



FEMA

# BUILDING COMMUNITY RESILIENCE WITH NATURE-BASED SOLUTIONS

A GUIDE FOR LOCAL COMMUNITIES



JUNE 2021

**RiskMAP**  
Increasing Resilience Together

# LEVERAGING NATURE-BASED SOLUTIONS IN AN ERA OF CLIMATE CHANGE

Natural hazards pose a serious risk to states, localities, tribes and territories throughout the United States. These hazards include flooding, drought, hurricanes, landslides, wildfires and more. Because of climate change, many natural hazards are expected to become more frequent and more severe. Reducing the impacts these hazards have on lives, properties and the economy is a top priority for many communities.

Nature-based solutions are sustainable planning, design, environmental management, and engineering practices that weave natural features or processes into the built environment to promote adaptation and resilience. Such solutions enlist natural features and processes in efforts to combat climate change, reduce flood risks, improve water quality, protect coastal property, restore and protect wetlands, stabilize shorelines, reduce urban heat, add recreational space, and more.

Nature-based solutions offer significant benefits, monetary and otherwise, often at a lower cost than more traditional infrastructure. These benefits include economic growth, green jobs, increased property values, and improvements to public health, including better disease outcomes and reduced injuries and loss of life.

The implementation strategies for nature-based solutions are diverse; one size does not fit all. Choosing a solution depends on a number of factors, including the level of natural hazard risk reduction, land use planning, economics and more. The following are examples of nature-based solutions:

- In Tucson, Arizona, almost 45% of the city's water is used for outdoor (non-potable) purposes. The city of Tucson's Commercial Rainwater Harvesting Ordinance aims to reduce this demand. It requires commercial property developers to harvest rainwater for at least 50% of their landscaping needs.
- The GreenSeams program in greater Milwaukee, Wisconsin, permanently keeps floodprone lands in high-growth areas from being developed. Since 2001, the program has preserved more than 3,000 acres of land that can store 1.3 billion gallons of water.
- Los Angeles, California, saw an increase of more than 2,000 jobs from its \$166 million investment in nature-based solutions from 2012 to 2014. Many of these jobs are local, providing an extra boost to the local economy.
- The Quabbin and Wachusett reservoirs serve 2.5 million people in Massachusetts. The Massachusetts Water Resources Authority has spent \$130 million over the past 20 years on nature-based solutions. These solutions protect 22,000 acres of the watershed that drains into nearby reservoirs. A water filtration plant would have cost \$250 million to build and \$4 million annually to operate and maintain.

At the Department, we must — and we will — do more to address the climate crisis. DHS will implement a new approach to climate change adaptation and resilience, and we will do so with the sense of urgency this problem demands.

– *Secretary of Homeland Security*  
*Alejandro N. Mayorkas*

The primary goal of this guide is to help communities identify and engage the staff and resources that can be used to implement nature-based solutions to build resilience to natural hazards, which may be exacerbated by climate change.

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FEMA would like to express appreciation to the National Oceanic and Atmospheric Administration (NOAA) nature-based solutions and coastal community resilience subject matter experts who provided their valuable and constructive suggestions during the development of this resource. Their willingness to devote their time and expertise so generously to enhance the impact of this resource for communities is greatly appreciated.

COVER PHOTO: *Buffalo Bayou Park in Houston, TX. The park serves as both critical flood infrastructure and an important recreational and cultural asset for the downtown area. The popular park stretches 2.3 miles along the floodprone Buffalo Bayou and includes trails, public art installations, gardens, two festival lawns, a skate park, and a restaurant. In the park's first year, a survey counted nearly 150,000 trail users in a single month.*

# INTRODUCTION

Flooding, high wind, drought, landslides, and other natural hazards pose major threats to communities across the United States. Natural disasters are becoming more frequent and more costly as a result of climate change. Reducing the threats these disasters pose to lives, properties, and the economy is a top priority for many communities. The National Mitigation Investment Strategy identifies nature-based solutions as a cost-effective approach to keep natural hazards from becoming costly disasters. The promise of nature-based solutions comes from the many benefits they offer and the many partners they can draw to the table.

Nature-based solutions weave natural features and processes into a community's landscape through planning, design, and engineering practices. They can promote resilience and adaptation while being integrated into a community's built environment (for example, a stormwater park) or its natural areas (for example, land conservation). While nature-based solutions have many hazard mitigation benefits, they can also help a community meet its climate, social, environmental, and economic goals. Communities across the country are finding nature-based solutions to be a highly effective way to provide public services that were traditionally met with structural or "gray" infrastructure. Local officials and their partners are using nature-based solutions to improve water quality in Lenexa, Kansas; to reduce flood risks in Milwaukee, Wisconsin; to limit erosion in coastal North Carolina; and to provide neighborhood amenities in Houston, Texas.

FEMA and its federal partners produced the [National Mitigation Investment Strategy](#) to increase our nation's resilience to natural hazards. Its purpose is to coordinate the use of federal, state, local, and private resources to help communities survive and thrive in the face of natural disasters. This Guide builds on the three key goals of the Investment Strategy.

1. To motivate communities to invest in mitigation (for example, by showing how to measure its value);
2. To shrink barriers to investing in mitigation (for example, by improving access to risk information and funding); and
3. To make investing in mitigation standard practice (for example, by considering mitigation in all investment decisions for public infrastructure).



Hatteras, NC. The Durant's Point living shoreline project protects the shoreline from storm surge while providing habitat for many species. Since its construction, the project has weathered hurricanes, a summer of drought, and tropical storms. Photo: N.C. Coastal Federation

## GOAL OF THE GUIDE

The key goal of this guide is to help communities identify and engage the staff and resources that can be used to implement nature-based solutions to build resilience to natural hazards, which may be exacerbated by climate change. Planning and building cost-effective nature-based solutions will require collaboration. Many departments may need to be involved in planning and carrying out the strategies in this guide. Consider including the following local government partners:

- Parks and Recreation
- Public Works
- Planning and Economic Development
- Environmental Protection
- Utilities
- Transportation
- Floodplain Administration
- Emergency Management

In addition, non-governmental community partners like civic associations, watershed groups, and non-profit organizations should be involved in the planning process. They may have the capacity to customize and implement nature-based solutions.

The focus of this guide is local communities, but many of the ideas and advice may also apply to state, territorial, and tribal governments.

## STRUCTURE OF THE GUIDE

Some local communities may use this guide to learn about nature-based solutions and weigh their value for the community. Others may be ready to move from planning to action. The guide includes six sections, and users can jump in at any point, depending on their current knowledge base and interests. The six sections are described below.

### WHAT ARE NATURE-BASED SOLUTIONS?

Describes three broad categories of nature-based solutions.  
Identifies types of nature-based solutions in each category.

### THE BUSINESS CASE

Outlines the many hazards that can be mitigated with nature-based solutions.  
Discusses the multiple benefits of nature-based solutions, in addition to hazard mitigation.

### PLANNING AND POLICY-MAKING PHASE

Identifies planning processes and programs that can help users invest in nature-based solutions.  
Discusses how plans and policies can be updated to allow and encourage nature-based solutions.

### IMPLEMENTATION PHASE

Reviews how local resources can be mobilized to preserve, restore, and build nature-based solutions.  
Discusses innovative ways of promoting private investment.

### FEDERAL FUNDING OPPORTUNITIES

Outlines federal funding sources for nature-based solutions.  
Emphasizes FEMA's Hazard Mitigation Assistance (HMA) grant programs.

### KEY TAKEAWAYS AND RESOURCES

Summarizes key points for communities.  
Provides additional resources.

# WHAT ARE NATURE-BASED SOLUTIONS?

This guide defines nature-based solutions as sustainable planning, design, environmental management, and engineering practices that weave natural features or processes into the built environment to build more resilient communities. While this guide uses the term nature-based solutions, other organizations use related terms, such as green infrastructure, natural infrastructure, or Engineering with Nature®, a program of the U.S. Army Corps of Engineers. As a best practice, use the term that best resonates with your target audience.

