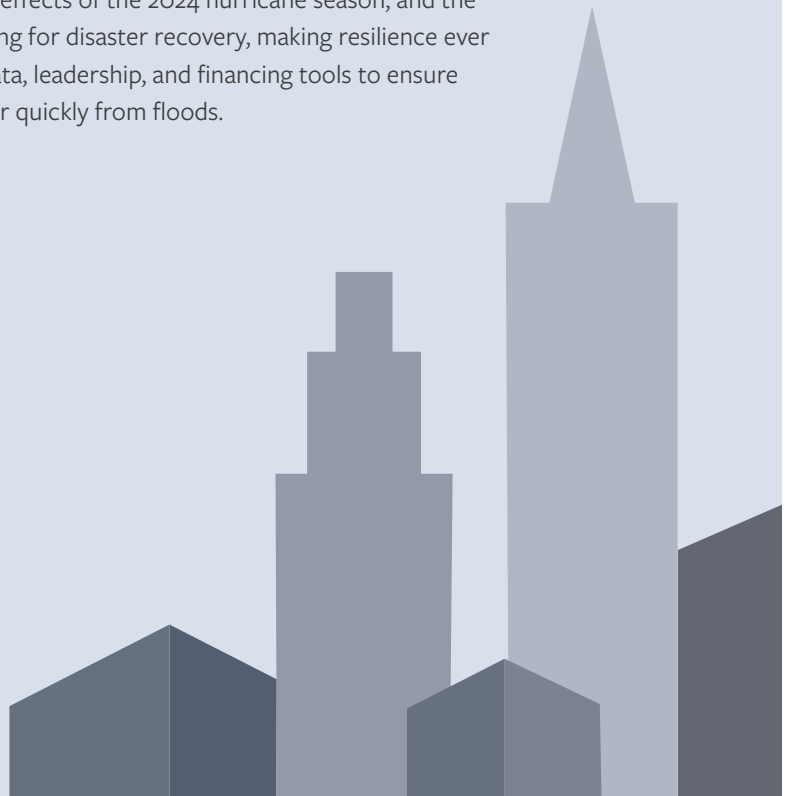




DATA AND FINANCING FOR FLOOD RESILIENT INFRASTRUCTURE

**WINTER 2025 POLICY MEETING
JANUARY 15-16 • WASHINGTON DC**

Many areas of the country are still reeling from the effects of the 2024 hurricane season, and the new administration is expected to cut federal funding for disaster recovery, making resilience ever more critical for US cities. This panel will explore data, leadership, and financing tools to ensure communities are prepared to withstand and recover quickly from floods.



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For length, clarity, and printing purposes, many of these sources have been abbreviated and/or edited from their original form. To read the full, unabbreviated resources from this book, please visit our website or view them on the usb drive provided in your meeting materials.

RESOURCES

PAGE

1

Pages excerpted from “Water Rising: Equitable Approaches to Urban Flooding” US Water Alliance, Aug. 11, 2020.

24

“Best bang for your buck: Flood resilience projects and long-term return on investment,” American Flood Coalition, Nov. 15, 2022.

26

“A Climate Change Success Story? Look at Hoboken.,” Michael Kimmelman, New York Times, Nov. 3, 2023.

31

“Climate-resilient infrastructure that brings people together,” Medium, Jun. 18, 2024.

40

Pages excerpted from “Resilience Focus Area Strategy,” Department of Energy & Environment, District of Columbia, 2023.

47

“Financing Resilience through Municipal Bonds,” Matt Posner, Court Street Group LLC, Jul. 15, 2024.



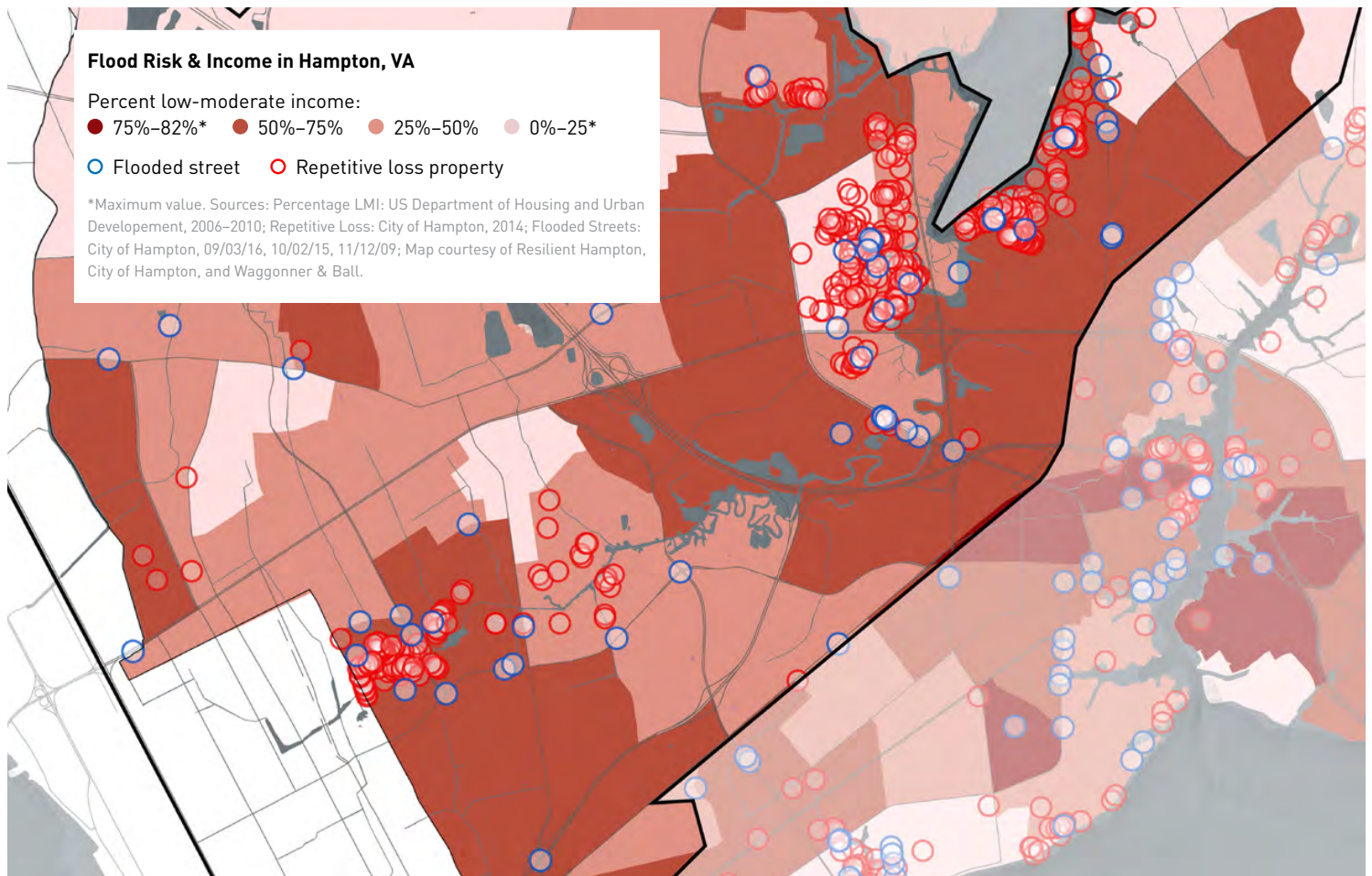
Water Rising: Equitable Approaches to Urban Flooding



Priority Action #1:

Use data to identify risks, assets, and community vulnerabilities.

Like many cities, repetitive flood losses are more prevalent in low-income communities in Hampton, VA.



As a critical first step to protect all communities from flooding, water professionals must consider both infrastructure and social risks. Water utilities and city agencies have a general understanding of how the geography of an area contributes to flooding and what infrastructure needs may exist. Technologies to assess this information in the face of a changing climate are constantly improving. What is missing from the growing body of climate and water data is that this information is rarely overlaid with data on socio-economic disparities within a service area. Water professionals need to know which populations are most vulnerable to flooding and why. By collecting and integrating social data with climate data, they can work alongside high-risk communities to better inform storm-water management, emergency response, and flood mitigation.

Flood risk assessments look at geography and infrastructure over an entire service area.

Utilities manage risk over a broad service area. They are often responsible for stormwater in a metropolitan city, and sometimes in surrounding suburbs. Assessments from this geographic scale consider the risks posed overall to stormwater systems, capacity, and infrastructure assets. Utilities may include or coordinate with floodplain managers, who inform mitigation practices, including zoning, ordinances, and building requirements. Undertaking flood risk assessments at the citywide or regional scale can highlight inequities that may exist within a service area.

Given this, water professionals are starting to scale down climate data to better understand flood risk and improve resilience planning. While climate models are robust, they generally use precipitation (and other) data collected at a macro scale. Agencies must increase the resolution of this data to make meaningful local predictions for a high-level understanding of existing and future flood risk over a utility's entire service area. This scaling down process is tedious and time-consuming. But it better informs capital projects for gray and green infrastructure,

retrofits on existing assets, new operations and maintenance controls, and emergency management practices within the context of a changing climate.

It is important to augment flood risk assessments with analyses that reveal who is most vulnerable.

Because climate change and flooding impacts on specific populations are not inherent in technical assessments, it is also important to consider community vulnerability. Utilities should not rely on community groups alone to bring forth this information. Water professionals must actively identify social, economic, and environmental vulnerabilities. As discussed earlier in this report, there are many reasons certain groups may be more vulnerable to flooding. It is important to both identify these high-risk populations and understand the particular challenges they have with flooding.

The methods used in gathering this information are important. Social and economic data are commonly available only at a macro scale (such as census blocks) or include outdated information (for instance, augmented census survey data). Water professionals must work with communities to obtain and verify information, so it is as precise and complete as possible. This means meeting the community where its members live. For example, if a city agency holds a midday workshop to gather and understand information, very few people from vulnerable communities will be able to attend. Some cities, such as Seattle, have hired utility liaisons in vulnerable communities that connect with residents' day-to-day lives. This is proving an effective method to identify how flooding affects vulnerable populations.

Key populations to consider when assessing vulnerability include but not limited to:

1. The elderly
2. Families and individuals living in poverty
3. Individuals with disabilities or health conditions
4. Individuals with limited English proficiency
5. Renters
6. Racial, ethnic, and indigenous minorities
7. Young children

Water professionals can leverage social and demographic data collected by city agencies and community organizations.

Incorporating community vulnerability into flood risk assessments does not necessarily mean launching an entirely new data-gathering effort. Water utilities may need to coordinate with other water professionals, as well as housing departments, planning agencies, community development corporations, and community-based organizations to collect and cross-tabulate data. Many agencies already collect an array of social and demographic information that can be overlaid with climate data. In Richmond, CA, the City recently launched a Climate Action Plan Open Data Dashboard. The online portal serves as a convenient location to collect a wide array of social and demographic data in a transparent, accessible way. The portal is available for use by all communities in their resilience planning. The City is updating map tools to display data geographically for flood risk, infrastructure assets, and social vulnerabilities together.

Public health departments may also provide helpful vulnerability-related information. These agencies can identify early warnings of illnesses related to water quality impairments because they review data from healthcare providers, clinical laboratories, and hotlines, which are the first places where water-related illnesses become apparent. Tracking such public data can be especially important after unexpected water system failures occur from flooding, storm surges, or extended cold spells followed by rapid snowmelt. Public health data is also useful in anticipating cumulative impacts on communities facing multiple climate stressors. Health officials can also help utilities conduct public outreach, as they often have developed reliable methods of outreach for vulnerable and hard-to-reach residents.

Technical data paired with equally important social data drives resilient solutions.

Despite the vast amount of information out there, many cities lack specific details on where urban flooding occurs, the specific consequences, and who it affects the most.¹ Water professionals should seek many types of information to fill this gap and build a comprehensive risk analysis. The information can include data from climate models, topographical details of the watershed, information from both federal and commercial insurance claims, and data on social vulnerabilities. Few cities are collecting this social information and systematically overlaying it with flood mapping and infrastructure assessments.

Qualitative research can help supplement missing or incomplete information. Working directly with communities to collect *and* use vulnerability information helps build trust and ensure investments are cost effective, meet multiple objectives, and contribute to community resilience. As the needs of communities change with the impacts of climate change, this approach becomes even more important.

One example of where this is happening is in East Pittsburgh. Climate experts at the RAND Corporation are working with Pittsburgh Water and Sewer Authority to integrate technical and social data for innovative green infrastructure system design and policy evaluation. Advanced modeling of wet weather events in the Negley Run Watershed is identifying hilly areas that already experience regular flooding. Paired with social information, a more comprehensive approach to mapping risks emerged. The Larimer and Homewood neighborhoods have historically poor drainage systems. RAND is working with community outreach groups to develop neighborhood-level runoff reduction strategies and target best management practices on individual lots.²⁶

Case Example

City Management Partners with Residents to Identify Neighborhood-Friendly Solutions in Hampton, VA

Location

Hampton is a historic coastal city at the mouth of the Chesapeake Bay, which opens to the Atlantic Ocean.

Land Characteristics

The city is low-lying, with a highest inland elevation of about 20 feet. Much of the city has been impervious since 1610. Almost one-third of the city lies in FEMA flood zones. Most of these areas experience repetitive loss claims, or when an insurable structure experiences two or more flooding events in 10 years that cause \$1,000 or more in damage.

Key Water and Climate Challenges

- Nuisance flooding
- Projected sea level rise of at least three feet by 2100
- Land subsidence
- Coastal storms (nor'easters, storm surges)
- More intense rainfall
- More frequent hurricanes
- Increased groundwater levels

A unique partnership between two remarkable women is brewing in the Briarwood Terrace neighborhood of Hampton, VA. Mary Bunting, the City's first female city manager, and Velva Goodman, a long-time resident and the president of the Briarwood Terrace Community Association (BTCA), are bringing together technical data with social considerations to better inform flood management in a historically underserved area.

Briarwood Terrace is in an area of the city subject to heavy rainfall flooding compounded by tidal events such as hurricanes or nor'easters. Residents are predominantly senior and/or African American. It is also among the first for evacuation orders during hurricanes. Velva brought her neighborhood's flooding concerns to the city manager and Department of Public Works. The City put together the Resilient Hampton Initiative, an effort to prepare for climate-related water challenges, and soon began working with Velva through this effort. City officials, including Mary, visited the neighborhood and attended meetings to further learn about and document flood issues.

