costs but cannot be used for ongoing operations and maintenance expenses—activities that are critical to ensure the long-term performance of green infrastructure and ultimately the success of a green infrastructure plan. Residents and property owners who are unfamiliar with green infrastructure approaches could lose confidence in their ability to deliver promised benefits if initial projects fall into disrepair and stop working.

When a city's green infrastructure plan involves private property, maintenance agreements are critical to ensure the plan's long-term success by helping property owners understand their responsibility to maintain green infrastructure practices in working order. Best practices for maintenance agreements include specifying required activities and their frequency, inspection and reporting requirements, and necessary easements (as appropriate). Requirements to periodically renew maintenance agreements can help sustain engagement and remind homeowners of their responsibilities to maintain their systems. Communities can provide a list of contractors qualified to maintain green infrastructure practices to give property owners additional options and create a market for maintenance services.[122] The Northeast Ohio Regional Sewer District has prepared templates for an easement allowing the construction, operation, inspection, and maintenance of site-scale green infrastructure and a template for a cooperative agreement for operations and maintenance.[123]

EPA created a document that examines the operations and maintenance practices of 22 green infrastructure projects funded through Clean Water State Revolving Fund programs.[124] It discusses challenges to implementing an effective operations and maintenance program and best practices learned from the experiences of the communities that implemented these projects.

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[121] Gordon, Emily, Jeremy Hays, Ethan Pollack, Daniel Sanchez, and Jason Walsh. *Water Works: Rebuilding Infrastructure, Creating Jobs, Greening the Environment*. Green for All. 2011. http://greenforall.org/focus/water/water-works-rebuilding-infrastructure-creating-jobs-greening-the-environment.
[122] American Rivers and Green for All. Op. cit.
[123] Northeast Ohio Regional Sewer District. Op. cit.
[124] EPA. *The Importance of Operation and Maintenance for the Long-Term Success of Green Infrastructure*. 2013. http://water.epa.gov/grants_funding/cwsrf/upload/Green-Infrastructure-OM-Report.pdf.

I. Identifying Federal Government Resources

The federal government has numerous funding and technical assistance programs that could help communities implement a sustainable communities and green infrastructure plan. For example:

- Pittsburgh used $50,000 from the U.S. Department of Housing and Urban Development's Community Development Block Grant (CDBG) Program to fund a pilot project called the Green Up Program. Under this program, the city identified vacant lots that could be converted to other productive uses including community gardens, urban agriculture, passive green space, and redevelopment. After a successful pilot, the Pennsylvania Department of Community and Economic Development gave the Green Up Program $500,000 to expand. The program has transformed more than 120 lots into community assets that help manage stormwater, stabilize property values, and attract new development.[125]
- In 2012, the city of Hartford, Connecticut, received a Transportation Investment Generating Economic Recovery (TIGER) grant from the U.S. Department of Transportation to improve connections between its historic Main Street and the city's regional transportation hub. Part of this grant funded the incorporation of green infrastructure into streets as they were redesigned to facilitate walking and biking.[126]
- The city of Kinston, North Carolina, used funding from the Federal Emergency Management Agency to buy property damaged by Hurricane Floyd in 1999 to mitigate flood risk. The city developed a plan to incorporate green infrastructure into the new open space, which will help the city adapt to climate change and provide amenities the entire community can enjoy.[127]
- The city of Aiken, South Carolina, received $3.34 million from the Clean Water State Revolving Fund program for the design, construction, and post-construction monitoring of green infrastructure, including bioswales, pervious pavement, and a cistern.[128] The goals of the project were to capture, store, infiltrate, and treat stormwater downtown to

[125] City of Pittsburgh. "Office of Neighborhood Initiatives: Program History." http://pittsburghpa.gov/neighborhoodinitiatives/greenup/history. Accessed Feb. 5, 2014.
[126] U.S. Department of Transportation. *Tiger 2012 Awards.* 2012. http://www.dot.gov/sites/dot.dev/files/docs/fy2012tiger_0.pdf.
[127] U.S. Department of Homeland Security. "GIS Becomes a New Method for Floodplain Management in Kinston." https://www.llis.dhs.gov/content/gis-becomes-new-method-floodplain-management-kinston?mitssId=844. Accessed Apr. 4, 2014.
[128] Clemson University. *Sand River Headwaters Green Infrastructure Project*. City of Aiken. 2013. http://www.clemson.edu/public/ecology/aiken_green/index.html.

address chronic stormwater erosion in a 2,100 acre urban forest a few blocks from the historic downtown.