## Green Infrastructure and Low Impact Development

Some organizations use the term green infrastructure to capture the value and functions of natural lands. For example, the [Conservation Fund](#) defines green infrastructure as “a strategically planned and managed network of natural lands, working landscapes, and other open spaces that conserves ecosystem value and functions and provides associated benefits to human populations.”

Other organizations use the term green infrastructure for nature-based solutions to urban stormwater pollution. These organizations emphasize solutions that protect water quality and aquatic habitat. The other outcomes, such as mitigating natural hazards, are seen as co-benefits. Low impact development is another term that is often used to describe nature-based solutions for urban stormwater. In the field of stormwater management, “green infrastructure” and “low impact development” are sometimes used interchangeably.

## Natural Infrastructure

The term “natural infrastructure” is often used to describe natural or naturalized landscapes that are actively managed to provide multiple benefits to communities. The [International Institute for Sustainable Development](#), a think tank, notes that active management is what sets natural infrastructure apart from nature. For example, a managed wetland is a type of natural infrastructure. Manipulating water levels and cleaning out plant growth can enhance a managed wetland’s water quality, habitat, and flood storage benefits.

## Engineering with Nature

Organizations that design and operate water infrastructure projects may also refer to Engineering with Nature®, a term that comes from the [U.S. Army Corps of Engineers’ \(USACE\) Engineering with Nature Initiative](#). This term refers to water resources projects that use collaborative approaches to project design and operation to create multi-functional infrastructure. Engineering with Nature® can result in projects that deliver a broader range of economic, ecosystem services, and social benefits.

## Bioengineering

Bioengineering is a term that is used to describe projects that mimic natural processes in order to reduce hazards. An example of bioengineering would be using a combination of natural and manmade materials to stabilize a slope, giving vegetation a chance to become established to reduce future erosion.

## Tying It All Together

The common thread among these terms is that nature-based solutions often provide more value than single-purpose gray infrastructure. Gray infrastructure refers to public works structures that are engineered to provide a specific level of service under specific scenarios. In the context of drinking water and wastewater, gray infrastructure includes water and wastewater treatment plants, pipes, catch basins, and stormwater basins. In the context of coastal communities, gray infrastructure

includes sea walls, groins, and breakwaters. While gray infrastructure provides only the service for which it was designed, nature-based solutions yield additional community and ecosystem services benefits.

Ecosystem services is a term used to describe all of the benefits that we get from the environment — everything from air, food, and water to the enjoyment of nature and natural resources.

## CATEGORIES OF NATURE-BASED SOLUTIONS

This guide categorizes nature-based solutions practices based on scale and location:

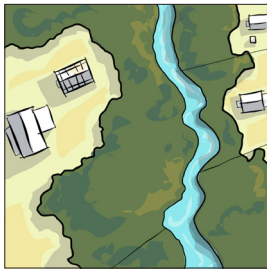
- **WATERSHED OR LANDSCAPE SCALE:** Interconnected systems of natural areas and open space. These are large-scale practices that require long-term planning and coordination.
- **NEIGHBORHOOD OR SITE SCALE:** Distributed stormwater management practices that manage rainwater where it falls. These practices can often be built into a site, corridor, or neighborhood without requiring additional space.
- **COASTAL AREAS:** Nature-based solutions that stabilize the shoreline, reducing erosion and buffering the coast from storm impacts. While many watershed and neighborhood-scale solutions work in coastal areas, these systems are designed to support coastal resilience.

The illustrations on the following pages are examples of nature-based solutions and do not cover all options.



Rain Garden — City Hall in Bay Village, OH

# WATERSHED SCALE



## LAND CONSERVATION

Land conservation is one way of preserving interconnected systems of open space that sustain healthy communities.

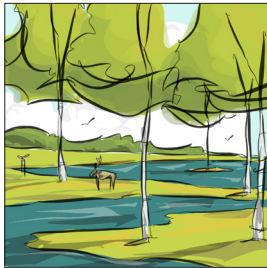
Land conservation projects begin by prioritizing areas of land for acquisition. Land or conservation easements can be bought or acquired through donation.



## GREENWAYS

Greenways are corridors of protected open space managed for both conservation and recreation.

Greenways often follow rivers or other natural features. They link habitats and provide networks of open space for people to explore and enjoy.



## WETLAND RESTORATION AND PROTECTION

Restoring and protecting wetlands can improve water quality and reduce flooding. Healthy wetlands filter, absorb, and slow runoff.

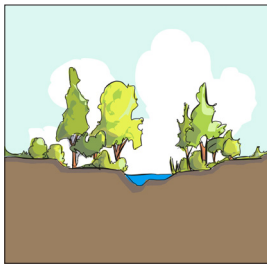
Wetlands also sustain healthy ecosystems by recharging groundwater and providing habitat for fish and wildlife.



## STORMWATER PARKS

Stormwater parks are recreational spaces that are designed to flood during extreme events and to withstand flooding.

By storing and treating floodwaters, stormwater parks can reduce flooding elsewhere and improve water quality.



## FLOODPLAIN RESTORATION

Undisturbed floodplains help keep waterways healthy by storing floodwaters, reducing erosion, filtering water pollution, and providing habitat.

Floodplain restoration rebuilds some of these natural functions by reconnecting the floodplain to its waterway.



# NEIGHBORHOOD OR SITE SCALE



## RAIN GARDENS

A rain garden is a shallow, vegetated basin that collects and absorbs runoff from rooftops, sidewalks, and streets.

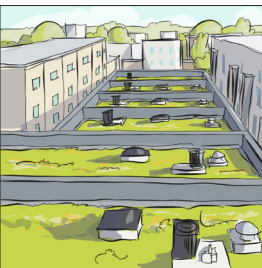
Rain gardens can be added around homes and businesses to reduce and treat stormwater runoff.



## VEGETATED SWALES

A vegetated swale is a channel holding plants or mulch that treats and absorbs stormwater as it flows down a slope.

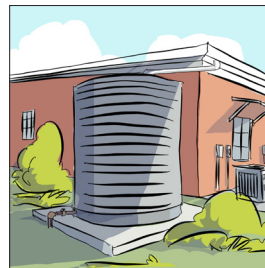
Vegetated swales can be placed along streets and in parking lots to soak up and treat their runoff, improving water quality.



## GREEN ROOFS

A green roof is fitted with a planting medium and vegetation. A green roof reduces runoff by soaking up rainfall. It can also reduce energy costs for cooling the building.

Extensive green roofs, which have deeper soil, are more common on commercial buildings. Intensive green roofs, which have shallower soil, are more common on residential buildings.



## RAINWATER HARVESTING

Rainwater harvesting systems collect and store rainfall for later use. They slow runoff and can reduce the demand for potable water.

Rainwater systems include rain barrels that store tens of gallons and rainwater cisterns that store hundreds or thousands of gallons.



## PERMEABLE PAVEMENT

Permeable pavements allow more rainfall to soak into the ground. Common types include pervious concrete, porous asphalt, and interlocking pavers.

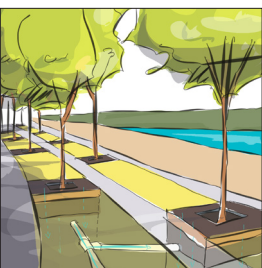
Permeable pavements are most commonly used for parking lots and roadway shoulders.



## TREE CANOPY

Tree canopy can reduce stormwater runoff by catching rainfall on branches and leaves and increasing evapotranspiration. By keeping neighborhoods cooler in the summer, tree canopy can also reduce the “urban heat island effect.”

Because of trees’ many benefits, many cities have set urban tree canopy goals.



## TREE TRENCHES

A stormwater tree trench is a row of trees planted in an underground infiltration structure made to store and filter stormwater.

Tree trenches can be added to streets and parking lots with limited space to manage stormwater.

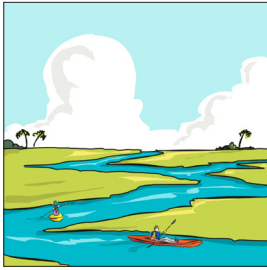


## GREEN STREETS

Green streets use a suite of green infrastructure practices to manage stormwater runoff and improve water quality.