As Mary's team spent time with Velva and her neighbors, they quickly saw a need to look beyond the City's assessments. They had to consider the neighborhood's infrastructure, geography, and social vulnerabilities to ensure solutions fit the neighborhood's unique characteristics. The City, therefore, began actively using neighborhood demographics to inform where to focus mitigation, as well as what strategies make the most sense for the residing population. For instance, in Briarwood Terrace, relocation is very difficult for seniors who have lived in their homes for decades, many for 50 years or more. Residents in wheelchairs or with mobility issues also have trouble maneuvering around old building designs and tight spaces, making it difficult to evacuate on their own. Many rely on one another when deciding to evacuate or in the aftermath of a flood. Seeing their homes repeatedly flood frustrates Velva and her neighbors, yet the idea of moving is emotionally difficult and not financially feasible for some. Residents in Briarwood Terrace prefer to stay in their homes and work with the City to minimize flooding rather than relocate.

The pairing of this technical and social information led the City to prioritize the Newmarket Creek area, which includes Velva's neighborhood of Briarwood Terrace. But Mary's team is taking this approach a step further to better address the needs of those most vulnerable. They developed the *Newmarket Creek Water Plan* for a multi-faceted approach to stormwater management: slow, store, redirect, adapt. Pilot projects are underway to alleviate flooding and add community benefits such as greenways and recreation areas. The Big Bethel Blueway pilot will use a stepped weir approach to manage stormwater flows and improve water quality with green infrastructure. This will reestablish water as a key community asset by incorporating a linear park and trail system. The Blueway will run along the creek behind Velva's house.

Velva, Mary, and many other individuals working with them do not always agree. But they share a common goal of keeping the Briarwood Terrace a safe neighborhood for all residents. To do this, they are collaborating around efforts that identify vulnerabilities and working to find multi-benefit solutions.

Priority Action #2:

Commit to ongoing and meaningful community engagement.

Father Taylor discusses equity and sustainability with forestry students at a rain garden in front of St. Ambrose Episcopal Church in Raleigh, NC.



Community engagement is often talked about in resilience work. Too often, approaches to community engagement involve deciding on a strategy and *then* informing or garnering input from those most affected. To effectively communicate risk and design flooding solutions that work for communities, cities must go beyond this kind of engagement. They must identify problems and develop solutions in tandem with communities, involving residents from the outset *and* throughout the implementation of projects. This inclusive approach supports better prioritization of community needs and safety. It further allows cities to examine potential unintended consequences, such as how new inequities may emerge, and build toward long-term stewardship of flooding infrastructure as a public asset.

Information exchange creates a collective understanding of risk.

Resilience planning should incorporate all types of knowledge. Utilities, other city agencies, and communities all have useful knowledge that informs flood risk and recovery, and they need channels to share this information with each other. This may involve qualitative research, such as talking to residents or surveying vulnerable communities. People living in high-risk areas have extensive knowledge of the realities of chronic flooding. They know their neighborhood's specific challenges with floodwaters and have a better understanding of external factors, such as affordability concerns, that affect their ability to prepare, cope with, and recover from disasters. This lived experience can help evaluate appropriate flood mitigation. Citizen science techniques may be useful to fill data gaps. Some organizations use cell phone cameras and apps to document flooding impacts and provide localized information in a visual format.

Similarly, residents need a better understanding of climate uncertainty and potential infrastructure solutions. Utilities can provide educational resources to help communities understand what complex scientific information means in terms of localized flooding impacts, as well as emergency preparedness and what people can do to protect themselves. Information may need to be broken down or provided in multiple languages. Information exchange better positions communities to assess their risks and weigh in on decisions. This leads to local strategies that address residents' needs while contributing to broader urban flood management. It also leaves communities more prepared to activate emergency response during extreme events that can result in major flooding such as hurricanes and nor'easters.

Sharing multiple options with communities leads to comprehensive decision-making processes.

Since climate change means a range of possible futures that impact flooding, it is helpful to present communities with multiple mitigation solutions, allowing them to compare and contrast options. Understanding different scenarios and working with communities to evaluate various options helps vulnerable residents take control of their futures and build trust with cities and utilities. When considering multiple scenarios, several alternatives emerge. Cities, utilities, and communities must work together to explore these alternatives. Together, they can arrive at a decision that meets the utility's regulatory mandate and reduces vulnerability in each neighborhood. This ensures that infrastructure investments, mitigation solutions, and supporting policies benefit everyone. For example, in the low-lying, low-income Proctor Creek neighborhood of Atlanta, GA, the Department of Watershed Management partnered with community-based organizations to gain intensive input from the community on what kinds of green infrastructure solutions would and would *not* be effective. They are also working to engage residents in the long-term maintenance of the planned green infrastructure facilities.²⁷

Communities need support to participate authentically.

Sometimes community representatives have the knowledge and willingness to work with water professionals but lack the time or ability to engage as deeply as they would like. Cities or utilities can support widespread participation by providing a stipend to compensate community members for their time, providing transportation to meetings and events, offering childcare, ensuring translation services are available, and providing healthy meals. Community

partners can offer advice on how best to engage their communities, and they can also recommend local vendors and services. Utilities or cities can hire community leaders as paid consultants to help develop these strategies, vet scenarios, or gather input on potential flooding solutions.

Building relationships with community leaders enhances trust in vulnerable neighborhoods.

Community-based organizations can make good partners for water professionals since they often have trust among residents. Utilities and city agencies can build relationships with these organizations to help gain trust in neighborhoods. They can invite leaders from these organizations to serve on advisory committees to help define the issues and co-develop goals, visions, and principles to guide planning processes.²⁸ Advisors may include people like neighborhood nonprofit staff, healthcare professionals, or block club leaders. Working through community organizations can help with course-corrections and finding alternative solutions for a neighborhood when unforeseen challenges arise. Such ongoing local feedback helps ensure that vulnerability information is not just collected but also used throughout the process. In turn, this helps build trust and ensure that investments are cost effective, meet multiple objectives, and enable community resilience.

For example, the Milwaukee Metropolitan Sewerage District (MMSD) was rehabilitating the Kinnickinnic River to increase flood capacity and meet public safety objectives. This \$80 million flood protection project would require a wide land footprint along some residential corridors. MMSD worked through local community health centers, trusted voices and spaces in neighborhoods, to reach Spanish- and English-speaking residents. Recognizing the critical link between environmental health and community health, MMSD also partnered with the Sixteenth Street Community Health Center to forge a coalition working to restore the river, and in so doing, helped to reinvigorate and revitalize the surrounding community. The team developed goals and objectives based on the list of critical design issues and stakeholder input.²⁹ Ultimately, residents helped decide how the project would daylight a river to restore green space and reduce flood risk. As part of this process, the utility and community worked together to purchase homes in the flood zone and relocate residents to safer areas.

**US Water Alliance Water Equity Taskforce:
Best Practices for Community Engagement**

The US Water Alliance's Water Equity Taskforce is a network of seven cities across the United States that established cross-sector teams to work on water and equity challenges from 2017 through 2020. Though their work did not focus solely on climate issues, insights from these cities about how to invest in and maintain community engagement is useful for the context of urban flood resilience.

- **Acknowledge historic injustices as contributing factors to water challenges.** Many communities are already suffering from disproportionate climate impacts and have a distrust in local and government agencies that needs to be acknowledged and addressed.
- **Assume everyone has good intentions.** Many water professionals come from the communities affected by their policies. When navigating disagreements about what approach to take, all stakeholders should keep in mind the shared goals of public safety and resilience.
- **Honor lived experience, academic information, and technical expertise.** All are important forms of knowledge that can inform solutions to flooding.
- **Provide varied engagement opportunities and share power.** Multiple touchpoints with communities ensure people with schedule, resource, or participation challenges can still engage.
- **Slow down and build trust.** Relationships and co-creating take time. When possible, agencies can accept a slower pace for decisions or project timelines, identifying easy wins along the way.
- **Water always finds a way. Be like water.** Equity and resilience are hard work. Stakeholders may have to step outside their normal bounds to find a solution.

Case Example

Community Advises and Oversees Flood Mitigation Efforts in Raleigh, NC

Location

Raleigh is the capital of North Carolina. It is an inland city located in the eastern-central part of the state. With several universities and technology institutions, the city is part of the area known as the Research Triangle.

Land Characteristics

Raleigh lies where the coast meets a hilly region known as Piedmont. There are many parks and wooded areas. Impervious cover ranges from 20 to 65 percent throughout the city, which lies about 400 to 500 feet above sea level.

Key Water and Climate Challenges

- Alternating floods and droughts
- Extreme precipitation events
- More frequent and severe hurricanes
- Longer and more frequent droughts
- Hotter temperatures
- Risk of over 30,000 properties being inaccessible during inundation, and of road damage during flood events

When it comes to stormwater management, community engagement has taken on new meaning in Raleigh, NC. The City is pairing an aggressive, multi-faceted approach to address flooding with creative solutions residents have raised.

For neighborhoods such as Rochester Heights, this is important. In 1957, a local policy developed the area as an African American neighborhood.³⁰ Like so many communities of color across the nation, Rochester Heights is in an area with frequent sewer overflows and previously had been a garbage dumping ground. Many of the streets are in the floodplain, making them prone to frequent rising waters. The City has also historically underinvested in the neighborhood's infrastructure. As a result of these inequities, many residents have an inherent mistrust of city agencies and officials. Although there were some property buyouts following Hurricane Fran in the 1990s, recent gentrification means that affordable housing issues are adding another layer of vulnerability onto neighborhood residents.

Given these historical and continuing injustices, it is critical that residents have a central role in deciding how the City addresses flooding. One way this happens is through residents participating in the Stormwater Management Advisory Committee (SMAC). City Council backs the interagency group SMAC, which provides input on flood mitigation. Community advocates and residents work alongside utility and city officials through the committee. SMAC meets regularly to guide decisions and develop and implement projects. Their efforts are part of the City's broader *2030 Comprehensive Plan*, which directs infrastructure resilience. The City coordinates plans across stormwater, transportation, public utilities, housing, parks, and cultural resources departments. The plan includes several priorities in preparing for a changing climate: assisting with response and recovery, reducing sensitivity to climate impacts, building adaptive capacity, and reducing exposure.

The Reverend Jemonde Taylor of St. Ambrose Episcopal Church is a SMAC member. A mechanical engineer by training, he has long educated residents on stormwater and is working with the Walnut Creek Wetland Park to install rain gardens and develop "parks with a purpose" to help mitigate nuisance flooding. In Rochester Heights, Father Taylor's work with SMAC at the municipal level bolsters the neighborhood's green infrastructure projects. A proposed "no new development" in the floodplain restriction for commercial and residential properties is perhaps the most promising example. This emerged following a recent convening that looked at the city's floodplain regulations.

Stakeholders included differing interests from real estate developers, homebuilders' associations, commercial interests, residents, and the Public Works Department. They found common ground through a series of discussions that assessed all risks and vulnerabilities. The proposed restriction is in review by City Council. Meanwhile, the Stormwater Management Division and Office of Emergency Management are implementing a flood early warning system that combines stream gages with remote monitoring cameras. Water sensors at low-lying road crossings activate flashing lights to warn motorists. The next phase will include an advanced warning of flooding based on rainfall predictions and a streamflow model.

Through all these efforts, Raleigh is working to improve collaboration with the community and implement policies and systems that will improve its resilience and keep residents safe during flooding conditions.

Priority Action #3:

Set a proactive vision and build strategic alignment.

Water Trails design concept for Des Moines, IA.
Credit: Bolton & Menk, Inc.



A proactive vision for flood management enables water managers, public agencies, and community partners to align their capacities and resources. Flood resilience is not just one agency's purview. Floodwaters cross social, political, and geographical boundaries. It is important to build a strategy that considers needs and leverages opportunities across all these boundaries. In turn, this allows agencies and neighborhoods to enact cost-effective, multi-benefit solutions. Local alignment can achieve public safety, water quality, and regulatory goals while building coalitions to prioritize equity. This strengthens coordination for additional support from the government at the broader metropolitan region, state, and federal levels.

Innovative thinking around flood prevention can produce more equitable results.

Research shows that for every dollar invested in pre-disaster mitigation, society saves six dollars in recovery costs later.²³ Whether preparing for hurricanes or reducing nuisance floods, preventing flood impacts is more cost-effective than responding to them. Yet the nation's current federal disaster relief framework is reactive and does not encourage or enable proactive thinking and measures. The Federal Emergency Management Agency (FEMA) is the primary source of federal funding for flooding—and the resources almost always flow in the wake of a hurricane or flood disaster. As much as 85 percent of FEMA's public assistance dollars for disasters go toward flood-related losses, not prevention.³¹ From 2005 to 2014, the federal government spent nearly \$278 billion on disaster assistance, with limited and insufficient funds going toward preparation and mitigation efforts.³²

As the nation experiences more extreme events, federal attention is shifting toward the importance of flood mitigation. In 2020, FEMA will roll out a newly established Building Resilient Infrastructure and Communities (BRIC) program. BRIC's goal is to move "away from reactive disaster spending and toward research-supported, proactive investment in community resilience."³³ BRIC improves on FEMA's existing Pre-Disaster Mitigation program by allocating a set amount of funds—six percent—to this purpose and streamlining the process for communities to access those funds.

There are many ways that cities can also be proactive and unlock a focus on flood mitigation for historically marginalized or vulnerable communities. Some are specifically targeting equity in flood response. Others are infusing equity considerations in local and regional efforts. In Chicago, flooding is an increasing concern. Many residents in south Chicago neighborhoods commonly report localized flooding issues. In fact, "87 percent of flood damage insurance claims were paid in communities of color" between 2007 and 2016.³⁴ More recently, rising lake levels combined with significant erosion along the shore are causing additional flooding in these and other areas. The mayor recently appointed the city's first chief equity officer, charged with examining racial and other injustices, bringing an equity lens to policymaking and practices across city departments. This involves helping city agencies identify how to share decision-making power with communities. An alignment of equitable approaches across sectors will allow the City to address flooding proactively and other issues in vulnerable communities.

Alignment around flooding can occur across a neighborhood, a city, or even a region.

As water utilities prepare for climate change, many other agencies may be doing related work in parallel. Sharing social vulnerability data and aligning goals, approaches, and resources among agencies can make flood resilience processes more efficient and equitable. Water utilities can find opportunities to coordinate with other municipal or regional departments and agencies during their planning processes.

The New York City Department of Environmental Protection's green infrastructure program initially focused on reducing stormwater runoff to control combined sewer overflows. The utility, however, is now incorporating these projects into the design of public spaces and streets to better serve areas like Southeast Queens,

a historically disadvantaged neighborhood with predominantly communities of color. This is part of a \$1.9 billion investment in green and grey infrastructure projects throughout the city.³⁵ In Southeast Queens, investments will target drainage system improvements and rain gardens to mitigate nuisance flooding in homes and manage heavier rainfall events. The Southeast Queens program emerged from the mayor's 2015 *OneNYC Plan* that integrates equity, sustainability, and resilience across all sectors. NYCDEP's curbside rain gardens and drainage system projects align with broader city efforts to fight the impacts climate change has on vulnerable communities, including the City's Green New Deal and Climate Mobilization Act.³⁶

Coordinating efforts across sectors can extend benefits beyond flood management.