Communities that have a comprehensive vision for green infrastructure are often best able to take advantage of the myriad funding and technical assistance resources available.

Comprehensive listings of federal funding and technical assistance programs are available on EPA's green infrastructure website[129] and the website for the federal Partnership for Sustainable Communities.[130] Communities that have a comprehensive vision for green infrastructure that recognizes its multiple benefits are often best able to take advantage of the myriad funding and technical assistance resources available from the federal government (and other sources) because they can tailor applications to emphasize aspects of the plan that match a specific program's criteria. Communities can complete green infrastructure projects incrementally as funding becomes available, and the projects' benefits begin to accrue even before the overall plan is realized.

The federal government also has many resources that could help communities develop or implement a sustainable communities and green infrastructure plan. Several EPA websites have compiled these resources, including:

- The green infrastructure website covers basic information about green infrastructure and compiles tools, case studies, and available research.[131]
- The smart growth website includes research, tools, and case studies to help communities grow in ways that expand economic opportunity, protect public health and the environment, and create and enhance the places that people love.[132]
- The brownfields and land revitalization website compiles information, success stories, tools, and technical information about the cleanup and reuse of potentially contaminated properties, including how to safely plan for green infrastructure.[133]

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[129] EPA. "Green Infrastructure Funding Opportunities." http://water.epa.gov/infrastructure/greeninfrastructure/gi_funding.cfm. Accessed Feb. 5, 2014.

[130] EPA, the Department of Transportation, and the Department of Housing and Urban Development formed the partnership to help communities nationwide improve access to affordable housing, increase transportation options, and lower transportation costs while protecting the environment. For information on Partnership assistance programs see: Partnership for Sustainable Communities. "Partnership Grants, Assistance & Programs." http://www.sustainablecommunities.gov/partnership-resources.

[131] EPA. "Green Infrastructure." http://water.epa.gov/infrastructure/greeninfrastructure/index.cfm.

[132] EPA. "Smart Growth." http://www.epa.gov/smartgrowth.

[133] EPA. "Brownfields and Land Revitalization." http://www.epa.gov/brownfields.

- The Superfund website includes resources for planning green infrastructure at hazardous waste sites.[134]
- The Urban Waters website includes information on how to improve access to, restore, and benefit from urban waters and the surrounding land.[135]
- The green building website includes information on creating and using healthier and more resource-efficient models of construction, renovation, operation, maintenance, and demolition.[136]
- The environmental justice website includes information about grants, programs, and other resources that help communities work with minority, low-income, tribal, and other vulnerable populations to protect the environment and public health.[137]

[134] EPA. "Green Infrastructure: Thinking Regionally." http://www.epa.gov/superfund/programs/recycle/activities/greeninfrastructure.html.
[135] EPA. "Urban Waters." http://www2.epa.gov/urbanwaters.
[136] EPA. "Green Building." http://www.epa.gov/greenbuilding/index.htm.
[137] EPA. "What is Environmental Justice?" http://www.epa.gov/environmentaljustice/index.html.

V. Conclusion

Communities across the country are creating sustainable communities and green infrastructure plans that can help achieve a broad range of goals, including improving water and air quality, reducing flood risk, increasing resilience to climate change impacts, improving public health, providing more recreation opportunities, and creating green jobs. Best practices learned from these plans include:

- Identify an individual, organization, or entity to take the lead in organizing stakeholders and developing a plan—a local champion committed to improving a neighborhood, city, or region's quality of life and sustainability.
- Get local government support, making sure that public land incorporates green infrastructure approaches and that regulations, policies, and programs are consistent with the plan.
- Engage stakeholders early and often to develop the plan and maintain enthusiasm and momentum during its implementation.
- Develop a vision for what the community will look like after plan implementation that incorporates local knowledge, experience, and insight.
- Set explicit goals that the plan could achieve, spanning a range of areas from stormwater management to economic development and climate change resilience.
- Assess assets and opportunities for green infrastructure approaches in the community to achieve the maximum benefits for each investment.
- Look for opportunities to increase the amount of green infrastructure by using existing public land, acquiring new public land, giving incentives to private property owners, and ensuring that regulations are consistent with the community's goals.
- Incorporate brownfields cleanup and reuse into the plan to help ensure that these properties are returned to productive use, and carefully plan green infrastructure implementation to make sure that contamination is not spread.
- Explore options for establishing a dedicated revenue source for capital projects, operations, and maintenance so that lack of funding does not slow plan implementation.
- Develop a process to measure how well the plan's implementation helps the community achieve its environmental, social, and economic goals.
- Plan for how green infrastructure will be maintained over its lifetime at the time of project planning so residents can see it deliver promised benefits.
- Tailor grant and/or loan applications to emphasize aspects of the plan that match a specific program's criteria to increase the number of funding sources available for implementation.

Appendix: Resources

Benefits and Costs

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U.S. Water Alliance. *Barriers and Gateways to Green Infrastructure*. 2011. http://www.uswateralliance.org/news-media/alliance-publications/barriers-and-gateways-to-green-infrastructure.

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EPA. "Green Infrastructure: Thinking Regionally." http://www.epa.gov/superfund/programs/recycle/activities/greeninfrastructure.html.

EPA. *Implementing Stormwater Infiltration Practices at Vacant Parcels and Brownfield Sites.* 2013. http://water.epa.gov/infrastructure/greeninfrastructure/upload/brownfield_infiltration_decision_tool.pdf.

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EPA. "Climate Resiliency Infographic." http://water.epa.gov/infrastructure/greeninfrastructure/climate_res_infographic.cfm.

EPA. *Green Infrastructure for Climate Resiliency*. 2014. http://water.epa.gov/infrastructure/greeninfrastructure/upload/climate_res_fs.pdf.

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EPA. *Green Infrastructure in Arid and Semi-Arid Climates.* 2010. http://www.epa.gov/npdes/pubs/arid_climates_casestudy.pdf.

New York City Soil & Water Conservation District. *Greening Vacant Lots: Planning and Implementation Strategies.* 2012. http://docs.nrdc.org/water/wat_13022701.asp.

EPA. *Stormwater Guidelines for Green, Dense Redevelopment*. 2005. http://www.epa.gov/smartgrowth/emeryville.htm.

Environmental Justice

EPA. *Creating Equitable, Healthy, and Sustainable Communities.* 2013. http://www.epa.gov/smartgrowth/equitable_development_report.htm.

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EPA. *Managing Wet Weather with Green Infrastructure Municipal Handbook: Incentive Mechanisms*. 2009. http://water.epa.gov/infrastructure/greeninfrastructure/upload/gi_munichandbook_incentives.pdf.

EPA. *Water Quality Scorecard: Incorporating Green Infrastructure Practices at the Municipal, Neighborhood, and Site Scale.* 2009. http://www.epa.gov/smartgrowth/water_scorecard.htm.

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EPA. *The Importance of Operation and Maintenance for the Long-Term Success of Green Infrastructure*. 2013. http://water.epa.gov/grants_funding/cwsrf/upload/Green-Infrastructure-OM-Report.pdf.

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EPA. *Using Smart Growth Strategies to Create More Resilient Communities in the Washington, D.C., Region*. 2013. http://www.epa.gov/smartgrowth/sgia_communities.htm#dc.

EPA. "Greening America's Capitals." http://epa.gov/smartgrowth/greencapitals.htm.

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EPA. *Getting in Step: Engaging Stakeholders in your Watershed*. 2nd Edition. 2013. http://cfpub.epa.gov/npstbx/files/stakeholderguide.pdf.

EPA. "Stormwater Outreach Materials and Reference Documents." http://water.epa.gov/polwaste/npdes/stormwater/Stormwater-Outreach-Materials-and-Reference-Documents.cfm. Accessed Aug. 12, 2014.

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