Adding green infrastructure features to a street corridor can also contribute to a safer and more attractive environment for walking and biking.

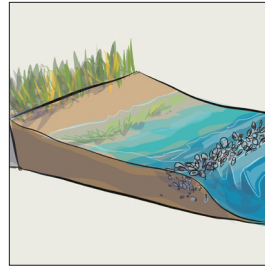
# COASTAL AREAS



## COASTAL WETLANDS

Coastal wetlands are found along ocean, estuary, or freshwater coastlines.

They are often referred to as “sponges” because of their ability to absorb wave energy during storms or normal tide cycles.



## OYSTER REEFS

Oysters are often referred to as “ecosystem engineers” because of their tendency to attach to hard surfaces and create large reefs made of thousands of individuals.

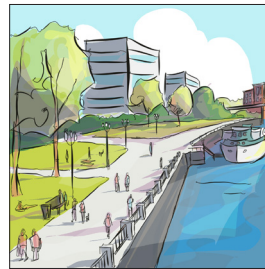
In addition to offering shelter and food to coastal species, oyster reefs buffer coasts from waves and filter surrounding waters.



## DUNES

Dunes are coastal features made of blown sand. Healthy dunes often have dune grasses or other vegetation to keep their shape.

Dunes can serve as a barrier between the water’s edge and inland areas, buffering waves as a first line of defense.



## WATERFRONT PARKS

Waterfront parks in coastal areas can be intentionally designed to flood during extreme events, reducing flooding elsewhere.

Waterfront parks can also absorb the impact from tidal or storm flooding and improve water quality.



## LIVING SHORELINES

Living shorelines stabilize a shore by combining living components, such as plants, with structural elements, such as rock or sand.

Living shorelines can slow waves, reduce erosion, and protect coastal property.

# THE BUSINESS CASE

In response to natural hazards and to proactively address climate related risks, many communities are looking for ways to build resilience that yield the most benefit for the least cost. This section builds the business case for nature-based solutions by summarizing their potential cost savings and their non-monetary benefits. Thoughtfully planned nature-based solutions can contribute to a community's triple bottom line, providing social, environmental, and financial value.

## HAZARD MITIGATION BENEFITS

Nature-based solutions can help reduce the loss of life and property resulting from some of our nation's most common natural hazards. These include flooding, storm surge, drought, and landslides. As future conditions, like climate change, amplify these hazards, nature-based solutions can help communities adapt and thrive.

### Riverine Flooding

Communities can mitigate riverine flooding by investing in watershed-scale practices. Land conservation, floodplain restoration, and waterfront parks can keep development out of harm's way. They also store and slow floodwaters.

The GreenSeams program in greater Milwaukee, Wisconsin permanently keeps floodprone lands in high-growth areas from being developed. Since 2001, the GreenSeams program has preserved more than 3,000 acres of land that can store 1.3 billion gallons of water.

### Urban Drainage Flooding

When the amount of stormwater flowing into a community's storm sewer system exceeds the system's capacity, water can back up and flood streets, basements, and homes. This type of flooding is most common where new development and changing rainfall patterns produce more runoff than the system was designed to handle. While urban drainage flooding is often less damaging than riverine flooding, it also tends to be more frequent. Over time, repeated minor floods can cost a community more than the extreme floods. They can also decrease real estate values and drive businesses away. Communities can mitigate this type of flooding by encouraging or requiring neighborhood- and site-scale nature-based solutions like bioretention systems. Bioretention systems include practices such as rain gardens, rainwater harvesting, green roofs, and more. These practices soak up runoff from hard surfaces and reduce the amount of stormwater flowing into the storm sewer system.

In Huntington, West Virginia, many neighborhoods experience flooding after heavy rainfalls. The city's comprehensive plan recommends using nature-based solutions that manage stormwater onsite to reduce the burden to the storm sewer system and reduce flooding.

## Coastal Flooding and Storm Surge

Coastal flooding can be caused by unusually high tides, strong winds, or storm surge. As future conditions lead to more intense storms and rising sea levels, coastal flooding is becoming more frequent and storm surges are becoming more severe. Communities can mitigate coastal flooding by investing in nature-based shoreline stabilization. Living shorelines, reefs, and dunes can slow waves, reduce wave height, and reduce erosion. At the same time, these practices benefit the ecosystem by filtering and cleaning water and providing habitat.

According to a 2014 journal article in *Ocean & Coastal Management*, North Carolina properties with natural shoreline protection measures withstood wind and storm surge during Hurricane Irene (2011) better than properties with seawalls or bulkheads. The storm damaged 76 percent of bulkheads surveyed, while there was no detected damage to other shoreline types.

## Drought

Droughts are also expected to be amplified by future conditions. As precipitation patterns become more unpredictable, communities can increase their resilience. Two options are conservation and rainwater harvesting. Conservation is a watershed-scale approach. It preserves or restores rainwater infiltration to increase groundwater. At the site scale, rainwater harvesting can help. It offsets some of the demand for non-potable water. This demand can be further reduced by xeriscaping, or drought-tolerant landscaping.

In Tucson, Arizona, almost 45 percent of the city's water is used for outdoor (non-potable) purposes. The City of Tucson's Commercial Rainwater Harvesting Ordinance aims to reduce this demand. It requires commercial property developers to harvest rainwater for at least 50 percent of their landscaping needs.

## Landslides

Landslide hazards tend to be highest in steeply sloped areas. They are particularly high when soils are saturated and vegetation has decreased, or as a result of fires and droughts. At the watershed scale, communities can reduce landslide threats through conservation aimed at steeply sloped land. At the neighborhood and site scale, communities can invest in green stormwater infrastructure and bioretention systems. This includes trees, rain gardens, bioswales, infiltration basins, and pervious pavement. These stabilize slopes by keeping them drier and adding vegetation and root structures.

The Minnesota Department of Natural Resources lists stabilizing slopes using native vegetation and drainage improvements as one way to mitigate landslide hazards.



*Mud slide with rock, boulders, and debris*

## COMMUNITY CO-BENEFITS

The biggest selling points for nature-based solutions are their many benefits beyond mitigating the effects of natural hazards. Nature-based solutions can provide short- and long-term environmental, economic, and social advantages that improve a community's quality of life and make it more attractive to new residents and businesses. Unlike gray infrastructure, a single nature-based project can yield a variety of community benefits that fulfill many departments' goals. Local leaders can highlight these co-benefits to encourage collaboration and make nature-based solutions standard practice. The bottom line is that collaboration on nature-based solutions can help communities survive in the long-term and thrive day-to-day.

### Ecosystem Services

- **Improved water quality:** Nature-based solutions can be used to filter pollutants from stormwater runoff and to reduce the volume of polluted water flowing into rivers, lakes, and coastal waters. In older cities with combined sewer systems, they can also reduce the untreated sewage going into community waterways. Combined sewer systems send all stormwater and sewage to a wastewater treatment plant before releasing the treated wastewater into waterways. When it rains, these systems sometimes carry more water than the treatment plant can handle. As a result, some of the mixed stormwater and sewage will be released untreated into waterways. These events are called combined sewer overflows (CSOs). By lowering the volume of rainwater flowing into a combined sewer system, Nature-based solutions can reduce CSOs and improve water quality.

The City of Lenexa, Kansas focuses on nature-based solutions to prevent stormwater pollution and reduce stormwater runoff.

- **Cleaner water supplies:** Nature-based solutions that protect the land around drinking water reservoirs can keep polluted runoff away from a community's water supply. New York City has high-quality tap water because the city invested in nature-based solutions around its 19 reservoirs. The city's \$600 million investment to conserve and restore the land keeps the water draining into the reservoirs clean. It provided the same level of service as the \$6 billion water filtration plant that the city would have needed otherwise.