In addition to coordinating on flood management, water managers can also coordinate with agencies in other sectors who are planning projects in the same neighborhoods. Coordinating with transportation, education, clean energy, and public space projects that are taking place within vulnerable neighborhoods can help maximize benefits and minimize disruptions. As municipalities undertake improvements to roads or public transportation, utilities can partner with other city departments to make any below-ground infrastructure repairs and limit the disruption to neighborhoods. At the same time, utilities can develop above-ground assets such as green infrastructure in the public right-of-way.

Or there may be opportunities to add flood mitigation benefits to existing city improvement projects. In Jackson, MS, plans are underway to open the Museum-to-Market Trail. The 2.5-mile greenway will enhance walking and biking between the city's museums and farmer's markets. The project is a partnership between the Mississippi Department of Transportation and Central Mississippi Planning and Development District. City Council is working with the Department of Public Works and other water professionals to explore whether adding stormwater management components like bioswales and rain gardens along the greenway could reduce flooding for nearby neighborhoods.

Partnerships that leverage funding reduce the cost burden for single agencies.

Utilities can look for partners as an opportunity to leverage resources, from staffing to materials to outreach efforts. Flood resilience projects can serve to create public spaces and educational resources for vulnerable communities. For instance, projects could include designing and retrofitting schoolyards and public spaces to double as stormwater management assets and environmental education gardens. Park departments can work with utilities to fund community green space above water infrastructure components such as pumps and tanks. Many utilities have partnered with community groups and local artists to transform utility assets by incorporating local artwork into projects, as well as creating green space, recreational facilities, and educational training centers. Local philanthropic foundations are also potential partners.

There is an enormous opportunity to pool resources. San Francisco Public Utilities Commission (SFPUC), for instance, is partnering with San Francisco Unified School District for the city's first "stormwater schoolyard" at Robert Louis Stevenson Elementary School. This joint effort will manage 476,300 million gallons of stormwater per year through green infrastructure that further enhances nature play for kids.³⁷

Alignment and partnerships create a stronger pitch when applying for federal grants or loans for pre-disaster mitigation projects. Promoting partnerships to enable larger projects is one of the guiding principles of FEMA's new BRIC program. Such alignment may also further position stakeholders to navigate tricky federal programs and leverage future interventions.

Case Example

Regional Collaborations Drive an Equitable, Multi-Pronged Flood Strategy in Des Moines, IA

Location

Des Moines, Iowa's capital, is in the center of the state. It lies at the confluence of the Des Moines River and Raccoon River, where the two watersheds intersect.

Land Characteristics

Suburbs and agriculture surround this inland city. Ninety-five percent of native prairie ecosystems have been removed for development and agriculture across the state.

Key Water and Climate Challenges

- One of the fastest-growing areas in the Midwest, with increased development and impervious surfaces.
- More than 150 miles of waterways within the metro area.
- Precipitation has increased over the past 10 years, causing more frequent riverine and urban flooding issues.

Torrential downpours hit Central Iowa and the Midwest in the summer of 2018. Major flash and riverine flood damage occurred throughout the area, including Des Moines. The city also suffered severe river flooding in 2010, 2008, and 1993. Those affected during the floods included low-income communities, migrants, persons with disabilities, those over age 65, the single head of household families, and people of color. Standing in front of the collapsed basement wall of her now uninhabitable home, an elderly resident of the most heavily affected neighborhood reported, "I'm strong, I'm alive, I survived."

These impacts are driving stakeholders to take a broad, collaborative approach to flood management in the Des Moines area. Efforts are underway to build resilience for both riverine and urban flooding with a comprehensive strategy that crosses scales, sectors, and jurisdictions. Coordination occurs across water, transportation, agriculture, and emergency planning, as well as from the neighborhood level up to the regional scale.

For Jonathan Gano, director of public works, neighborhoods are a key focus in this push. As his team works to improve flood resilience along smaller tributaries in Des Moines, their proactive approach includes investments in a greenway system along the 500-year floodplain. Although FEMA previously provided funding for buyouts following

disasters, the City realized this was inequitable when the relief inventory removed affordable housing. Jonathan's team is working with communities to weigh decisions on voluntary buyout options to relocate residents to safer grounds. Current efforts include prioritizing funding for buyouts and flood resilience projects in previously underserved neighborhoods with immigrant and senior residents, such as in Fourmile Creek. The Department of Public Works is also installing in-field agricultural watershed improvements and large-scale detention basins upstream to slow and store water downstream to Fourmile Creek and other tributaries. Levees enhance flood protection in the downtown central business district.

The City of Des Moines' work aligns with much of the regional water-related efforts led by the Metropolitan Planning Organization (MPO) and MPO Associate Planner Allison van Pelt. She works with regional watershed management authorities and their member jurisdictions to establish and promote stormwater best management practices (BMPs) and cost-share programs for private properties through the Rain Campaign. She also works to develop and adopt cohesive regional stormwater ordinances and regulations across the metro area and other major watershed improvements throughout Central Iowa. MPO's recent *Greater Des Moines Water Trails and Greenways Master Plan* outlines opportunities to enhance 150 miles of regional waterways into recreational amenities that also provide flood mitigation, ecological and safety enhancements, and economic development opportunities. Many executives in the Des Moines area deemed the more than \$100 million regional project a "game-changer," to help raise awareness of the importance of water quality and watershed improvements among those in the mainstream business world. The MPO and its partners were recently awarded a \$25 million federal Better Utilizing Investments to Leverage Development (BUILD) grant that will significantly accelerate the project. Equity and inclusion are key components.

Together, these actions are building a suite of flood reduction measures that enhance equitable flood resilience. Allison and her colleagues are also developing a regional online mapping tool that will gather social, water, and climate-related data across jurisdictions. Communities are contributing information for the tool. After compiling data, an online education and engagement platform will be publicly accessible. A detailed database of practices, projects, funding, and more will be available to city and other staff to use in developing local and regional projects.

Priority Action #4:

Fully incorporate equity into resilience planning processes.

Green infrastructure helps mitigate flooding and offers multiple benefits in Philadelphia, PA. Credit: Philadelphia Water Department



Every step of the climate resilience planning process is an opportunity to consider equity. By incorporating social vulnerabilities, flood resilience strategies can be more reflective of all communities. When utilities and cities help the most vulnerable, they create more durable outcomes. In turn, it can boost efficiency, reduce costs, and improve project outcomes. This is even more important in the face of a changing climate.

Consideration of social vulnerability in planning activities across all operations provides a clear path for equitable flood management strategies.

The climate resilience field itself is still fairly new and rapidly evolving. It may not follow a linear path through agencies. Cities and states generally develop climate adaptation plans across several agencies, including water utilities. Large utilities may create their own plans. Efforts to integrate stormwater and flood management within this broader context are still emerging. Because responsibilities for stormwater, flood mitigation, and climate adaptation cross multiple local government agencies and utilities, all agencies and efforts should consider equity. The steps that each agency takes will vary. Successful processes generally move from risk identification and data gathering, through assessments and planning, to funding and implementation, building in monitoring and adjustment.

One way the San Francisco Public Utilities Commission—a water, sewer, and electric power utility serving 2.6 million people in Northern California—works to consider equity in all operations is through a community benefits assessment. Such assessments are guiding the utility's Sewer System Improvement Program (SSIP), a 20-year citywide investment to upgrade San Francisco's aging sewer infrastructure to ensure a reliable, sustainable, and seismically safe sewer system now and for generations to come. The SSIP calls for building new facilities using a climate change design criterion so that the sewer system will respond better to rising sea levels and other impacts. Community benefits and inclusion are an important level of service goal for these facilities, with strategies to ensure economic and job benefits to the communities they serve and maintain ratepayer affordability. The utility

also established a level of service goal tied to flooding—which is driving the use of innovative green stormwater projects together with upgrades to sewer pipelines to minimize how stormwater affects neighborhoods and the sewer system. By linking climate resilience, flooding, and equity goals, the SFPUC can maximize the benefits of the sewer system rebuild.

Scenario planning helps consider future climate possibilities and impacts on vulnerable communities.

Although climate data and models have improved significantly, there is still some uncertainty in how much the climate will change and what localized impacts will be. This is particularly true when looking at the compounding impacts of climate change on different vulnerable populations.

The Water Utility Climate Alliance (WUCA), for instance, is a collaboration of 12 utilities building leadership to better understand and address how the climate affects water resources and infrastructure systems. WUCA works with uncertainties through scenario planning to inform decision-making processes. WUCA conducts trainings for other utilities and water managers on how to incorporate climate science and manage uncertainty for no-regrets solutions.

Scenario planning can scale up equitable flood resilience efforts. Looking at a range of future scenarios can lend insight into what flooding challenges may arise and how flood risk might change in a given community. Incorporating equity considerations into the scenario planning process can provide an important opportunity for advancing water equity amidst uncertainty. Water professionals can work with community representatives to help determine which scenarios to consider, as they have a sense of how different circumstances may affect their neighborhoods. The assessment stage of risks and future uncertainties can include data collected on social vulnerabilities. Findings from this work can then inform planning processes to develop equitable adaptation strategies.

Strategies grounded in community solutions and shared decision-making improve outcomes.

Communities are increasingly taking it upon themselves to identify their own climate challenges, including flooding, and develop solutions from the ground up. Fully incorporating social vulnerability into resilience planning may involve integrating community efforts with utility

or citywide initiatives and plans. The National Association of Climate Resilience Planners notes that “processes grounded in community assets can amplify resilience strategies already in play and embody desired outcomes at every stage.”³⁸ This provides multiple touchpoints along the planning process for different “stakeholders to vision, experiment, reflect, and refine solutions [as they] reflect on habits and patterns that perpetuate inequities and limit resiliency.”²²

For example, in Philadelphia, an interagency Flood Risk Management Task Force (FRMTF) has been operating since 2015. Eight city departments—including water, emergency management, parks sustainability, and others—came together to coordinate resources and address flooding as it affects different neighborhoods. More than 15 other local and federal agencies advise on projects and provide technical assistance to the group. The FRMTF builds resilience through four key components: public information, mapping and regulations, flood preparedness, and flood damage reduction. The group has engaged communities throughout the process, tailoring flood management to the various challenges in different neighborhoods. To improve the involvement of vulnerable communities, the FRMTF began piloting a community-led sub-task force in 2020. The goals are to give voice to community leaders, empower stakeholders to guide decisions on flood resilience projects, and improve risk communication and information flow between the agencies and residents.

Equitable resilience is a new approach; utilities and communities learn as they go.

Embedding equity is a continuous, adaptive process with routine monitoring and adjustments. While the intersections of water, climate, and equity run deep, it is only in recent years that they have begun to challenge our existing ways of approaching flood solutions. Building a shared understanding of risks and finding cost-effective solutions that meet community needs and regulatory requirements can be challenging. Stakeholders are learning as they go about what works and what does not.

On the east side of Detroit, MI, torrential downpours combined with riverine flooding have caused property damage and flooded basements in the Jefferson Chalmers neighborhood. The neighborhood is predominantly African American and has a low median household income compared to other parts of the city. Most of the neighborhood’s houses built in the early 1900s also lack air conditioning systems. This poses a dual threat, as the community grapples with hotter summers and more frequent, heavy rains. The Detroit Water and Sewerage Department (DWSD) is working with the Housing and Revitalization Department; Buildings, Safety, Engineering, and Environmental Division (BSEED); and the community-based Southeast Michigan Long Term Recovery Organization to reevaluate disaster risks and a range of solutions to improve emergency response, while building out long-term mitigation strategies.

Across the nation, the stakes are high and both communities and utilities must remember that working together is an ongoing process and may change over time. As community needs change, or new flooding challenges arise, strategies may also need to evolve. Opportunities for continuous learning and course correction of strategies along the way allow water professionals to check in with communities regularly, re-evaluate risks and needs, and update management actions accordingly.

Case Example

A Focus on Equity Centers Communities in Climate Plans in Seattle, WA

Location

Seattle is among the fastest growing cities in the US and is located on Puget Sound in the Pacific Northwest.

Land Characteristics

This heavily urbanized city has filled natural ponds and wetlands over time, increasing impervious cover. Median home prices grew by 14 percent in 2018, compared to 4.1 percent nationwide.

Key Water and Climate Challenges

- Rise in the Puget Sound shoreline (already more than 6 inches in the 1900s).
- Sea level on Seattle's coastline, which may rise another 10 inches by 2050 and 28 inches by 2100.
- Localized flooding from intense rainfall, king tides, and high winds.
- Urban flooding in streets, particularly in areas lacking sufficient drainage.

In the Pacific Northwest, Seattle Public Utilities (SPU) is reorienting as an anchor institution in the city, a "community-centered utility." Three pillars guide this shift: risk and resilience, affordability and accountability, and equity and engagement. SPU is integrating these pillars throughout all services, with accountability metrics to institutionalize them in practice. SPU's ongoing robust approach to climate adaptation, based on extensive modeling and the use of climate data, prepares for sea level rise and reduces urban flooding risks.

Keeping equity front and center means the utility considers all factors that contribute to flood vulnerability. Affordable housing is one of the biggest issues in this rapidly developing city. SPU is considering how the housing crisis has a significant effect on public safety during water- and climate-related disasters in vulnerable neighborhoods. The utility is overlaying the Racial and Social Equity Index—a tool developed by Seattle's Office of Planning and Community Development to help all departments prioritize improvements—with a comprehensive analysis of drainage system capacity and wastewater management. The updated hydrologic and hydraulic models, coupled with environmental justice

information from the index, will drive infrastructure investments over several decades.

This is important for areas like South Park, an industrial neighborhood along the Duwamish River. Many parts of South Park lack sidewalks, curbs, gutters, and sufficient drainage infrastructure. The neighborhood experiences regular flooding from stormwater, water main surcharges, and extreme high tides along the Duwamish. The area has a high concentration of immigrants, many of whom face language barriers when it comes to flood risk communication from the City.

Climate resilience has not always been top-of-mind for South Park. As with many vulnerable populations, South Park is dealing with much more immediate and pressing challenges related to economic displacement and health disparities. Therefore, SPU sees a need to integrate those challenges into their flooding solutions, and Ann Grodnik-Nagle, SPU's climate policy advisor, works closely with the community to address this head-on. Robin Schwartz of the Duwamish River Cleanup Coalition is a key partner organizing grassroots efforts in the area to align community voices and prioritize environmental needs. One of those voices is Monica Duarte, a community health worker at Villa Comunitaria, a South Park-based community service organization. Her work did not primarily focus on flooding issues until she saw the connections between climate effects and public health, making Monica an important educator on flooding within the Latinx communities.