- **Improved air quality:** Trees, parks, and other plant-based, nature-based solutions can absorb and filter pollutants and reduce air temperatures. Doing so reduces smog and improves air quality.
- **Healthier wildlife habitats:** Watershed and shoreline nature-based solutions preserve open space and natural environments. If thoughtfully designed, they can also connect habitats to give plants and animals more space to move across the landscape. Both types of nature-based solutions protect aquatic and wildlife habitats by improving water quality.

### Economic Benefits

- **Increased property values:** If a property is near a park or has more landscaping, it generally has a higher value. A study of 193 public parks in Portland, Oregon found that parks had a significant, positive impact on nearby property values. A park within 1,500 feet of a home increased its sale price by \$1,290 to \$3,455 (adjusted to 2020 dollars). As parks increased in size, their impact on property value grew.
- **Improved property tax base:** Nature-based solutions can improve the tax base in both high-growth and low-growth communities. In high-growth areas, nature-based features translate into a higher property tax base. In low-growth communities, nature-based solutions can stabilize property values in areas with high vacancies.

In Philadelphia, Pennsylvania, vacant lots were found to deflate neighborhood property values by as much as 20 percent. The Pennsylvania Horticultural Society initiated a program to green and maintain vacant lots. This program now maintains about 7,000 parcels totaling 8 million square feet. A 2012 study of the program found that homes within a quarter mile of a greened lot increased in value by 2 to 5 percent annually – generating \$100 million in additional annual property taxes.

- **Green jobs:** Green stormwater infrastructure creates new job opportunities in sectors like landscape design, paving, and construction. It also opens new job opportunities in emerging industries.

Los Angeles, California saw an increase of more than 2,000 jobs from its \$166 million investment in nature-based solutions from 2012-2014. The best part about this job growth is that many of these jobs are local, providing an extra boost to the local economy.

- **Improved triple bottom line:** The triple bottom line is an accounting framework that measures the value of social and environmental benefits, as well as financial benefits. Nature-based solutions often provide more triple bottom line benefits than traditional, gray infrastructure. As a result, they increase a community's return on investment, an especially important factor when considering climate change.

### Social Benefits

- **Cooler localized temperatures:** Built-up areas tend to be hotter than nearby rural areas, particularly on summer nights. The “urban heat island effect” can lead to higher rates of heat-related illness. Adding trees and vegetation can help reduce these effects on hot days by providing shade and cooling through evapotranspiration.

Hunter’s Point South Park in Queens, New York City gives residents a new space to play and relax outdoors, while also mitigating flood risk along the East River. Nature-based features include bioswales and street-side stormwater planters to slowly absorb and release stormwater, and 1.5 acres of new wetlands to shield upland areas from storm surge.

- **Improved public health:** Many of the environmental and social benefits of nature-based solutions also benefit public health, including mental health. Improved air and water quality reduce exposure to harmful pollutants. Cooler summer temperatures reduce the risk of heat-related illness. Additional recreation spaces increase opportunities for physical activity and social engagement.
- **Added recreational space:** Nature-based solutions that preserve and enhance open space provide more areas for recreation. In addition, nature-based solutions such as greenways and green streets can increase opportunities for active transportation, such as biking and walking. These spaces can also provide aesthetic benefits that contribute to improved mental health and physical well-being.



Hunter's Point South Park, a part of Gantry Plaza State Park, NY

## COMMUNITY COST SAVINGS

The final piece of the business case for nature-based solutions is the potential for cost savings. Savings may come when nature-based solutions cost less than alternative investments, avoid the need for certain infrastructure altogether, reduce the cost of rebuilding and repairs after a disaster, and help mitigate the impacts of future conditions like climate change. It is important to emphasize that it is often, *but not* always, possible to identify nature-based approaches that are cheaper than gray infrastructure alternatives.

### Avoided Flood Losses

Nature-based solutions can also help communities save money by reducing losses from future floods and other natural disasters. The U.S. Environmental Protection Agency (EPA) studied this issue in a landmark 2015 study. The study estimated the flood losses that would be avoided nationwide by adding requirements to manage stormwater onsite. It found that, over time, using nature-based solutions in new development and redevelopment could save hundreds of millions of dollars in flood losses.

### Reduced Stormwater Management Costs

Using nature-based infrastructure can reduce the cost of stormwater management for new development because material costs are lower. Nature-based solutions can reduce the need for expensive below-ground infrastructure. They can also reduce the number of curbs, catch basins, and outlet control structures required. Nature-based solutions can save money on site preparation because they requires less land disturbance.

In older cities with combined sewer systems, using both green and gray infrastructure can reduce combined sewer overflows (CSOs) at a lower cost. The traditional, gray infrastructure approach is to install below-ground tanks and tunnels and expand existing facilities. This process has extremely high capital costs. It also delays water quality improvements until the end of a decades-long design and construction process. Many nature-based solutions practices have lower capital costs and begin to provide benefits in a few years. New York City developed a plan to reduce CSOs using both green and gray infrastructure. The nature-based

solutions component will eventually capture runoff from 10 percent of the impervious areas of the combined sewer watersheds. While the gray infrastructure option would cost about \$3.9 billion in public funds, the nature-based alternative will cost about \$1.5 billion.

In older cities with combined sewer systems, using both green and gray infrastructure can reduce combined sewer overflows at a lower cost. The traditional, gray infrastructure approach is to install below-ground tanks and tunnels and expand existing facilities. This process has extremely high capital costs. It also delays water quality improvements until the end of a decades-long design and construction process. Many NBS practices have lower capital costs and begin to provide benefits in a few years. New York City developed a plan to reduce CSOs using both green and gray infrastructure. The NBS component will eventually capture runoff from 10 percent of the impervious areas of the combined sewer watersheds. While the gray infrastructure option would cost about \$3.9 billion in public funds, the NBS alternative will cost about \$1.5 billion.

### Reduced Drinking Water Treatment Costs

Watershed-scale conservation practices can keep drinking water clean. They are often more cost-effective than building filtration plants to treat polluted water.

The Quabbin and Wachusett Reservoirs serve 2.5 million people in central Massachusetts and the Boston area. Over 20 years, the Massachusetts Water Resources Authority spent \$130 million on nature-based solutions. The nature-based solutions protect 22,000 acres of the watershed that drains into these reservoirs. A water filtration plant would have cost \$250 million to build and \$4 million annually to operate and maintain.

# PLANNING AND POLICY-MAKING PHASE

The goal of this guide is to help communities identify and engage the staff and resources that can be used to implement nature-based solutions to build resilience to natural hazards, which may be exacerbated by climate change. Planning and carrying out nature-based solutions requires an integrated approach that works across agencies and departments. This section provides tips for adding nature-based solutions to traditional community planning processes and programs. For each program area, this section recommends which officials to engage (ENGAGE); which types of nature-based solutions to consider (ASSESS); and how to update plans, policies, and ordinances to drive those solutions (UPDATE).

## LAND USE PLANNING

The Land Use Element of a community's Comprehensive Plan (sometimes called a Master or General Plan) typically guides land use planning. It sets goals for where and how land will be developed and preserved over the next 20 to 30 years. It also identifies strategies to support these goals. The Land Use Element provides the basis for the community's land use regulations, including zoning ordinances and subdivision and land development ordinances (SALDOs).

**ENGAGE:** Planning staff typically develop the Comprehensive Plan in coordination with other government and public stakeholders. For coordinated investments in nature-based solutions, planning staff should invite other departments to help develop the Land Use Element. Include staff with roles in parks and recreation planning, public works, environmental protection, utilities planning, transportation planning, floodplain management, and emergency management.

Like any other project, nature-based solutions must follow local, state, and federal regulations and permit requirements. This usually includes environmental and historic preservation (EHP) review. Reaching out to EHP authorities early in project design can help communities identify potential benefits and limitations of the proposed solution, and avoid delays in implementation.

**ASSESS:** The land use planning process can help drive investments in nearly every type of nature-based solution. To prioritize nature-based solutions, consider the community's most pressing issues, including development or hazards and risks. For communities approaching build-out, for example, preserving parks and greenways before all remaining land is developed may be most important.

Communities may choose to restore natural ecosystems like wetlands, and reconnect natural areas. This can help native plants and animals compete against invasive species and resist other stressors.