SPU's goal is to align citywide efforts with community priorities to increase resilience. One exciting project for South Park is an innovative virtual reality (VR) experience of sea level rise. SPU is developing this tool in coordination with Seattle Public Library and the University of Washington Climate Impacts Group, building on a VR history of the Duwamish River that Seattle Public Library developed in 2019. The new tool will bring maps showing the two-to-four foot high water mark to life, allowing Ann and Monica, plus local schools and community-based organizations, to articulate a visual representation of the risks to residents and help prioritize their adaptation needs. As the City extends beyond infrastructure improvements, it will continue to focus on leveraging utility investments by driving economic opportunities and anti-displacement measures across neighborhoods.

Priority Action #5:

Target investments in vulnerable communities.

Flooding from Hurricane Harvey was widespread and disproportionately impacted Black and Brown communities throughout Texas. Port Arthur, TX, 2017.



Equitable resilience will require a careful rethinking and, at times, a reallocation of resources to neighborhoods most affected by flooding. Along with the planning process, it is essential to dedicate funding sources for vulnerable communities, particularly since climate impacts can increase financial volatility for utilities. It can be unwise to defer investments in equity, even in times where budgets are squeezed. Preparing for an uncertain future calls for no-regrets solutions and strategies that provide multiple benefits. Creating targeted funds for equity and setting benchmarks for spending helps include vulnerable communities in flood adaptation and mitigation strategies. By working together, cities can address system risks and needs for all communities.

Considering social vulnerabilities reorients the prioritization of investments.

Water professionals have a range of tools and strategies at their disposal to strengthen the communities that are most vulnerable, such as different types of early flood warning systems or a blend of green and gray infrastructure upgrades. Because vulnerable communities are often in high-risk areas, they may have a greater need for investment in flood management measures. For example, Cleveland's *Climate Action Plan* placed neighborhood revitalization at the center of efforts to manage an increase in precipitation volume and frequency. The Office of Sustainability worked with over 50 organizations to assess risks, needs, and resilience strategies. It built a toolkit with residents to guide neighborhoods in developing their own stormwater projects. A Climate Action Fund was established to finance neighborhood projects. The City has awarded \$100,000 to 25 different projects to date, including rain barrels, community gardens, and programs to hire from within vulnerable communities.

When selecting sites for physical adaptation strategies, it is important to weigh the economic and social implications of different options like building seawalls or levees, expanding the natural infrastructure like wetlands and dunes, or increasing the capacity of stormwater drainage systems. In some extreme cases, housing, businesses, and some physical infrastructure assets may need to relocate to safer areas. FEMA has buyout programs that compensate people for homes and businesses that may need to relocate—but the process is lengthy and circuitous. Unfortunately, most flood-prone homes belong to low-income owners who are least likely to be able to navigate long, drawn-out federal processes.³⁹ To counter lag times in FEMA buyout programs, the Charlotte-Mecklenburg Storm Water Services in North Carolina created an innovative local voluntary buyout program. The utility funds the program through fees collected from impervious area charges at offices, government buildings, and homes. Many of the properties are then turned into retention ponds, greenways, and community gardens, or reforested, providing community amenities in addition to managing floodwaters.⁴⁰

In these situations, it is crucial to provide adequate funding for vulnerable residents to relocate in an equitable manner by buying out their homes at the market rate. Fair processes and compensation are necessary when flood resilience requires any kind of managed retreat.

Capital investments balanced with affordability programs lead to benefits for all.

Building climate resilience will be an expensive process, on top of the rising costs of infrastructure development and maintenance. Utilities must repair and retrofit existing systems and build new infrastructure components to handle increased precipitation and better manage flash floods or extreme events. Emergency response, adaptation efforts, and mitigation projects all come at a significant cost to utilities and cities. As they prepare for these expenses, agencies should consider the ability of vulnerable populations to pay. Many low-income households have a hard time paying their water bills currently and cannot support rate increases. At the same time, rates are often the primary funding source for day-to-day utility operations and investments in system improvements. Utilities commonly raise rates to keep up with the rising costs of labor and materials and make debt service payments on bond-financed capital improvements—and this will only increase as they prepare for climate change.

As utilities plan for climate change, they should have robust affordability and assistance programs to ensure that the necessary rate increases to manage stormwater and flooding will not harm their most vulnerable customers. Affordability programs should tailor to each locality's circumstances and the characteristics of its low-income communities. For example, a city with a high proportion of residents below the poverty line may have different affordability needs than a generally affluent community with isolated areas of poverty. Key considerations may include the distribution of poverty, homeownership rates, and the community's existing social service network. Affordability measures should include specific measures for renters. In some jurisdictions, there are legal barriers to certain rate structures and bill assistance options. Stakeholders must understand and work together to address such barriers to develop viable approaches.

Projects designed to deliver economic benefits that reduce flood vulnerabilities boost resilience.

Capital investments in water systems can generate economic benefits to communities through contracting opportunities and job growth to help address underlying factors that contribute to overall resilience. As they become more resilient, utilities will need to expand their workforce to construct, maintain, and operate updated systems. At the same time, underemployment and unemployment are chronic issues for many communities.

For instance, the City of Columbus' integrated wet weather management plan has three major goals: removing stormwater from sanitary sewers, routing runoff to green infrastructure, and investing in the local economy. Over 30 years, the plan known as *Blueprint Columbus* will boost the local economy by creating an estimated \$3.3 billion in regional output, providing \$900 million in earnings, and creating 700 new jobs. The City established a Green Infrastructure Workforce Development Training Program, an innovative workforce development program, sponsored by a partnership between the City, T&M Associates, Columbus State Community College, and the Columbus Urban League. The program teaches students the skills to construct and maintain green infrastructure, like rain gardens and pervious sidewalks. It includes classroom instruction and field training on topics such as hydrology, soil basics, vegetated systems, and maintenance. Graduates are also issued an Occupational Safety and Health Administration (OSHA) Construction Safety Awareness card and a certificate in Green Infrastructure Construction/Maintenance, recognized as equivalent to work experience that provides eligibility for green infrastructure contracting.⁴¹

Utilities can partner with city and state agencies, schools, and trusted nonprofits to develop career pipelines for recruitment when permanent utility positions open. And as utilities invest in the neighborhoods that are most vulnerable to flooding and other climate-related impacts, they can commit to local hiring in those same areas. In doing so, they can generate multiple benefits from flood resilience to local economic vitality.

Case Example

New Policy Re-Focuses Spending on Flood Resilience to Advance Equity in Houston, TX

Location

Houston is a large metropolitan city in Southeast Texas. The city lies just northwest of Galveston Bay, which feeds into the Gulf of Mexico. It has a large land area and is the most populous in the state.

Land Characteristics

There are 22 bayous and watersheds within the metropolitan Houston area. The land has a relatively flat topography and clay soils.

Key Water and Climate Challenges

- Thirty percent of Houston lies in a floodplain.
- Overland sheet flow
- Riverine flooding
- Localized flooding
- Sixty percent of stormwater infrastructure fails to meet current standards.
- More erratic precipitation patterns
- Hotter temperatures

A series of extreme events in Houston has spurred a coalition of city agencies to join efforts to improve resilience. Jamila Johnson, an infrastructure policy manager, and Tanu Hiremath, the stormwater maintenance managing engineer, at Houston Public Works are working closely with Marissa Aho, the City's chief resilience officer, to prioritize investments and help communities better prepare for such events.

From 2015 through 2017, three storms exceeding the 500-year flood moved inland and made landfall in Houston. Although shallow, brief urban flooding is relatively common throughout the city, these events revived citywide flood management efforts, particularly in historically disadvantaged areas. Then Hurricane Harvey broke all storm records in 2017. Nearly 52 inches of rain fell in four days, an outcome that even advanced weather and climate models could not predict. Flooding affected nearly every area of the city, but the aftermath devastated vulnerable communities. Pre-existing vulnerabilities such as health disparities (life expectancy varies as much as 20 years from one area to another), housing and

transportation affordability, and a lack of adequate infrastructure investment have made flooding impacts worse and stalled recovery efforts.

In the Kashmere Gardens neighborhood, the storm damaged 42 percent of structures. The National Flood Insurance Program policy covered only 10 percent of these structures, largely due to homeowners lacking insurance. The average claim was around \$56,000. Most of the other homeowners had to recover with their own resources along with FEMA individual assistance payments, which only averaged \$4,300.⁴² The equity implications of this are staggering. Nearly 97 percent of residents in Kashmere Gardens are African American or Hispanic, and median incomes for the neighborhood are about one-third that of the rest of the city.

Situations like this have driven groups like the Coalition for Equity, Environment, and Resilience (CEER) to pursue a more equitable recovery approach. Iris Gonzalez, CEER's coalition director, led nearly 25 community and environmental organizations to advocate for better flood policies and infrastructure investments in communities like Kashmere Gardens. Iris has found support among local government agencies through a partnership with Jamila, Tanu, and Marissa. The group has also garnered allies in public institutions, such as Dr. Earthea Nance of the Houston Flood Consortium and Texas Southern University. Together, they are guiding recovery in Kashmere Gardens and raising the neighborhood's profile for a "complete communities" city project to streamline green and gray infrastructure for flood management.

On the one-year anniversary of Harvey, Harris County voters passed a \$2.5 billion flooding bond known as the "Harris Thrives" resolution in a three-to-two split along party lines. The resolution accelerates flood infrastructure spending in areas where people are in the greatest danger of flooding. But it was the first time a measure set a policy framework for advancing equity by using a "worst first" formula. The formula uses eight separate criteria, including the CDC's Social Vulnerability Index, to consider different stressors during disasters.^{43,44} The resolution will fund over 230 flood mitigation projects with "an equitable distribution of resources."⁴⁵ A community oversight committee is working to define equity and guide implementation. Iris is part of this committee and will work with Jamila, Tanu, and others on the selection and prioritization of projects in Houston. The committee is an accountability mechanism, ensuring that funding investments target vulnerable communities.

Conclusion

The water sector can leverage this moment of a global crisis and transition to more resilient and equitable water systems and infrastructure. True resilience will only be achieved when all communities are prepared for a changing climate. Equitable flood resilience entails more than managing water and strengthening infrastructure assets. How quickly all communities can adapt, respond, recover, and bounce forward matters. Communities and cities with the strongest solutions are those leading with community leadership, participation throughout the process, and shared decision-making. As the waters rise, so too must water professionals and communities rise together to meet current challenges and whatever uncertainty the future holds.

The Bootcamp cities, and others, demonstrate such a path forward. They are beginning to show what is possible when cities embrace flooding adaptation and mitigation strategies that support all communities. Their efforts are a work in progress, with stakeholders learning from one another as they go.

At the heart of their work, water professionals, city agencies, and communities who are tirelessly working to address flooding care about the same thing: keeping people, property, and the environment safe. Because flood risk looks different from a hydrological, city, and resident perspective, water professionals must bring the work of all stakeholders together to co-create solutions and hold each other accountable. The dual mandates of protecting public and environmental health make equitable climate resilience an important frame for water utilities. Utilities and other water professionals can use their authority and established relationships to uplift community needs, recognize all forms of knowledge about flooding, and create a shared space for decision-making that strengthens communities.

As the nation looks toward an equitable and resilient future, the five priority actions offer tangible ways for water professionals, communities, and cities to begin this work. They challenge stakeholders to look beyond individual actors or sectors' actions and meet the complicated nature of urban flooding with holistic solutions that activate community resilience. As we learned from the Bootcamp cities, this will better inform both adaptation and mitigation efforts, minimize unintended consequences, and ensure all residents access to the same protections and benefits. Proactive planning for equity can build trusting relationships between water professionals and their communities. Communities will be more likely to support flood management measures, and cities as a whole will be better prepared for climate change.

Political will, leadership in the water sector, and funding all remain significant gaps.¹ Federal coordination is essential. We need regulatory frameworks that support proactive and equitable responses. Regulators need to encourage and work with utilities to consider these issues holistically alongside regulatory mandates to incorporate urban flooding into planning efforts. This goes hand in hand with stakeholder interests: regulators must learn from communities about flooding impacts to represent and address their challenges better. We also need utility leaders and elected officials willing to step up and challenge the status quo. Urban flooding will worsen in the absence of strong leadership and coordinated program efforts.

Rational long-term planning is also critical. Moving forward, the water sector must direct attention toward emphasizing the necessity for land planning and zoning to protect vulnerable communities in low-lying areas. Stakeholders must prevent future development in these areas where hazards already exist and that are further threatened by climate change impacts.

Finally, both structural and non-structural solutions require money. We need significant investments to address urban flooding in an equitable way. Climate and resilience funders can use these actions as a framework for continued investment in local projects. They can encourage the implementation of equitable resilience by supporting efforts that carry out priority actions. But water professionals also need more local, state, and federal funding to implement coordinated small-and large-scale flood management projects. Current federal funding is insufficient, and even with FEMA or other federal agency funding that has been around for years, too many people remain in harm's way. In many parts of the country, small drainage districts with no support system run levees that protect small housing clusters (often immigrant and low-income communities). Upgrading and expanding these protections require significant funding. Cities unable to get bonds will need innovative financing models or low-interest loans for climate resilience projects.

Funding structures, policies, and leadership must all work together to build more equitable pathways to urban flooding resilience. Each agency must use the best available climate data to invest in infrastructure and community assets that strengthen all residents' capacity to prevent flooding and prepare for unavoidable conditions. The five priority actions will not only improve flood management across the United States but may serve as an example of how equitable resilience strategies can solve other climate-related challenges across all sectors.

AFC BLOG

Best bang for your buck: Flood resilience projects and long-term return on investment



November 15, 2022

The [passage of the Infrastructure Investment and Jobs Act](#) gives communities a unique opportunity to upgrade or improve infrastructure against flooding — especially as communities face stronger storms and rising seas.

When disasters strike, damages can cost communities billions of dollars. So when building or upgrading infrastructure, governments must consider the impacts of future disasters like floods. Doing so may increase upfront costs but can spare communities from some of the crippling costs of disaster recovery.

That's why leading up to the infrastructure bill becoming law, AFC engaged with federal lawmakers on [a dozen comprehensive priorities](#) that strengthen and fund resilience, disaster preparedness, and flood-risk reduction programs in the United States.

Many of those priorities were included in the infrastructure law, and now [state and local leaders can start to apply for programs](#) to fund their own resilience projects. Not only do these flood resilience projects save lives, but many of these up-front investments can also save communities money in the long run.