**UPDATE:** The land use planning process should begin with the goals and principles in the Land Use Element. This will provide the rationale and stimulus for ordinance improvements, policy and procedure changes, and training. Once the Land Use Element is updated, make more detailed updates to zoning ordinances and subdivision and land development ordinances. Depending on the type of nature-based solutions prioritized by the community, update ordinances and procedures to:

- Establish riparian buffers and protect stream corridors;
- Direct development to previously developed areas and areas with existing infrastructure;
- Promote compact (e.g., mixed-use and transit-oriented) development;
- Reduce impervious cover; and
- Modify landscape requirements, including tree protection requirements.



## HAZARD MITIGATION PLANNING

Hazard mitigation activities are typically guided by a Hazard Mitigation Plan (HMP), which is updated on a five-year cycle. The HMP identifies specific risk reduction projects as mitigation actions. Each action is linked to a plan that describes how and when the project will be completed.

**ENGAGE:** A Steering Committee typically leads the development of the HMP. The committee often includes planners, emergency managers, and other local officials. To enable joint investments in nature-based solutions, invite other departments to help define the HMP's goals and mitigation actions. Include staff with roles in parks and recreation, public works, planning, environmental protection, utilities management, and transportation planning. They can participate in both the five-year plan update process and the annual reviews and updates.

**ASSESS:** Hazard mitigation planning can drive investments in nearly every type of nature-based solution. To prioritize nature-based solutions, consider the community's most pressing hazards. For example, addressing droughts may be most important for communities in arid environments with high water demand. FEMA's Local Mitigation Planning Handbook specifically identifies projects that protect natural systems as important mitigation activities. These actions minimize losses and preserve or restore the functions of natural systems.

**UPDATE:** Nature-based solutions can be integrated into HMPs through both long-term goals and specific mitigation actions. Mitigation actions may include nature-based projects, but they should also promote nature-based solutions more broadly. Consider policies and regulations, education and outreach, and incentive-based programs. Develop these projects, policies, and incentives with relevant departmental staff so that they can also integrate nature-based solutions into their programs and planning processes.

The Capital Region Council of Governments in Connecticut established the following goal in its 2019-2024 HMP: Increase the use of natural, "green," or "soft" hazard mitigation measures such as open space preservation and green infrastructure. Specific mitigation actions encouraged adopting regulations to promote low impact development and nature-based techniques. They also supported education initiatives to help municipal staff and elected officials understand nature-based solutions practices.

## STORMWATER MANAGEMENT

Stormwater management programs typically aim to reduce water pollution, preserve aquatic ecosystems, and protect the public from stormwater flooding. Many must also comply with federal and state stormwater management regulations. These regulations are designed to reduce pollutant discharges from Municipal Separate Storm Sewer Systems (MS4s) and CSOs. Communities with MS4s typically base their program on a Stormwater Management Program Plan (SMPP). Those with CSOs typically use a local Long-Term Control Plan (LTCP). These plans are carried out by various local programs, ordinances, and development procedures.

**ENGAGE:** Stormwater or public works departments typically develop the SMPP or LTCP. To coordinate investments in nature-based solutions, invite others to help develop the plan and put it into action. Include staff with roles in parks and recreation planning, environmental protection, utilities planning, transportation planning, floodplain management, and emergency management.

**ASSESS:** Stormwater management programs are best suited to drive investments in neighborhood- or site-scale nature-based solutions that retain and treat stormwater onsite. To choose which nature-based solutions to emphasize, consider the community's most pressing stormwater issues and priorities. Communities with a lot of existing development and limited new development might emphasize tree trenches, green roofs, and rainwater harvesting. These nature-based practices have smaller footprints and are easily integrated into tighter spaces. If that community also had limited water supplies, it might prioritize rainwater harvesting; if it did not have enough tree cover, it might prioritize tree trenches.

**UPDATE:** Updating a community's stormwater management program should begin with its SMPP or LTCP. To encourage the use of nature-based solutions, many communities are adding stormwater retention standards to their post-construction stormwater programs. According to an EPA summary, 28 states and two territories have post-construction retention standards. This type of standard requires some runoff volume to be managed onsite. This reduces both pollutant loads and erosive peak flows. Communities can also develop a hierarchy of acceptable nature-based solutions. For example, the Philadelphia Water Department divides these practices into three preference levels: Highest, Medium, and Low.

Once the SMPP or LTCP is updated, make more detailed updates to stormwater management ordinances and procedures. Depending on the type of nature-based solutions prioritized by the community, update ordinances and procedures to:

- Include nature-based solutions in proposed capital projects for stormwater management for public projects;
- Make nature-based solutions legal and preferred for managing stormwater runoff for private projects;
- Have stormwater management plan reviews take place early in the development review process for private projects;
- Provide other ways for developers to meet stormwater requirements when onsite alternatives are not feasible, such as “payment-in-lieu of” programs for private projects;
- Emphasize collaboration between the stormwater management department, streets department, and private developers to build green streets;
- Ensure that local building and plumbing codes allow harvested rainwater for exterior and non-potable uses; and
- Include effective monitoring, tracking, and maintenance requirements for stormwater management.



Rain Garden — Greenbriar Middle School in Parma, OH

## TRANSPORTATION PLANNING

The Transportation Element of the local Comprehensive Plan, the regional Long-Range Transportation Plan, and the Transportation Improvement Program typically guide transportation planning. These plans set goals for a community's transportation system over the next 20 to 30 years. They also identify strategies and projects to support these goals. The plans provide the basis for local codes related to transportation and for local investments in transportation infrastructure.

**ENGAGE:** Planning staff typically develop the Comprehensive Plan, with input from local staff and the public. To coordinate investments in nature-based solutions, planning staff should invite other departments to help develop the Transportation Element. Include those with roles in parks and recreation planning, public works, environmental protection, utilities planning, floodplain management, and emergency management.

**ASSESS:** Transportation and land use planning are closely linked and often interdependent. As with the land use planning process, the transportation planning process can help drive investments in nearly every type of nature-based solution. To prioritize nature-based solutions, consider the community's most pressing issues. For communities with limited options for pedestrians, retrofitting streetscapes to increase walkability may be most important.

For an excellent model of how to systematically incorporate nature-based solutions into the transportation planning process, communities should review the [“Eco-Logical” Approach](#) promoted by the Federal Highway Administration.

**UPDATE:** Updating the transportation planning process should begin with the goals and principles in the Transportation Element. These provide the rationale and stimulus for ordinance improvements, policy and procedure changes, and training. Once the Transportation Element is updated, make more detailed updates to the policies, procedures, and ordinances on street and parking design. Communities can update their street design standards to provide clear direction on the appropriate installation of nature-based solutions. They can adopt a complete streets policy that encourages designs including nature-based solutions. And they can create a green streets manual that provides guidance on designing nature-based solutions.

Local ordinances and procedures related to street design and parking can also be updated. Use this process to minimize impervious cover and promote nature-based solutions. Depending on the type of nature-based solutions prioritized by the community, update ordinances and procedures to encourage or require:

- Adding nature-based solutions to proposed transportation projects in the Transportation Improvement Plan and capital improvement plan;
- Making street trees a part of public capital improvement projects;
- Making streets no wider than is necessary to move traffic effectively;
- Using pervious materials for lower-traffic paving areas, including alleys, streets, sidewalks, driveways, and parking lots;
- Providing alternative parking requirements (e.g., shared or offsite parking), and varying requirements by zone to reflect places where more trips are by foot or transit;
- Using alternative measures to reduce required parking, such as transportation demand management; and
- Using nature-based solutions to strengthen the resilience of transportation infrastructure to natural hazards.

## OPEN SPACE PLANNING

The Open Space and Recreation Element of a community's Comprehensive Plan typically guides open space planning. This element establishes a policy framework and action program. These are used for maintaining, improving, and expanding the community's open space and recreational facilities.

**ENGAGE:** Planning staff typically develop the Comprehensive Plan with government and public stakeholders. To coordinate investments in nature-based solutions, invite other departments to help develop this element. Include staff with roles in hazard mitigation, public works, environmental protection, utilities planning, floodplain management, and emergency management.

**ASSESS:** The open space planning process can help drive investments in nearly every type of nature-based solution. At the watershed scale, it can support interconnected systems of greenways and parks. These mitigate natural hazards and provide co-benefits to the community. At the neighborhood scale, open space planning can incorporate nature-based solutions into local parks and recreational facilities. This helps reduce and treat neighborhood stormwater runoff. In coastal areas, open space planning can drive investments in living shorelines, waterfront parks, and other coastal nature-based practices.



Folly Beach, SC

**UPDATE:** Updating the open space planning process should begin with the Open Space and Recreation Element of the Comprehensive Plan. Once the plan is updated, consider more detailed updates to facilities management programs, park planning and design, and local ordinances.

Facilities management programs can add neighborhood-scale nature-based solutions to existing parks and playgrounds. As local governments retrofit existing facilities, they can incorporate nature-based solutions to reduce impervious cover, enhance tree cover, and treat and soak up stormwater runoff. Park planning and design are also opportunities. Communities can apply nature-based practices and principles as they expand their network of parks and trails and design each park site. Using nature-based solutions for retrofitting existing parks or acquiring and designing new parks can mobilize new partners and funding sources. Finally, updating local ordinances can help to preserve watershed-scale nature-based solutions. Based on the needs of the community, ordinances can be updated to:

- Protect natural resource areas and critical habitat;
- Establish no-development buffer zones and other protections around wetlands, riparian area, and floodplains; and
- Limit development and land disturbance in source water protection areas.

FEMA's Community Rating System (CRS) allows participating communities to earn lower flood insurance rates for property owners, renters, and businesses. They get credit for actions that reduce risk under the National Flood Insurance Program. FEMA recently elevated the potential CRS credit values for nature-based solutions. Credit is given for actions such as preserving open space, restoring wetlands, and developing a living shoreline. The number of points awarded for preserving open space is now among the highest given in the program. Credits are awarded according to the percentage of preserved open space in a community's floodplain. The larger the percentage, the more credit is awarded, accompanied by potentially higher insurance discounts. [Folly Beach, South Carolina](#) incorporated nature-based solutions into their CRS program and received a 30-percent reduction in premiums.

# IMPLEMENTATION PHASE

To build a network of nature-based solutions, communities should encourage both public and private investments. This section provides tips for boosting public investment and incentivizing private investment. Many of these tips rely on the diverse benefits of nature-based solutions. Recognizing these diverse benefits can help pool resources from public and private partners to mobilize more funding for nature-based solutions. This section is aligned with the third goal of the National Mitigation Investment Strategy – to make mitigation investments standard practice.

## BOOSTING PUBLIC INVESTMENT

### Diversifying Local Resources

Traditional local funding sources for public infrastructure include general funds, bond proceeds, taxes, and fees. Support for nature-based solutions investments could come from taxes levied on property, special or business improvement districts, or tax increment financing (TIF) districts. Local fees could include development impact fees, fee-in-lieu payments, or utility fees (including stormwater utilities). Pooling resources is also a way to integrate NBS practices into planned or ongoing capital improvement projects. Consider NBS when creating or improving roads, streetscapes, stormwater management projects, parks, and parking areas. Incorporating NBS into public improvements is an opportunity to lead by example and to educate other departments, private developers, and the public.

GENERAL FUNDS	BOND PROCEEDS	TAX AND FEE REVENUES
<p><b>PROS</b></p> <ul style="list-style-type: none"><li>• Financial flexibility</li></ul> <p><b>CONS</b></p> <ul style="list-style-type: none"><li>• Funds can be reassigned</li><li>• Influenced by changes in community, including political climate</li></ul>	<p><b>PROS</b></p> <ul style="list-style-type: none"><li>• Dedicated and consistent source of funding</li></ul> <p><b>CONS</b></p> <ul style="list-style-type: none"><li>• Could increase local taxes and fee rates</li><li>• Influenced by credit rating</li><li>• Repayment often includes interest</li></ul>	<p><b>PROS</b></p> <ul style="list-style-type: none"><li>• Dedicated and consistent source of funding</li></ul> <p><b>CONS</b></p> <ul style="list-style-type: none"><li>• Lack of financial flexibility</li><li>• Could increase local taxes and fee rates</li></ul>

While each funding source has pros and cons, communities should use more than one internal resource. Pooling resources is a more cost-effective and fiscally responsible funding choice. Pooling resources is also a way to integrate nature-based solutions practices into planned or ongoing capital improvement projects. Consider nature-based solutions when creating or improving roads, streetscapes, stormwater management projects, parks, and parking areas. Incorporating nature-based solutions into public improvements is an opportunity to lead by example and to educate other departments, private developers, and the public.

## Attracting Grant Funding

To maximize public investment in nature-based solutions, communities should creatively combine local and external resources as often as possible. Since nature-based solutions provide many different co-benefits, a single project may be eligible for a variety of private, state, and federal grant programs. The key to leveraging these resources is to think outside the box when applying for funding, and to apply to diverse programs. For example, a coastal community may seek grant funding for a flood risk reduction project that uses nature-based approaches. In addition to applying for hazard mitigation grants, this community could apply for habitat conservation grants, water quality grants, and coastal resilience grants. The final section of this guide lists some of the most common federal grant funding opportunities for nature-based solutions. Communities should also identify and leverage the financial assistance available through state-specific programs. Other potential sources are non-profit organizations, special districts, and private foundations.

As a growing suburb of Kansas City, Lenexa, Kansas is managing the effects of increased impervious cover through nature-based solutions. To integrate nature-based solutions into major capital projects, such as rebuilding roads and parks, Lenexa is using funds from several internal and external sources:

1. sales tax revenues;
2. stormwater utility fees;
3. new development fees; and
4. state and federal grants.

## Building Nature-Based Solutions into the Capital Improvement Plan

The Capital Improvement Plan (CIP) process is another tool for increasing investments in nature-based solutions. Many communities use a CIP to plan the timing and financing of public improvements over the medium term (approximately five years). Agencies submit projects to be evaluated and included in the CIP, and the CIP team analyzes and ranks submitted projects. Ultimately, highly ranked projects are funded first. Rankings often consider how the project advances mandated activities and community priorities. They are also based on whether the project is fiscally responsible. Including a nature-based component can help increase a project's ranking, as nature-based solutions may contribute toward federal Clean Water Act requirements, hazard mitigation, and other community priorities. It is important to emphasize the multi-functional nature of these solutions and how they can provide more bang for the public's buck.

## Funding Nature-Based Solutions with Stormwater Utility Fees

Stormwater utility fee programs are designed to pay for the cost of managing stormwater runoff. Typically, stormwater fees are collected in a fund dedicated to the stormwater management program and stormwater-related projects. This can be a good, steady source of funding that does not compete with other community priorities.

Many stormwater utilities are structured to charge users based on their property's stormwater runoff volume. For example, communities can charge a fee based on a property's impervious area, rather than its total area. For this type of fee structure, communities need to have a good understanding of their impervious cover. Stormwater utilities are also able to collect fees from all property owners, including those otherwise exempt from property taxes.

The 2017 Western Kentucky University Stormwater Utility Survey identified 1,639 stormwater utility programs in 40 states. The smallest program served a population of 88.

## Financing Nature-Based Solutions with the Clean Water State Revolving Fund

The Clean Water State Revolving Fund (CWSRF) is a financial assistance program established through the Clean Water Act. It provides low-interest loans for water infrastructure projects (including nature-based solutions) that address water quality.

The EPA provides funding to all 50 states and Puerto Rico to operate CWSRF programs. States provide a 20-percent match for all federal funds. Since the CWSRF was established, it has supplied more than \$43 billion to state programs. With that support, states have given \$133 billion in loans to communities.

For most projects, public, private, and non-profit entities get an average interest rate of 1.4 percent. The loan period must not exceed 30 years. A key benefit of the program's low interest rate is that communities may be able to cover debt service payments without raising the rates for local taxes or fees. By further reducing operation and maintenance costs for infrastructure, nature-based solutions help communities meet their loan repayment terms.