As communities navigate the infrastructure law and identify funding that works for them, **we'll offer real-world examples of infrastructure projects specifically designed to be flood resilient — and how these projects make economic sense, too.**

Communities can save \$5–7 for every \$1 spent on resilience

First, let's start with some data. Oft-cited [research](#) by the National Institute of Building Sciences (NIBS) finds that **for every \$1 spent on resilience, communities save \$5 to 7 in disaster response and recovery**. But what does that mean in the context of floods?

The NIBS report finds that building above a base flood elevation, for example, can save \$6 for every \$1 spent. Specifically, building 1 foot above the 100-year flood elevation adds roughly “\$90 million of construction costs per year for new construction, while saving \$550 million”, largely through property damage avoided.

Additionally, the research puts forward the economic benefits of elevating buildings on riverine floodplains by five feet, rather than one foot. Though elevating buildings is a significant undertaking for a community, spending \$900 million up front on such projects can avoid \$4.2 billion in losses — or \$5 saved for every \$1 spent, according to NIBS.

Flood resilience in action

But such gains are not just hypothetical. In previous years, communities across the country have invested in flood resilience solutions that suit their needs, as a result, both increasing their flood protection and saving money.

The examples given have all been at least partially funded by the federal government. They're also snapshots of what communities can do with federal investments like those included in the Infrastructure Investment and Jobs Act.

Floodwall in Greenville, North Carolina

In 1999, heavy rain from Hurricane Floyd flooded the water treatment plant in Greenville, North Carolina, under nine feet of water. Using a \$4.8 million grant from the Economic Development Administration, the facility [raised its surrounding floodwall](#).

When Hurricane Matthew hit in 2016, the new floodwall protected the facility from flooding. **The floodwall prevented an estimated \$212 million in direct damages and other disruptions to the community**, such as loss of service and environmental clean-up.

Elevated rail in Coralville, Iowa

In 2010, the city of Coralville, Iowa, [received a \\$7.8 million grant](#) to elevate rail and nearby trails next to the Iowa River. The elevated railbed serves to protect trains along the line, while the elevated trails can also act as levees to protect buildings along the city's Iowa River shoreline.

The lowest point of the original railbed was at the same elevation as the outermost limit of the FEMA-mapped 100-year floodplain, and two feet lower than the boundary of the 500-year floodplain. Elevating the rail four feet higher than the 500-year floodplain is conservatively **estimated to save Coralville \$17 million in future disaster impacts**.

Relocation in Grand Forks, North Dakota

Following the 1997 Red River Flood, the U.S. Department of Housing and Urban Development helped the city of Grand Forks in eastern North Dakota fund a major relocation project. The [program](#) included voluntarily acquiring more than 700 properties, relocating salvageable single-family homes, and demolishing all unsafe structures in neighborhoods along the bank of the Red River.

This program allowed Grand Forks and neighboring East Grand Forks, Minnesota, to establish a greenway of roughly 2,200 acres of natural space between the levee system and the banks of the river. Though some community members were initially skeptical about the program, many came around, especially after seeing its effects: While the Red River has flooded multiple times in the last 25 years, **damage has been greatly minimized by the absence of structures inside the floodplain**.

Elevated Houses in Mandeville, Louisiana

In 1993 Mandeville, which sits across Lake Pontchartrain from New Orleans, [increased its building elevation standards](#) to require newly constructed or significantly renovated buildings to be one foot above the 100-year flood elevation — or the expected limit of floodwaters should a severe storm (with the intensity of storm that has a 1-in-100 chance of striking on any given year) hit the community.

After Hurricane Isaac caused severe flooding in 2012, FEMA [conducted a Losses Avoided Study](#) in Mandeville and other nearby communities impacted by the storm. The study included an analysis of the storm's flood impacts on 14 homes in Mandeville that had been elevated prior to Isaac. Although elevating the buildings initially cost about \$1.5 million, **FEMA estimated a 74% return on investment after Isaac, with a savings of \$79,000 in avoided damages per structure**.

What leaders can do next

The infrastructure law added resilience measures as an eligible use of funds for billions of dollars of annual federal investments. Now it's up to state and local governments to take advantage of this new project flexibility through the law.

When planning and selecting projects, communities should prioritize the resilience of infrastructure, if the long-term savings described above are to be realized. And to support communities investing in resilient infrastructure, the American Flood Coalition has several resources available:

- Our [Adaptation for All guide](#) highlights 26 approaches broken down by costs, benefits, and other considerations to help communities of any size evaluate how specific approaches can fit into their flood resilience strategies.
- Our [Flood Funding Finder](#) simplifies and filters the federal funds that are available, helping communities identify the right programs to fund flood resilience.
- On our blog page, we [broke down the resilience provisions in the infrastructure law](#), and we also created a [checklist of how to prepare for infrastructure funding](#).

As communities consider new infrastructure projects, resilience should be a top priority. Though such an approach may increase up-front costs, the savings are clear in the long run.

—

This post was authored by Matt Rowland, AFC Policy Director; Gian Tavares, AFC Senior Strategy Associate; and Brandon Pytel, AFC Communications Associate.

Credit for photo at top: [Virginia Department of Transportation](#)

CRITIC'S NOTEBOOK

A Climate Change Success Story? Look at Hoboken.

This flood-prone city on the Hudson River has bundled water-absorbing infrastructure into benefits residents asked for, like parks and safer streets.



By Michael Kimmelman

Nov. 3, 2023

This story is from Headway, an initiative from The New York Times exploring the world's challenges through the lens of progress. Headway looks for promising solutions, notable experiments and lessons from what's been tried.

The city of Hoboken, N.J., once a marshy outcropping that the Lenape inhabited only seasonally, hugs the Hudson River. Three-quarters of it occupies a flood plain. It is, in other words, a water magnet. Some scientists have forecast that, with rising seas, a big chunk of Hoboken will be Atlantis by 2100.

But for more than a decade this city of some 60,000 residents has been trying to thwart fate—and it is making progress. In 2012, Hurricane Sandy left Hoboken underwater and without electricity for days, causing more than \$110 million worth of property damage. The city had to call in the National Guard.

In September, another storm socked the city. Though it wasn't nearly as severe as Sandy, it still dumped more than 3.5 inches of rain on a single Friday morning, 1.44 inches of it during the hour that coincided with high tide. Early in the day, television crews filmed flooded intersections. City officials declared a state of emergency.

Except this time was different. Across the river, the same storm drowned several of New York City's subway lines and forced Brooklyn residents to wade through thigh-deep water. But in Hoboken, the fire department only towed six cars, and by that evening there were just a few inches of standing water at three of 277 intersections. An arts and music festival, the city's biggest cultural blowout and moneymaker, remained on course for the weekend. Television crews, returning to Hoboken early Saturday to film the usual aftermath, left empty-handed. The city's flooding was no longer news.

Which was, of course, the real story.

Let's take a moment to give a shout-out to Hoboken. As climate change delivers more extreme weather and rising seas, communities across America are struggling to prepare. Severe storms hurt businesses, destroy inventories and wreck houses, and the losses and rebuilding cost fortunes. Insurance companies no longer want to cover these expenses, depressing property values, which has ripple effects on city revenues. Some homeowners in high-risk coastal areas have begun lobbying for government buyouts.



Hoboken's Pier C promenade juts into the Hudson River. Daniel Arnold for The New York Times

That's not Hoboken's situation. New York City has been spending billions on flood walls and breakwaters and is still contemplating giant gates to hold back rising tides, but it hasn't done as much to deal with rain. Hoboken has been adding infrastructure to cope with both rain as well as sea-level rise. Flood walls can't stop rain, after all, which needs somewhere to go when it lands on impermeable streets and sidewalks. Old sewers like New York's, which process both waste and storm water, were built to handle only a couple of inches of rain per hour. Big storms trigger sewage overflows that pile health and environmental crises on top of flooding.

Hoboken's goal is to collect and slow storm water. The city's strategy has been to rebuild its sewers, adding capacity, and also bundle invasive, time-consuming new infrastructure initiatives with benefits residents desire, like new parks and playgrounds that have cisterns and basins. Streets redesigned to minimize traffic accidents in Hoboken also collect and redirect water: The redesign was a big reason the city bounced back so swiftly that Friday in September.

The changes began under the city’s former mayor, Dawn Zimmer, who was in office when Sandy hit. “Before Sandy, our main focus was to mitigate the flooding caused by heavy rain events,” she told me the other day. “After Sandy, we focused additionally on the problem created by the storm surge that transformed the city into an island surrounded by the Hudson River.”

Damage on the scale caused by that hurricane demanded a federal response, and the Obama administration came up with an initiative called Rebuild by Design, which invited international engineers, architects and community organizations to collaborate on climate adaptation and other water-management strategies. Among the projects seeded by Rebuild, a plan emerged for fortifying the coast of Staten Island, another for protecting Lower Manhattan, which includes raising East River Park.

Hoboken also received federal help. Rebuild “saw our existing green investments,” Ms. Zimmer said, meaning the parks and playgrounds, “as something to build on.” The New York office of OMA, a Dutch architecture firm founded by Rem Koolhaas, teamed up with Royal HaskoningDHV, a Dutch engineering consultancy, and with local organizations, to come up with an integrated approach to storm surge and heavy rains.

Rebuild’s plan involves elevating vulnerable power lines, building flood protections and, most consequentially, creating those parks with underground tanks and pumps that can hold and then expel excess water from rain and tidal surges once the weather clears.



The new ResilienCity Park has playgrounds and fields — and the storage tanks underneath collected 1.4 million gallons of water during the September storm.

Daniel Arnold for The New York Times

The parks proved to be real lifesavers during the rain bomb in September. On that one morning, the largest park, a new five-acre, \$80 million site named ResilienCity Park, collected more than 1.4 million gallons of rainwater.

I spoke with Caleb Stratton, Hoboken's chief resilience officer, on the Monday morning after the storm. Having spent the past decade working as a city planner in Hoboken, then helping to oversee the city's climate initiatives, Mr. Stratton sounded like a high school senior who had just aced the S.A.T.

"I'm not saying we didn't flood, that some residents and businesses didn't have a hard time, but the issue is how quickly a community recovers," he told me. Hoboken needed weeks to get back on its feet after Sandy, he said. In September, the city only needed a day.

Each storm is different, of course, and Mr. Stratton wasn't saying the city could handle every one. He shared a study by the North Hudson Sewerage Authority, which has compiled weather data since 2015, estimating that Hoboken is prepared to manage nine out of 10 rain events without significant flooding. "It's just not realistic to talk about 100 percent unless you are going to take dramatic measures — buyouts, restoration of natural floodplains, abandoning infrastructure, down-zoning: all the tools that return the ecosystem to a natural state," he said, down-zoning being shorthand for reducing the population. "That's hard to imagine in a context like Hoboken, much less across the river in a place like Manhattan.

"So it's necessary to pivot to other strategies and talk about risk tolerance," he continued, "meaning what's possible within the bounds of what's financially practical."

But also potentially profitable. A study released by researchers for Rebuild by Design and Ramboll, an architectural engineering firm, suggests that every dollar invested in green infrastructure ultimately yields \$2 in "avoided losses" (office closures, waterlogged inventories, flooded basements) and other benefits (improved home values and public health). The argument is in part what led Mayor Ravi Bhalla, Dawn Zimmer's successor, to move Mr. Stratton's job into the Department of Administration, which oversees all of Hoboken's government, to coordinate climate strategies.

As Mr. Stratton points out, in most American cities, "all the infrastructure we create to handle water — roads, sidewalks, sewers — is overseen by different departments with different priorities, none of them specifically responsible for storms. There is no dedicated authority or budget for storm water in most cities."

That sort of siloing has promoted a political culture of shortsighted decision-making. Just days before the September storm, New York's mayor, Eric Adams, slashed \$75 million that had been slated for the city's Parks Department to deal with a budget crunch.

Disinvestment in parks is going to cost the city in the long run because parks are a first line of defense against climate change. As Amy Chester, who directs Rebuild, pointed out in the magazine *Vital City*, New York's natural acreage absorbs as much rainwater as \$580 million worth of green infrastructure.

I don't mean to suggest it has all been smooth sailing in Hoboken. Ms. Zimmer faced prolonged protests from community members furious about a proposed flood wall along a residential street. She battled with the state's then-governor, Chris Christie, and also had to seize property by eminent domain. City officials ended up reconfiguring the flood walls and storm water projects to blend less obtrusively into neighborhoods. The negotiations took years.

Even now, Ms. Zimmer fears the effort to safeguard Hoboken could be compromised if Rebuild's \$350 million, 9,000-foot-long project, involving flood walls, gates and another park, is not completed as planned.

The project, whose construction has just begun, jogs through neighboring Jersey City. Its mayor, Steven Fulop, has yet to sign off on several required easements. The easements appear to affect pre-existing plans for a light rail station, according to a representative from Mr. Fulop's office, making the station potentially more expensive to build, and Mr. Fulop wants the state to pay for those additional costs.

When I reached out to New Jersey's governor, Phil Murphy, an official representing his administration told me that the governor's office has "provided assurances in writing to Jersey City that Rebuild would not make the light rail impossible, and to the extent there are costs as part of the easement process, the state would pay those costs."

The September storm provided early proof of concept for Rebuild's work in Hoboken and for the effectiveness of its green infrastructure, although changing minds remains a hurdle in the current media landscape. "The news is eager to find water on roadways," Mr. Stratton said, "images that don't reflect how quickly a community recovers from storms."

Put differently, cities will flood. It's the speed at which they can bounce back, to borrow Mr. Stratton's words, that will be "the real measure of preparedness."

Climate-resilient infrastructure that brings people together

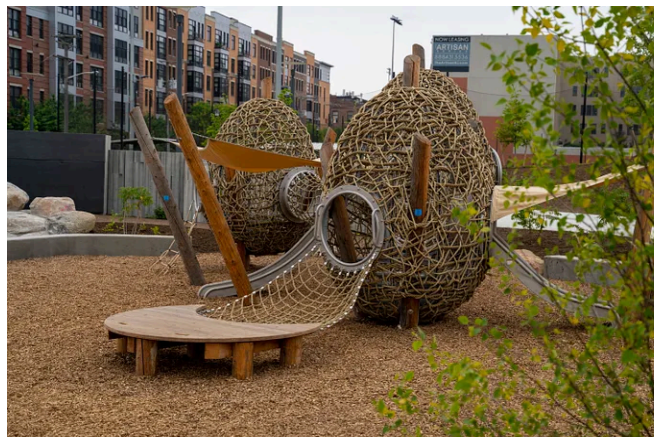
6 questions with Shalini Vajjhala



Reimagining the Civic Commons · Follow

Published in Reimagining the Civic Commons · 12 min read · Jun 18, 2024

Shalini Vajjhala, PhD is the Executive Director of [PRE Collective](#) and a nationally recognized infrastructure and climate resilience expert with 15 years experience designing, funding, and financing community-centered resilient infrastructure solutions. As part of this work, Vajjhala works with local communities in the “messy, early space of an infrastructure project, trying to find out what a community needs — as opposed to just rebuilding a shinier version of what they already have.” We spoke with Vajjhala about the need to create and build beautiful and resilient civic infrastructure in a time of accelerating climate change.