The Camden County Municipal Utility Authority was awarded a \$5.4 million loan from the New Jersey Infrastructure Bank, the state's CWSRF, to fund a city-wide nature-based solutions project. The project has an estimated cost savings of \$3.1 million over the 30-year loan. It involves building nature-based solutions throughout the City of Camden, including rain gardens and porous concrete sidewalks. The project also has a green jobs component. In the past 3 years, Camden trained about 240 youths in nature-based solutions maintenance.



*Managed dune on Long Beach Island, NJ. Dune restoration is an example of nature-based solutions that can be funded by many federal funding sources.*

## INCENTIVIZING PRIVATE INVESTMENT

While public investment in nature-based solutions is critical and continues to evolve, communities should also investigate ways to incentivize nature-based solutions on private property. One option is to make these investments more appealing to homeowners, businesses, and developers. Incentives typically use public funds to seed additional investments by private parties. Innovative incentive-based programs can create unique ways to fund and build nature-based projects. Some examples are public-private partnerships, rebates and financing programs, grants, and cost-share arrangements. Banking or credit trading programs, development or redevelopment incentives, local fee or tax discounts, and community awards and recognition programs have also been useful. Such voluntary programs can increase the use of nature-based solutions on private land, where most traditional development takes place. They can balance regulations and may relieve some of the administrative burden that communities carry when adopting and managing their own nature-based policies or projects.

### Public-Private Partnerships

Through partnerships, local governments and private-sector parties can invest together in public asset or service projects. These long-term partnerships are most successful when they have shared goals and benefits. Private partners may have more flexibility than a public agency. Linking any partnership with performance-based payments can encourage efficiencies in time and cost.

Local officials can work with private partners to develop and finance nature-based solutions in many ways. One key step is to demonstrate the benefits of nature-based solutions – to make the business case locally. Another is to offer continued technical assistance and coordination for nature-based projects. This may include policy support, training, or other ways to build capacity. Finally, seek long-term agreements with any private stakeholders that would provide these services traditionally delivered by the public sector. Above all, communities should create partnerships with private parties for specific projects.

### Green Certification Incentives

Certifications such as LEED and SITES offer guidance for developers to incorporate sustainability when designing buildings and landscapes. States and communities can provide incentives to developers to incorporate these certifications into new development and redevelopment projects.

In Prince George's County, Maryland, a new water resources plan proposed extensive stormwater-related restoration. Also, 20 percent of the county's impervious surfaces needed to be replaced. Recognizing its challenges in volume and timing, the county built a public-private partnership. A private party was contracted to restore 2,000 acres, with the potential for extending the contract to an additional 2,000 acres if it met performance metrics. This partnership met its project costs and deadlines. It was also recognized for meeting social goals such as hiring and training minority-owned businesses and focusing on projects in lower-income areas.

### Rebates and Financing Programs

Rebates, tax credits, or low-interest loans can encourage nature-based solutions and practices. For example, Tucson Water sponsors a Rainwater Harvesting rebate program. It provides rebates of up to \$2,000 to single-family residential or small commercial customers who install a rainwater harvesting system. Eligible options include passive rainwater harvesting, which directs and retains water in the landscape, and active rainwater harvesting, such as tanks that store water for later use. Often, participants in this kind of program need capital at the beginning of a project. Since residents may not want or be able to fund improvements on their own, many communities target their rebates and loans at businesses. Philadelphia, for example, offers low interest (1 percent) loans for nature-based solutions retrofits on non-residential property.

Another finance option for promoting nature-based solutions is the Department of Energy's Property Assessed Clean Energy (PACE). Communities can use PACE to help property owners finance nature-based solutions. It also applies to installing renewable energy or energy-efficient assets on private properties. Depending on state laws, communities can create PACE programs by issuing a revenue bond to the property owner. PACE borrowers can benefit immediately from new nature-based solutions and repay their debt by increasing property taxes. For example, increases are at a set rate for an agreed-upon term, typically 5–25 years. The PACE assessment is attached as a tax on the property, not the property owner. Because PACE is funded through private loans or municipal bonds, it creates no liability to local government funds.



## Grants and Cost-Share Agreements

Communities can also encourage nature-based solutions by directly funding property owners or groups. Onondaga County, New York has a Green Improvement Fund that funds nature-based solutions on private commercial and non-profit properties. Applicants in the target sewer districts can choose their own nature-based solutions techniques, but grants are determined by the amount of stormwater the project captures. The Green Improvement Fund has awarded 88 grants since 2010, for a total of nearly \$11 million. Nature-based solutions projects have included the installation of porous pavement, added green space, rain gardens, green roofs, and infiltration projects. Together, the completed projects can capture more than 38 million gallons of stormwater runoff per year. Philadelphia manages a similar voluntary retrofit grant program. It covers the upfront costs of typical nature-based solutions on private property if the owner agrees to maintain it.

## Banking or Credit Trading

Banking or credit trading programs can help developers meet onsite stormwater retention requirements when nature-based solutions are not feasible onsite. They create a mechanism for developers to pay the community to build nature-based solutions off site. This concept is like that of wetland mitigation banking.

Washington DC's Stormwater Retention Credit (SRC) Trading program allows large-scale development and redevelopment projects to meet stormwater management requirements by buying credits from properties with voluntary nature-based solutions improvements. The credit trading program encourages developers to choose cost-effective, nature-based solutions. It also creates an incentive for other property owners to integrate green stormwater practices. Through this program, properties that use nature-based solutions or reduce impervious cover can earn and sell credits to the Department of Energy and Environment or in an open market.

## Environmental Impact Bonds

Several traditional debt financing tools are available to communities. However, environmental impact bonds (EIBs) are a recent innovation. EIBs can help communities obtain upfront capital for hard-to-finance environmental projects. These bonds link project performance incentives to desired environmental outcomes. In practice, most EIBs function like traditional bonds, with a fixed interest rate and term. Unlike normal bonds, they offer investors a “performance payment” if projects perform better than expected. The primary benefit of this model is that it shifts the project performance risk to a private party and ties borrowing costs to the effectiveness of a project. If a project underperforms, investors must reimburse the borrowing entity; if it overperforms, the entity pays the investors. This model has potential applications for multiple areas of environmental restoration and resilience, including nature-based solutions.

Environmental Impact Bonds have already been issued in several cities, including Washington, DC and Atlanta, Georgia, where they are funding a range of nature-based solutions projects to reduce stormwater runoff and address critical flooding issues.



Modern rooftops, Brooklyn Heights, New York City

## Development or Redevelopment Incentives

Communities can update their land use, zoning, or other local regulations to provide incentives for using nature-based solutions. Zoning incentives can allow a greater height, density, or intensity of development if a developer uses nature-based approaches. One common zoning incentive is an increased floor-to-area ratio (FAR), which regulates the density of development on a site. The City of Portland, Oregon offers increased FAR as an incentive for installing green roofs. Communities can also exempt green roofs or pervious pavements from any regulations that apply to impervious cover.

More incentives for adopting nature-based solutions approaches can be used in the development application and review period. These include discounted application fees and discounted or waived maintenance bonding requirements. The City of Chicago, Illinois waives permit fees for developments that meet specific nature-based solutions thresholds. For redevelopment, communities can also give a one-time tax credit for using nature-based approaches that benefit the public.

More communities are moving from strict standards to more flexible instruments that include incentives. They are encouraging developers to use nature-based solutions through unified development ordinances. They are providing options for flexibility and creativity during the site plan review process.

The City of Norfolk, Virginia recently created a “resilient quotient system.” Developers earn points for adopting measures that reduce flood risk, manage stormwater, and increase energy resilience. Under this system, new developments must meet different resilience point values. The points are based on the size and type of development (residential, non-residential, mixed-use). Developers get points for installing green roofs, rain gardens, or other stormwater infiltration systems; using pervious paving systems; providing a community garden space; preserving natural, native vegetation; planting trees; and preserving large, non-exotic trees.