Shalini Vajjhala at ResilienCity Park in Hoboken, New Jersey. Image courtesy Shalini Vajjhala and image credit: “[Northwest Resiliency Park ribbon cutting](#)” Jake Hirsch/NJ Governor’s Office is licensed under [CC BY-NC 2.0](#)

Q: Parks and natural areas are mostly thought of by community leaders as places for events and recreation, but have many other benefits. What arguments are useful to convince community and government leaders of their importance as climate adaptation and resilience?

Shalini Vajjhala [SV]: This is an area of so much opportunity! Traditional planning and infrastructure design processes have been very unimaginative about the climate resilience value that nature provides. The ways in which we think about nature and climate resilience are oftentimes about what impacts we can delay or prevent, or the risks we can reduce, when in fact we should be thinking about how we can meet multiple goals — creating beautiful spaces that people can use *and* that are protective against that ‘once in a thousand years’ storm.

There are whole fields of people working on this, wonderful folks from fields like landscape architecture and economics, who are making the case for where and how nature can provide day-to-day benefits. Of course, those benefits include things like recreation, but they also include things like protection against storms and mitigating the impacts of sea level rise and wildfire.

One of the lovely things about civic infrastructure is that it provides these multiple benefits. These are places that people can use now, as well as places that protect against future harms. They reduce financial risks and disruption of people's lives from extreme weather. For example, if you have wetlands that are allowed to function naturally, they can keep your roads from being flooded, which helps your community in a time of growing climate risks.

A lot of times when we are examining successful resilience projects, we're looking at success meaning something *didn't* happen. A storm hits, and the community *isn't* flooded. The financial arguments for investment in the civic commons and what it can prevent in the future need to be talked about in the beginning. Because without talking about it, people may assume nothing beneficial happened — so why should we fund it?

One of my favorite examples of building this kind of infrastructure is in the City of Hoboken, which was underwater after Hurricane Sandy in 2012. In response, Hoboken has built an absolutely beautiful piece of civic infrastructure called the ResilienCity Park (formerly the Northwest Resiliency Park), a six acre formerly contaminated site that was completely reworked to become a living “urban sponge.” Recently, when a big storm hit the Tri-State Area, the park protected the city against flooding in ways that New York City across the river was not as well protected. Best of all, this infrastructure is beautiful and multipurpose, with community gathering spaces and outdoor recreation assets for all ages.



Bird's-eye rendering of the ResilienCity Park in Hoboken, New Jersey. Image courtesy OLIN.

Q: Another benefit of civic infrastructure — the parks, trails, town squares, main streets, play spaces, libraries, and other gathering spaces located in communities across the country — is their potential for supporting needed social connections between people. How can we better convince our leaders to understand and support this important function?

SV: These kinds of connections are so important, and as an example I go back to a terrible heat wave in Chicago during the 1990s, which killed over 700 people. There were differences when you analyze what happened, in who died and where the most people were impacted. It turns out that stronger social connections in Chicago were correlated to fewer deaths —that is, people in places where there were stronger social connections fared better. This means civic spaces are a big part of our emergency response infrastructure and the value of social infrastructure is already being demonstrated for traditional sectors like emergency management.

Another example of this kind of protective social infrastructure is the Cajun Navy, a group of people from along the U.S. Gulf Coast. They are an incredible group of folks that are and have been extraordinary disaster recovery actors, even though they are a bottom-up, stitched-together part of the social fabric and not part of a government agency. These examples show us that it's indispensable to have both the physical infrastructure and the social connections if we want to respond well in emergencies.

While these examples underline the necessity of social infrastructure as a part of resilience planning, our systems have not yet caught up. We need to rework funding structures to properly value the work of these informal social infrastructure scaffolds, and to set up systems to deploy them when government capacity is limited. That's where PRE Collective works, trying to bring those seams closer together.

Q: How do you help people understand that they are part of a local solution that scales up to a global solution in a time of skepticism and disconnection?

SV: I don't think trust is possible without spaces for listening. At PRE Collective we ask a ton of questions and we really try to listen. We work with everyone, from environmental justice communities that face harm after harm to fishermen in coastal regions that are trying to figure out how to preserve working waterfronts in the face of shifting economic forces and environmental challenges.

A lot of times our approach to healing and building more durable connections is to just start with a set of questions. Most of the time, people come into infrastructure with an idea of building something that they want to build and then they embark immediately on a persuasion campaign to build that specific thing. That is rarely where we start conversations. Oftentimes we'll ask, who's losing money if you don't do something here in your community?

It's rarely the city that is losing money, even though a city is responsible for protecting its residents. Instead, it's the hospital system, or it's a major employer, or it's the transit authority. Asking these questions upfront generally reveals who is disconnected, but needs to be part of the conversation.

The other questions we often ask are: who suffers if we don't do anything? Who is suffering now? For example, a lot of public transit systems become slower or even inoperable in extreme heat. During heat waves, train tracks across the country have been melting. And when you're operating a transit system and you are faced with damage from a heat wave, you run fewer trains and you run them more slowly, in order to reduce pressure on the superheated tracks. But think about the flip side of that action: it means the transit system is leaving vulnerable users — elders and people whose jobs depend on catching a train — out in extreme weather for longer periods.

Asking both who is losing money and who is suffering can bridge some of the very real disconnection that people feel right now.

When we talk about climate change, most of the time we talk to people about global action that creates societal-wide benefits far into the future. And while that global imperative is important, we need to bring our climate change arguments into conversations about what really matters to people now and in their backyards — rather than trying to persuade people to care about a big global problem.

If you are talking with a community about a retrofitting of a transit system that's going to take a decade and billions of dollars to complete, it's hard to get people to engage. But if you tell them that during the planning and construction period you'll put in more shade and shelters, and that you will increase their access to micro mobility programs, they will start to care and understand. Unless you have an understanding of the day-to-day needs of a community, and are able to address those needs in a timely manner, you cannot build trust.

Q. You have spoken about the need to “work at the seams” of infrastructure systems in order to solve win-win problems. What are some of your tips for fostering this cross-sector, cross-silo work for climate resilience?

SV: This is the bread and butter of what we do at PRE Collective, because I believe the best infrastructure is *multi-benefit infrastructure*. Single purpose pieces of infrastructure, like a road that just gets you from point A to point B but that doesn't protect against flooding or provide other types of connectivity, are just missed opportunities.

There are two tricks we use to try to enable bigger thinking and a more thoughtful approach to infrastructure. Both of them are designed to make complicated things less scary. The first trick is “English to English” translation, which means helping people of different professions and orientations see things from other perspectives. For example, a water infrastructure person might look at a street tree and see a water project, because that tree helps capture and absorb stormwater and reduce flood risks. A transportation person sees that same street tree as a pedestrian safety project. A public health person sees shade and heat protection. All of them are just using a different vocabulary.

A lot of times we're trying to make the pieces and parts responsive to all of these different peoples' core day-to-day jobs. And that is often an exercise in just learning each other's vocabulary, so that you can communicate more effectively. That means the person interested in water isn't going to the transportation person and saying “I need you to maintain this tree,” which to the transportation person is just a hassle. Frankly, that seems like extra work, as opposed to, “Hey, can I talk to your pedestrian safety program? I'd love to figure out how we can save money by maintaining these trees.”



New street trees and native plants are part of the green infrastructure system that permeates the Town Branch Commons multimodal park and trail system, designed by landscape architecture firm SCAPE with local design firm Gresham Smith. Image credit: Frank Döring Photography — Gresham Smith.

The second trick works on people who are in various departments or agencies that are at odds with each other. To help in this situation, we listen for the phrase “if they would just...” said in an exasperated tone. In a meeting someone might say “we could complete this great project *if they would just get out of the way.*” This comment typically reveals where people need to work together but are not currently doing so. An example of this is when planners in local government or in engineering and architecture firms are creating work for maintenance departments through their project design, without really thinking about what that means for the maintenance department’s staffing and workload.

Of course we need to maintain our civic infrastructure, and that costs money and time. But these places can also save on maintenance costs if you think about how a green space might keep water off the roads, or how trees planted in the public right of way can shade transit workers out in extreme heat. I’m coming right back to the importance of asking those questions again: who loses money? Who suffers? A lot of the time it’s our maintenance workers who are in the greatest danger if we are not climate resilient. They’re on the front lines, fixing, repairing and recovering things in extreme weather. Civic infrastructure can protect them and make their work safer in a lot of ways, but most of the time we do not think about that.

Q: What have you learned about helping communities finance climate-resilient infrastructure, in ways that help local communities better respond to the impacts of climate change?

SV: It's important to draw a line between *funding* and *financing*. Funding is money that you use for public projects that you don't necessarily have to pay back. Financing requires that you pay the money back. Financing means agencies and communities have to think about what value is being created, and how that value is captured, so that you can have the ability to pay the money back.

The simplest example of this is a toll road. You have drivers, they drive on the road, they pay a toll, and that's used to cover the cost of construction. In civic infrastructure you create value, but there are very few ways that value is captured. That same problem exists for climate resilient infrastructure, because a lot of the time, the benefits of investing in this infrastructure is prevention, that something bad didn't happen.

It's similar to how we fund preventative health care and emergency room services. We're better at funding the emergency room than we are at preventing bad health outcomes. Going back to that Hoboken project, one of the early questions we asked the city was, what do you need that's not flood infrastructure? They told us they didn't have enough green space or parks. They also told us that their streets were clogged with cars. So we asked, what if we could use parking fees to help pay for this project, for both flood protection and recreation?

That is our method, to figure out how we create what you want and help the infrastructure pay for itself. We create savings and efficiencies to pay for things, in much the same way that your insurance company might give you a discount for safe driving.

Q: How can we move community and elected leaders away from thinking about "hardscape" and "big systems" as climate resilience towards a more people-oriented vision of climate resilience? Where does the public realm fit into that people-oriented resilience strategy?

SV: I am optimistic about this question, because I think this is already starting to happen. While a lot of communities are building sea walls, other communities are thinking about more creative ways to make sure our infrastructure meets current needs and also protects us from harm. There's a wonderful landscape architecture firm out of the New York City area called SCAPE, and some of their projects are brilliant examples of this integration. They are creating flood protections for climate resilience that are also a river walk or a working oyster farm. This shows me we are at a turning point for how we think about and create our infrastructure.

I am seeing a culture change within traditional big engineering firms, within architecture firms, within conservation groups, all of which are talking to each other about how to build and maintain nature-based solutions. Folks in the investment world and in the finance world are starting to consider how to pay and invest in nature. People are thinking about big systems as being made up of lots of small pieces, instead of just constructing single-purpose levees and dams and dikes like we used to. If you want to break the infrastructure construction deadlock that we are seeing in America, meeting a community's needs with multi-benefit infrastructure is what makes projects easier to get done.

Reimagining the Civic Commons is a collaboration of The JPB Foundation, the John S. and James L. Knight Foundation, The Kresge Foundation, William Penn Foundation, and local partners.



2023 RESILIENCE FOCUS AREA STRATEGY

An equity-driven roadmap to achieve flood resilience in the District of Columbia.

flood.risk@dc.gov

RESILIENCE FOCUS AREA STRATEGY

PROJECT BACKGROUND

Throughout its history, Washington, D.C. has experienced significant riverine, coastal, and interior floods that have negatively impacted residents, federal and local operations, assets, infrastructure, and buildings. With climate change the District expects this risk to become ever more frequent and potentially more destructive with time. As a result, flooding is one of the main hazards that city planners and policymakers must consider to ensure a more secure and resilient capital. However, with so many communities within floodplains, so many rivers and creeks, and an increased risk of flooding from extreme rain events, how can the District government prioritize its investments in resilient infrastructure?

WHAT ARE RESILIENCE FOCUS AREAS?

The District's 2021 Comprehensive Plan broke the 500-year floodplain into 10 study areas called Resilience Focus Areas (RFAs). The RFA boundaries have since been revised to include 15 planning areas.

STRATEGY PRIMER

The Resilience Focus Area Strategy was born out of the District's need to be strategic in its flood resilience work and the need to prioritize the most vulnerable and valuable areas of the city. For these reasons, through a rigorous data-driven, equity-centered analytical process, the Strategy prioritizes areas of intervention by putting people and vulnerable populations at the center, then the critical infrastructure that is needed for a speedy recovery, and, finally, the District's ability to implement change. For these reasons, the Strategy prioritizes areas under local jurisdiction (non-federal) with vulnerable populations. The steps to achieving this Strategy include analyzing existing conditions to identify areas that are most vulnerable to flood hazards, developing a prioritization framework to quantitatively rank the RFAs in order of priority, and using the framework to strategize where to prioritize flood resilience projects.

INTENDED AUDIENCE

The Strategy's primary audience are the District's Department of Energy and Environment (DOEE) staff and floodplain managers within its "flood team", policymakers, city planners and hazard mitigation staff so that the District government can prioritize and coordinate planning, infrastructure funding and design across multiple agencies. Since the Strategy is aimed at assisting the District with prioritizing flood adaptation work that will protect residents and local infrastructure, federal agencies are only a secondary audience for this report as areas under federal jurisdiction are assumed to be a priority for the federal government to protect. Further analysis, beyond what is contained in this strategy, will be required for each RFA.

THREE-STEP PROCESS:



1 EXISTING CONDITIONS ANALYSIS

Delineate RFA boundaries to analyze existing conditions related to people, assets, and actionability within each RFA.



2 PLANNING PRIORITIZATION

Build prioritization framework to summarize existing conditions.



3 IMPLEMENTATION STRATEGY

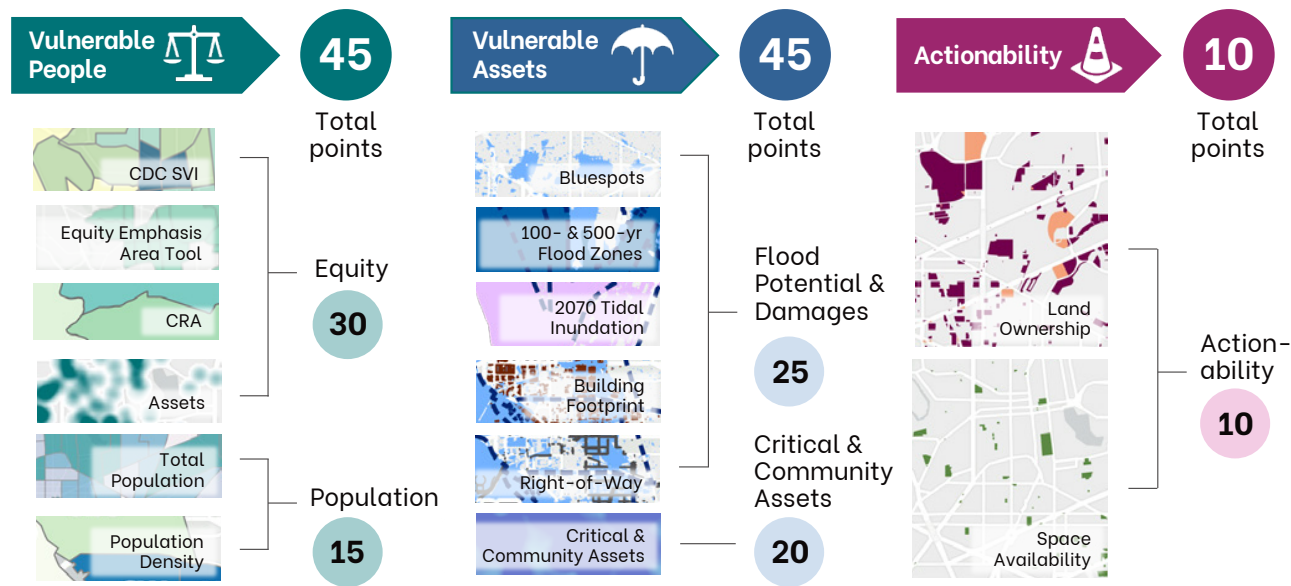
Use the framework results to prioritize planning and flood resilience projects.

RESILIENCE FOCUS AREA STRATEGY RESULTS

The Strategy resulted in the development of a prioritization framework that scored each RFA based on the existing conditions analysis, including inputs for population, equity, flood potential and damages, critical and community assets, and actionability. The framework and resulting prioritization of RFAs is displayed below.

PRIORITIZATION FRAMEWORK

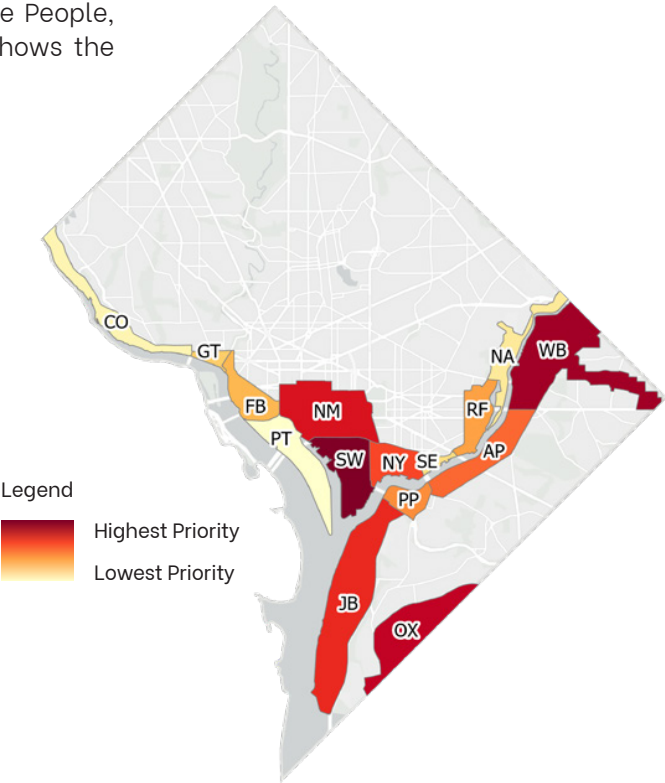
The RFA prioritization framework consists of a total of 100 points, broken down into three categories: Vulnerable People, Vulnerable Assets, and Actionability. Points are further broken down into subcategories.



OVERALL RESULTS

The overall RFA rankings in order of total score are shown in the table below. Total score is the sum of points within the Vulnerable People, Vulnerable Assets, and Actionability categories. The map shows the highest scoring, or highest priority, RFAs in darker colors.

Rank	RFA Name	Score (Max = 100)
1	SW/Buzzard Point	66.26
2	Kenilworth Park/Watts Branch	65.72
3	Oxon Run	65.57
4	National Mall/Federal Triangle	50.53
5	Joint Base Anacostia-Bolling	42.22
6	Navy Yard	37.48
7	Anacostia Park	35.38
8	Poplar Point	31.05
9	RFK Stadium	30.38
10	Foggy Bottom	20.42
11	Georgetown	19.58
12	SE Blvd	18.30
13	National Arboretum/Kingman Island	16.94
14	C&O Canal	14.64
15	Potomac Park	7.01

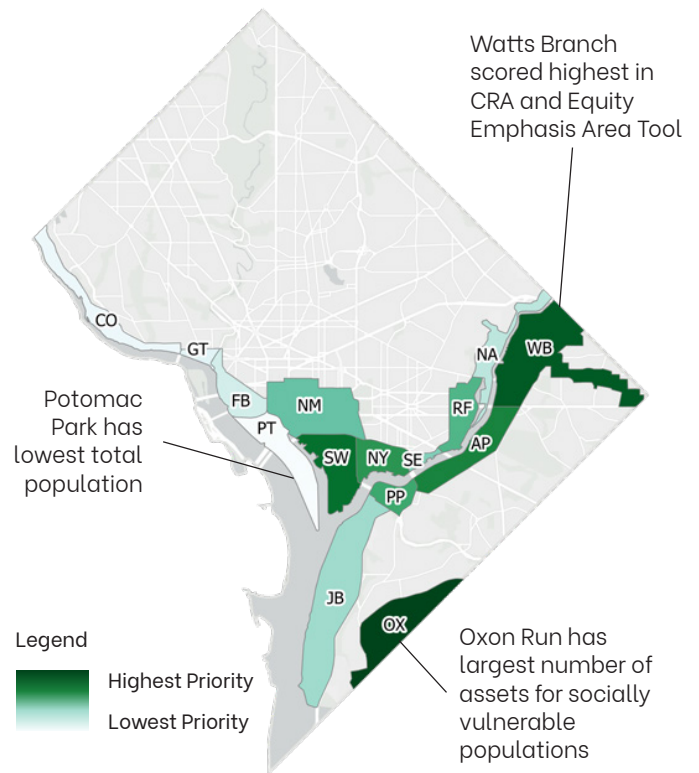


VULNERABLE PEOPLE



The RFA rankings within the Vulnerable People scoring category, ranked in order of total category score, are shown in the table below. The map shows the highest scoring RFAs in darker colors.

Rank	RFA Name	Score (Max = 45)
1	Oxon Run	41.78
2	Kenilworth Park/Watts Branch	36.53
3	SW/Buzzard Point	33.80
4	Navy Yard	29.17
5	Anacostia Park	20.77
6	RFK Stadium	19.20
7	Joint Base Anacostia-Bolling	19.07
8	SE Blvd	16.82
9	Poplar Point	16.80
10	National Arboretum/Kingman Island	14.92
11	National Mall/Federal Triangle	14.46
12	Foggy Bottom	10.35
13	Georgetown	8.35
14	C&O Canal	8.15
15	Potomac Park	3.60



DATA SOURCES

The Vulnerable People scoring category consists of the following data sources:



CENTER FOR DISEASE CONTROL'S SOCIAL VULNERABILITY INDEX

The CDC SVI uses U.S. Census data to determine the social vulnerability of every census tract and ranks each one on 16 social factors, including poverty, lack of vehicle access, etc.

Methodology: Weighted area average. Higher index = higher score. Scores interpolated between 0-1.



EQUITY EMPHASIS AREA (EEA) TOOL

The EEA Tool was developed by the Metropolitan Washington Council of Governments (COG). EEAs are 364 of the region's more than 1,300 census tracts with high concentrations of low-income individuals and/or traditionally disadvantaged racial and ethnic population groups.

Methodology: Weighted area average. Higher index = higher score. Score ranges set manually.



COMMUNITY RISK ASSESSMENT (CRA)

The CRA is developed by the District Homeland Security and Emergency Management Agency. The CRA used age, race, disability, and economic demographics at the Ward-level to determine the social and population vulnerability of each Ward based on a handful of hazard scenarios.

Methodology: Weighted area average. Higher index = higher score. Score ranges set manually.



ASSETS FOR SOCIALLY VULNERABLE PEOPLE

The count of childcare centers, senior living facilities, and affordable housing units available through OpenData. DC.gov were totaled to assess areas where vulnerable populations likely live.

Methodology: Number of assets. Higher count = higher score. Score ranges set manually.



TOTAL POPULATION / POPULATION DENSITY

U.S. Census population data was used to determine the total population and population density within each RFA.

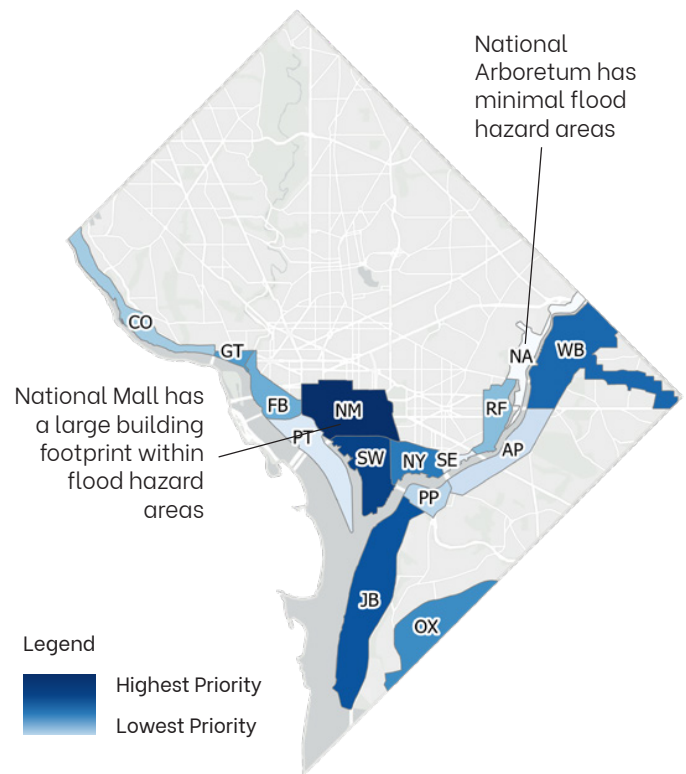
Methodology: Weighted area average / Density. Higher number = higher score. Scores interpolated between min/max / Ranges set manually.

VULNERABLE ASSETS



The RFA rankings within the Vulnerable Assets scoring category, ranked in order of total category score, are shown in the table below. The map shows the highest scoring RFAs in darker colors.

Rank	RFA Name	Score (Max = 45)
1	National Mall/Federal Triangle	33.10
2	SW/Buzzard Point	29.04
3	Joint Base Anacostia-Bolling	24.29
4	Kenilworth Park/Watts Branch	22.21
5	Navy Yard	14.80
6	Oxon Run	14.74
7	Georgetown	11.14
8	Foggy Bottom	9.95
9	RFK Stadium	8.59
10	C&O Canal	6.29
11	Poplar Point	4.14
12	Anacostia Park	4.08
13	Potomac Park	3.37
14	SE Blvd	0.78
15	National Arboretum/Kingman Island	0.02



DATA SOURCES

The Vulnerable Assets scoring category consists of the following data sources:



BLUESPOTS

Identified using an ArcGIS tool developed by the Danish Road Institute as a screening method for assessing flood risk. Bluespots identify surface depressions where rainfall collects without a means of conveyance.

Methodology: Total area. Larger area = higher score.



FEMA 100- AND 500-YEAR FLOOD HAZARD AREAS

The Federal Emergency Management Agency (FEMA) produces Flood Insurance Rate Maps and identifies Special Flood Hazard Areas as part of the National Flood Insurance Program.

Methodology: Total area. Larger area = higher score.



2070 TIDAL INUNDATION

Projected 2070 tidal inundation levels were determined adding NOAA's intermediate high sea level rise projections to the mean higher-high water (MHHW) level for the DC area.

Methodology: Total area. Larger area = higher score.



BUILDING FOOTPRINT AND RIGHT-OF-WAY (ROW) AREAS

Using ArcGIS, building footprint and ROW areas were overlaid on top of each flood hazard. The 'intersect' tool was used to find the total building and ROW areas that overlapped with flood hazards.

Methodology: Total area. Larger area = higher score. Score ranges set manually.



CRITICAL AND COMMUNITY ASSETS

The count of critical and community assets available through OpenData.DC.gov were totaled within each RFA including asset categories of emergency services, energy, transportation, educational, etc.

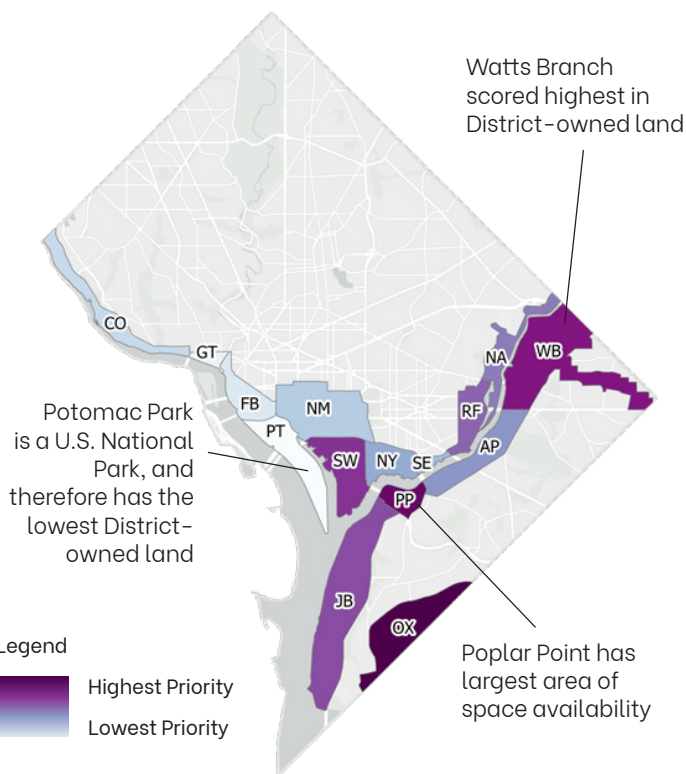
Methodology: Larger number = higher score. Score ranges set manually.

ACTIONABILITY



The RFA rankings within the Actionability scoring category, ranked in order of total category score, are shown in the table below. The map shows the highest scoring RFAs in darker colors.