## Stormwater Utility Incentives

Communities can use a local stormwater utility fee program to establish a dedicated funding stream for nature-based solutions. This type of program can offer incentives for property owners to incorporate nature-based solutions. For example, a program that charges users based on their property’s impervious area could offer discounts when property owners “disconnect” some of their impervious area from the storm sewer system by adding nature-based solutions. Other incentives may be offered for creating more buildings with green roofs and other retention or infiltration systems, or for rainwater harvesting.

In Nashville, Tennessee, properties in a combined sewer overflow area may receive a discount on their sewer fees if nature-based solutions are incorporated. Similar incentives are part of stormwater utility programs in Philadelphia and Washington, DC. In Lancaster, Pennsylvania, stormwater credits available to all property owners can reduce fees by up to 50 percent a year. To qualify, owners must use nature-based solutions on the property.



Father and toddler examining plants in a park in Norfolk, VA

# FEDERAL FUNDING OPPORTUNITIES

As governments have become more aware of the many benefits and financial value of nature-based solutions, federal agencies have provided more funding opportunities. Each year, the federal government provides millions of dollars in grants for nature-based infrastructure projects. These projects lead to safer, more resilient communities. Other levels of government and private organizations also fund and invest in nature-based solutions.

Some common nationally available federal grant funding opportunities for nature-based solutions are summarized below. This is a starting point, not a complete list. Additional funding may be available from other federal programs, state agencies, non-profit organizations, conservation districts, universities, and private foundations.

## NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)

### COMMUNITY-BASED RESTORATION PROGRAM

DESCRIPTION	PROJECTS
NOAA's <a href="#">Community-Based Restoration Program</a> provides funding for coastal and marine habitat restoration projects. The program supports projects that use a habitat-based approach to rebuild productive and sustainable fisheries, contribute to the recovery and conservation of protected resources, promote healthy ecosystems, and yield community and economic benefits.	Typical habitat restoration projects include hydrologic reconnection of wetlands, coral reef restoration, and bivalve shellfish habitat restoration that includes some form of protection from harvesting. Feasibility, design, and implementation projects are all eligible.

### NATIONAL COASTAL RESILIENCE FUND

DESCRIPTION	PROJECTS
The <a href="#">National Coastal Resilience Fund</a> , a public-private partnership between the National Fish and Wildlife Foundation, NOAA, Shell, and TransRe, provides grants to support natural infrastructure. Established in 2018, the Fund invests in projects that protect coastal communities from extreme storm and flood events while enhancing natural habitat.	Community capacity-building and planning, engineering, design, and construction projects such as living shoreline, floodplain-habitat restoration design, marsh and wetland habitat restoration, and natural channel design.

**U.S. DEPARTMENT OF HOMELAND SECURITY (DHS) –  
FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)**

**HAZARD MITIGATION ASSISTANCE**

DESCRIPTION	PROJECTS
<p>FEMA's <u>Hazard Mitigation Assistance</u> (HMA) includes three funding programs for risk reduction activities. They are the Hazard Mitigation Grant Program, Flood Mitigation Assistance Program, and Building Resilient Infrastructure and Communities (BRIC). States, territories, tribes, and local communities may apply for HMA funding if they meet all eligibility criteria for each program, including having a FEMA-approved hazard mitigation plan.</p> <p><b>Note:</b> BRIC replaces the Pre-Disaster Mitigation Program.</p>	<p>HMA funds projects for a broad range of hazards, including drought and flood risk reduction projects, such as aquifer storage and recovery, floodplain and stream restoration, and flood diversion and storage. Reforestation projects in wildfire-affected areas may also be eligible.</p> <p>BRIC Prioritizes projects that mitigate the risk to public infrastructure and community lifelines, incorporate nature-based solutions, and support modern building codes.</p>
<p><u>Public Assistance</u> (PA) is FEMA's largest grant program, providing funds to assist communities responding to and recovering from declared disasters. The program provides funding for both restoring community infrastructure and increasing resilience of disaster-damaged facilities. Funding is not awarded on a competitive basis and there is no upper limit on available support.</p>	<p>Primarily erosion control projects, such as bank or slope stabilization. There are many opportunities to expand the use of nature-based solutions with PA mitigation projects provided they meet the eligibility requirements.</p>

The City of Cuyahoga Falls, Ohio used Hazard Mitigation Grant Program funding to buy and remove four homes that had flooded repeatedly. The resulting open space was used to create [The Rain Garden Reserve](#), a beautifully landscaped public space. The Reserve also serves as a stormwater retention area, reducing flood risk for neighboring homes.



*Rain garden in Euclid Creek Watershed, OH. Photo: Cuyahoga Soil & Water Conservation District*

## U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)

### COMMUNITY DEVELOPMENT BLOCK GRANT

DESCRIPTION	PROJECTS
<p>The <a href="#">Community Development Block Grant (CDBG) Program</a> provides funding to ensure decent affordable housing, provide services to the most vulnerable in our communities, and create jobs through expanding and retaining businesses. Since 2001, the <a href="#">CDBG-Disaster Recovery Program</a> has provided additional assistance to areas affected by Presidentially declared disasters. This program supports disaster recovery activities such as housing redevelopment and rebuilding, infrastructure repair, and economic revitalization.</p> <p>In August 2019, HUD announced its first allocation of <a href="#">CDBG-Mitigation funds</a>. Nearly \$7 billion was made available to 14 grantees affected by recent Presidentially declared disasters, solely for the purposes of mitigating future disasters.</p>	<p>CDBG-Disaster Recovery: Infrastructure, housing, and economic development projects may incorporate nature-based solutions, usually at the neighborhood or site scale.</p> <p>CDBG-Mitigation: In addition to infrastructure, housing, and economic development projects, planning and administration projects can reduce regulatory barriers to nature-based solutions and help make mitigation investments standard practice.</p> <p>CDBG Funding is unique in that it may be used as a non-Federal match for other mitigation programs, such as HMA and PA Mitigation.</p>

## U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

### SECTION 319 NONPOINT SOURCE MANAGEMENT PROGRAM

DESCRIPTION	PROJECTS
<p>The <a href="#">Section 319 Nonpoint Source Management Program (Section 319)</a> was established under the Clean Water Act. It helps focus efforts to address nonpoint source (NPS) pollution caused by land runoff from rainfall and snowmelt. Section 319 funds can be used for technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and regulatory programs. Contact your state-designated <a href="#">NPS Program Coordinator</a> for more information.</p>	<p>Nature-based solutions demonstration projects related to water quality improvements may also provide hazard-reduction co-benefits; these may include stream restoration, riparian buffer creation, wetland creation, rain gardens, and other bio-retention projects.</p>

# KEY TAKEAWAYS FOR LOCAL COMMUNITIES

Communities that invest in nature-based approaches to reducing disaster risk can save money, lives, and property in the long-term AND improve quality of life in the short term. The key takeaways from this guide are:

1. Building the business case for nature-based solutions can generate widespread interest among diverse organizations. Nature-based solutions can reduce the loss of life and property from some of our Nation's most common natural hazards, such as flooding, storm surge, drought, and landslides. The biggest selling point for nature-based solutions, though, is the many ways it can improve a community's quality of life and make it more attractive to new residents and businesses. Unlike gray infrastructure, nature-based solutions projects serve multiple functions and goals.
2. To build resilience with nature-based solutions, diverse partners must collaborate. Planning and carrying out nature-based solutions requires many departments and processes to work together. Departments will need to cooperate to reduce the barriers to nature-based solutions and make using nature-based solutions a standard practice.
3. Scaling up nature-based solutions will require communities to align public and private investments. Communities can get more bang for their buck by using a range of strategies to enable public investment in nature-based solutions and incentivize private investment.
4. Many types of grant programs can be leveraged to fund nature-based solutions. Since nature-based solutions provide a variety of co-benefits, a single project may be eligible for many different private, state, and federal grant programs. The key to leveraging these resources is to think outside the box when applying for funding, and to apply to diverse programs.



*Volunteers planting sea grass on a beach in Florida.*

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