Rank	RFA Name	Score (Max = 10)
1	Oxon Run	9.06
2	Poplar Point	7.71
3	Kenilworth Park/Watts Branch	6.98
4	SW/Buzzard Point	3.42
5	Joint Base Anacostia-Bolling	3.02
6	RFK Stadium	2.73
7	National Arboretum/Kingman Island	2.45
8	Anacostia Park	2.13
9	Navy Yard	1.91
10	SE Blvd	0.72
11	National Mall/Federal Triangle	0.61
12	C&O Canal	0.20
13	Foggy Bottom	0.11
14	Georgetown	0.10
15	Potomac Park	0.03



DATA SOURCES

The Actionability scoring category consists of the following data sources:



LAND OWNERSHIP

To identify land ownership, the total area of District owned land from OpenData.DC.gov was summed within each RFA.

Methodology: Total area. Larger area = higher score. Scores interpolated between min/max.



SPACE AVAILABILITY

To identify open spaces, the total area of District owned parks and recreational areas from OpenData.DC.gov were summed within each RFA.

Methodology: Total area. Larger area = higher score. Scores interpolated between min/max.

IMPLEMENTATION

Future Updates and Prioritization:

This Resilience Focus Areas Strategy is meant to be the first version of a living document that is routinely revised to capture advances in science, updates in demographic data, new developments and changes in land uses, and the implementation of resilience measures that might change areas' exposure to flood risk. Future updates should follow the US Census decennial release as well as new flood data. The District is currently embarking on a multi-year Integrated Flood Model (IFM) project to map and model interior flooding in addition to coastal and riverine flooding in the District. Once complete, the IFM will be able to generate mapped scenarios of current and projected future flooding conditions throughout the District looking at climate change, sea level rise, and impacts of back-to-back storms. As a final phase of the project, floodshed management plans will be developed, to target neighborhood-level measures that can be taken to reduce flood risk. These plans will be exploring nature-based solutions and projects that will create multiple benefits for impacted communities and District residents. The IFM will produce the most comprehensive picture of flood risk in the District and its results should be used to update the Resilience Focus Area Strategy.

Next Steps for Resilience Planning:

The RFA Strategy is principally meant to guide the work of DOEE's "Flood Team" and, in general, the District's flood resilience planning and investments in the future. Thanks to the Strategy's analysis, the District will have a roadmap to flood resilience that prioritizes areas with the highest risk of flooding and areas with the most population in need.

DOEE's Flood Team has already started work in some of the top ranked RFAs. Currently, in the top ranked RFA, DOEE is completing the SW & Buzzard Point Flood Resilience Strategy. The District has local and FEMA construction funding to build the first few pilot projects for the Strategy, including the redesign of Lansburgh Park and portions of King Greenleaf Park into blue-green infrastructure floodable parks.

In the second ranked RFA, Kenilworth Park/Watts Branch, DOEE has completed several flood risk studies, including the Watts Branch Flood Risk Management Study conducted in partnership with the DC Silver Jackets. Most recently, the District has received FEMA funding to identify mitigation measures to effectively reduce flood risk.

In the third ranked RFA, Oxon Run, the District is undertaking a stream restoration and sewer rehabilitation project that will mitigate flooding and improve environmental quality along Oxon Run.

In high risk RFAs with mostly federal ownership, like the National Mall/Federal Triangle and Joint Base Anacostia-Bolling RFAs, the District is supporting federal partners with flood resilience through workshops and support for funding requests.

Community Finance Brief

Financing Resilience through Municipal Bonds



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The blessings of American prosperity have not, historically, been distributed equally. Of the many areas where this becomes hugely evident is when it comes to the resilience of our shared infrastructure, our homes and the related social fabric of our communities. Resilience has become a 'catch all' phrase as it pertains to impact investing as it transcends many areas: infrastructure, energy, water, agriculture/food systems, healthcare and financial systems. Yet, it is particularly difficult to pinpoint for government actors and their lenders based on some simple assumptions that must be defined in order to be properly engaged.

A thoughtful investment requires a vetting of assumptions around the present and future value of the object of an investment. Investing in resilience is almost entirely predicated on anticipating future risk/return while making present-day decisions. This poses significant policy and political challenges due to the complexities of present day calculations and the lack of immediate political rewards for doing so. Uncertain discount rates and future benefits versus present costs don't poll well. With this in mind, investing in communities that are overexposed to natural disasters and underinsured through municipal bonds offers a strategic approach to address both the immediate financial needs and long-term benefits. Competent and holistic resilience plans for communities require a multi-pronged approach but for the purposes of this [Brief](#) - we dive into why and how municipal bonds are critical to the capital stack.

Further, the outsized implications of climate risk for historically disinvested communities makes the role of government in their support all the more important. Government exists to protect all portions of our communities and, as such, have an extended obligation to engage these communities but also from a dollar and cents perspective, the future value of investing here plays larger dividends from a financial stability perspective as well as on a so-called social rate of return.

Quick Takes

Investing 'in resilience' in the amount of \$1.8 trillion globally between 2020 and 2030 could generate \$7.1 trillion in total net benefits
- [Global Center on Adaptation](#)

Damage from global natural disasters totaled \$380 billion in economic losses driven by earthquakes and severe convective storms in the U.S. and Europe
- [Aon](#)

Federal Emergency Management Agency's disaster relief fund is on pace to run out of funds in August this year.
- [FEMA Deputy Administrator Erik Hooks](#)

Issuance of municipal bonds is predicted to be just north of \$400 billion in 2024, up from the \$330 billion issued in 2023.
- [CSG, The Bond Buyer](#)

THE CASE FOR MUNI BONDS

Municipal bonds offer a robust foundation for state and local governments to build resilience against future risks due to several key advantages. A case for the asset class:

1. Securitizing Present Risk and Future Dividends

- **Present risk management:** municipal bonds allow governments to securitize the present risk of not adapting to future challenges by providing immediate capital to invest in necessary infrastructure. This upfront funding is crucial for initiating resilience projects that can mitigate long-term risks.
- **Future value realization:** The future benefits of resilience investments, such as reduced disaster recovery costs and enhanced community stability, correlate well with the financial structure of municipal bonds. These bonds essentially pass the dividends of future value back to the present, ensuring that today's investments yield significant returns over time.

2. Community Engagement and Confidence

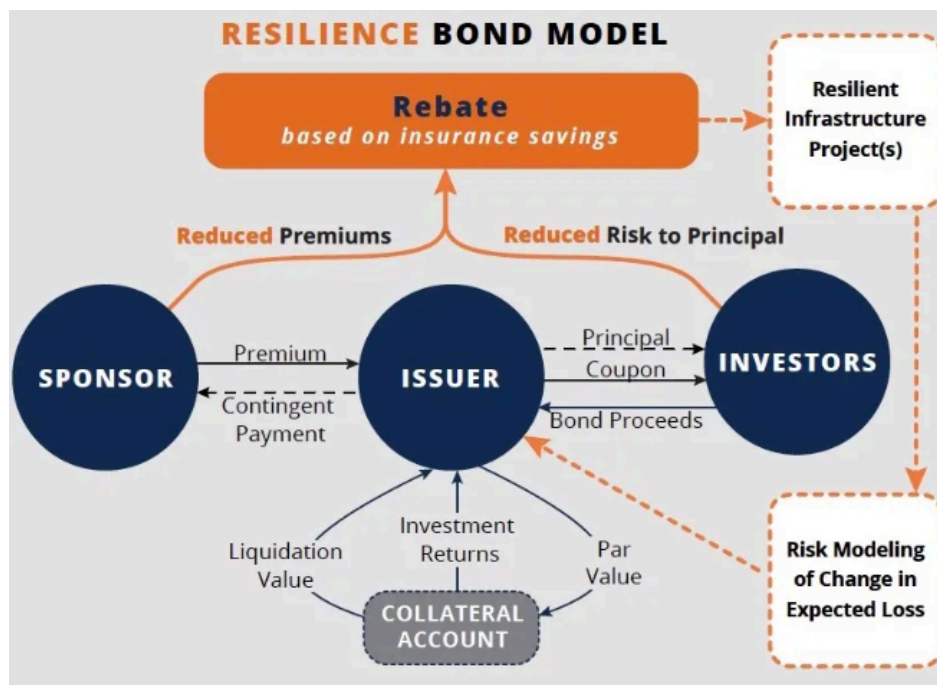
- **Government commitment:** The issuance of municipal bonds specifically for resilience projects sends a strong message to the community that the government is committed to addressing future risks. This can enhance public confidence and support for government initiatives, fostering a sense of proactive governance.
- **Community involvement:** By engaging the public in resilience financing, local governments can encourage community participation and awareness. This involvement is critical for the success of resilience projects, as it aligns public interest with governmental action as is described in [this international example](#).

3. Legal Obligation and Accountability

- **Bond covenants:** Municipal bonds create a legal obligation for governments to use the proceeds for specified resilience projects if they chose to so. This would ensure that funds are allocated and utilized effectively, providing accountability and transparency in the use of public resources.
- **Structured implementation:** The legal framework of municipal bonds requires detailed planning and execution of resilience projects, which helps in maintaining a

"Accelerating climate change adaptation is desirable from multiple perspective. The human imperative its to address existing climate-related inquiries, as the criss disproportionally impacts vulnerable countries. The environmental challenge is to protect the ecosphere. In addition to the human and environmental imperatives, there is also a strong economic rationale. The Global Commission on Adaptation found that the overall rate of return on investments in improved resilience is very high, with benefit-cost ratios ranging from 2:1 to 10:1. Specifically, the research shows that investing \$1.8 trillion globally from 2020 to 2030 could generate \$7.1 trillion in total net benefits." - [Global Center on Adaptation](#).

structured approach to tackling climate risks and other challenges. This legal obligation can prevent the diversion of funds and ensure that resilience remains a priority.



4. Economic Sense and Cost Efficiency

- Low cost of capital: Municipal bonds offer a relatively low cost of capital, making them an economically sensible option for financing large-scale resilience projects. The interest rates

on municipal bonds are often lower compared to other forms of borrowing, reducing the financial burden on governments.

- Cost of inaction: The increasing cost of not engaging in resilience projects—due to more frequent and severe climate events, infrastructure failures, and economic disruptions—far outweighs the cost of borrowing through municipal bonds. Investing in resilience now can save substantial amounts in future disaster recovery and economic losses.

RESILIENCE ACTION PLANS

The global increase in climate action among cities and regions around the world, by which the United Nations pegs the figure of engagement at six times higher in 2023 than in 2015, is welcome. The engagement in the U.S., like many things, has become politicized. While we see climate action plans as essential for cities, counties and state to systemically address the impacts of climate change - a roadmap for mitigating increased climate volatility in the form of a resilience plan could be a more results-oriented approach that focuses on *financing* resilience as the front-line action for policy-makers.

A key item here that differentiates itself is a focus on the financing elements. If a government would to begin by inquiring on the 'how do we pay for this' and 'who should pay for this' questions, the roll-out of actionable items would be more concrete. The situation of a project having received considerable policy-oriented endorsements and subsidies in pre-development

but having never secured financing to move on with construction is an example that does not happen within a resilience action plan (RAP) based approach.

Starting with a municipal bond foundation innately links policy and finance but the concept of securitizing the future value of adaptation projects offers a myriad of benefits from a financing perspective but is also **forces the community to quantify the cost of not adapting**. This is imperative to fully embracing the long-term upside of resilience.

Municipal bonds for resilience also lays a foundation for these policies to be focused on equity. Ensuring that the financial burdens and benefits are fairly distributed across different segments of the population is critical. Whether tax-backed or through another obligation, the use of a muni bond indicates community benefit rather than the promotion of a particular interest. The challenges of executing on this is evident, but starting with a bond like this offers an outcome that is more likely in the community benefit.

Beyond the structure of the bond itself, a competent RAP would lay out a more involved capital stack to encourage other types of investors. Cities can structure resilience bonds to include first-loss capital, where certain investors agree to absorb initial losses, thereby protecting other investors. This structure can make resilience bonds more attractive by lowering the overall investment risk.

By incorporating first-loss capital into a broader capital stack, cities can leverage additional funding sources, such as grants, public-private partnerships, and philanthropic contributions, to finance comprehensive resilience programs in vulnerable communities.

In summation, RAPs offer:

- Long-Term commitment: a focus on resilience and financing demonstrate a long-term commitment from state and local governments, fostering trust and support among stakeholders.
- Policy integration: These plans should integrate resilience financing strategies into broader policy frameworks, ensuring alignment with economic development, land use planning, and social equity goals.
- Cost-effective solutions: Investing in resilience through municipal bonds and other financial instruments can be cost-effective in the long run, reducing the economic burden of disaster recovery and enhancing community stability.
- Social equity: Targeted resilience investments can address vulnerabilities in marginalized communities, promoting social equity and ensuring that the benefits of resilience are widely distributed.

TRANSILIENCE:

RAPs should take advantage of the existing climate zeitgeist and promote *transilience*: combining the transition to zero along with adapting to increased climate volatility through

resilience efforts. By integrating both migration and adaptation, a comprehensive policy develops.

Climate action in this method addresses immediate and long-term goals while encouraging broader stakeholder engagement by demonstrating multiple benefits. The policy objectives around sustainable development also become clear when engaging in all efforts. Resilient and low-carbon infrastructure go hand-in-hand.

Further, state and local governments should ride the Greenhouse Gas Reduction Fund (GGRF) wave (while they can) and engage in transience. There are currently large and unprecedented tax-credits that can be transferred as cash to local governments for engaging in transition efforts that can also be geared more broadly within a resilience framework. Once again - the focus on financing projects as a policy objective can help develop more long-term solvency through programs that are born out of the transition to zero movement worldwide.

Insurance companies can also leverage the emerging state-level green banks to engage with the GGRF and other funding sources to support resilience initiatives. These green banks can serve as intermediaries, channeling funds into projects that bolster community resilience, reduce greenhouse gas emissions, and promote sustainable development.

RESILIENCE IN THE ABSTRACT AND IN THE FLESH

State and local governments can substantially improve their resilience financing strategies by embracing a financing-first approach that could very well lean heavily on municipal bonds. They should also consider wrapping these efforts up with transition to net zero efforts as they compliment each other from a policy perspective and there are novel financing structure and subsidies currently in place to support such efforts.

For the balance of the Summer and ahead of a series of workshops regarding resilience and public-private partnerships, **CFB** will cover theoretical models for resilience along with examples of how various communities are engaging in novel ideas now.

Broad areas of interest in the form of 'how':

- How to you structure resilience muni bond? **(see figure, page 3)**
- How can insurance companies change the way they invest in muni bonds to allow them to support communities whilst also offering affordable insurance in these same communities?
- How can bond banks level-up resilience efforts?
- How can data help these efforts?

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