

Hazard Mitigation Assistance

Mitigation Action Portfolio



FEMA

October 2023

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The Mitigation Action Portfolio (MAP), was prepared in compliance with Section 508 of the Rehabilitation Act of 1973. The MAP contains publicly available data for project descriptions, costs, and partnerships. The MAP was first published in August, 2020. This document may be periodically updated with additional content after its original release date.

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 Project type includes a Nature-Based Solution

FEMA Community Lifelines Addressed per Case Study

The table below displays the community lifelines addressed by the case studies in this portfolio, organized by primary hazard. The community lifeline that is considered the “primary community lifeline” is shaded for each case study in red. For more information on community lifelines, see page 8.

HAZARD	PROJECT NAME	COMMUNITY LIFELINES						
		 Safety & Security	 Food, Water, Shelter	 Health & Medical	 Energy (Power & Fuel)	 Communications	 Transportation	 Hazardous Material
All Hazards (4 Case Studies)	Blue Lake Rancheria Tribe Microgrid	x	x		x			
	Bronzeville Microgrid Project	x	x		x	x	x	
	Massachusetts State Hazard Mitigation and Climate Adaptation Plan	x	x	x	x	x	x	x
	LaGuardia Airport Flood Control	x			x		x	
Coastal Flooding (7 Case Studies)	Lubberland Creek Restoration and Coastal Flood Risk Mitigation	x	x	x	x		x	
	Mexico Beach Recovery and Resiliency Partnership	x	x				x	
	NYU Langone Medical Center Flood Resiliency Projects	x	x	x	x			
	Oyster Lake Outfall Improvement	x	x				x	
	Relocation of Newtok Village	x	x	x	x	x	x	
	Virginia Point Wetland Protection Project	x			x		x	
	Drought (1 Case Study)	Salinas Aquifer Storage and Recovery	x	x				
Earthquakes (3 Case Studies)	Alaska Building Codes	x	x					
	Berkeley Seismic Vulnerability Retrofits	x	x					
	Earthquake Safety Retrofits at Good Samaritan Hospital	x	x	x				
Hurricanes (6 Case Studies)	Strengthening Florida's Building Codes	x	x					
	Lightning Point Restoration Project	x					x	
	Nicklaus Children's Hospital Hurricane Retrofits	x	x	x				
	NY Rising Community Reconstruction: Path to Park Project	x	x	x			x	
	Renovation of Alexander Theater	x	x					
	USACE Engineer Research Development Center	x	x			x		
Inland Flooding (19 Case Studies)	Atlanta Stormwater Ordinance and Green Infrastructure Program	x					x	
	Bidwell Paiute Tribal Reservation Flood Mitigation Project	x	x		x			
	Buffalo, WY Flood Control	x					x	

HAZARD	PROJECT NAME	COMMUNITY LIFELINES							
		 Safety & Security	 Food, Water, Shelter	 Health & Medical	 Energy (Power & Fuel)	 Communications	 Transportation	 Hazardous Material	
Inland Flooding (19 Case Studies)	Charlotte-Mecklenburg Flood Mitigation Buyout Program	x	x						
	Cheyenne West Edge District Redevelopment	x				x		x	
	Cleveland and Northern Ohio Regional Stormwater Management and Flood Mitigation Program	x	x						
	Cuyahoga Falls Rain Garden Reserve	x	x						
	Exploration Green Stormwater Park	x	x	x			x		
	Foster Floodplain Natural Area	x	x				x		
	Harris County Flood Control District Voluntary Acquisition Program	x	x						
	Lincoln Wastewater Treatment Plant Flood Mitigation	x	x	x					
	Lower Arroyo de los Montoyas Stabilization	x	x					x	
	Minot Water Treatment Plant Floodwall	x	x						
	Northwest Resiliency Park	x	x				x		
	Petaluma Payran Reach Flood Control and Floodways	x	x	x			x		
	Resilient Shelby's Greenprint for Resilience	x	x				x		
	Resilient St. Vrain Nature-Based Flood Protection	x	x	x			x		
	Spring Creek Drainage Improvement Project	x					x		
	Worthington County Ditch 12 Flood Mitigation Project	x	x						
	Landslides (3 Case Studies)	American Samoa Rockfall Mitigation Project	x					x	x
		Hartsfield - Jackson International Airport	x					x	
		Washington DOT Landslide Mitigation Action Plan and Rail Corridor Improvements	x					x	x
Tornadoes (1 Case Study)	Mercy Hospital Rebuild	x	x	x					
Tsunamis (2 Case Studies)	Alaska DHS and EM Tsunami Education, Mapping, and Siren Check	x	x	x					
	Shoalwater Bay Tribe Tsunami Evacuation Structure	x	x						
Wildfires (2 Case Studies)	Cedar Heights Hazardous Fuels Reduction	x	x						
	Colorado Springs Wildfire Mitigation	x	x	x					
Winter Storms (1 Case Study)	Nebraska and Kansas Electrical System Ice and Wind Storm Mitigation Projects	x			x				

Introduction & Background

In recent years, Americans have witnessed the enormous and devastating effects of hurricanes, floods, wildfires, earthquakes, and other events. The increasing duration, intensity, and severity of such disasters which are exacerbated by changes in population, land use, and weather patterns are alarming and highlight one of the most important emergency management challenges facing the United States.

As a result, the effort to build resilience to natural hazards has shifted from a post-disaster discussion to one of improved pre-disaster actions. The impacts of natural hazards on communities, families, individuals, and our economy makes it imperative to invest in creating infrastructure and communities more resilient to natural hazards.

In response to these alarming impacts, the Mitigation Framework Leadership Group (MitFLG), which includes representatives from the federal, state, local, tribal, and territorial governments (SLTTs) and is chaired by FEMA, produced the National Mitigation Investment Strategy. The National Mitigation Investment Strategy is a single national strategy for advancing mitigation investment to reduce risks posed by and increase the nation's resilience to natural hazards, such as sea level rise, droughts, tornadoes, hurricanes, floods, wildfires, and earthquakes. The Hazard Mitigation Assistance (HMA) Division supports the MitFLG's National Mitigation Investment Strategy Implementation Team, which serves as a catalyst to identify and promote investments in mitigation by interagency collaboration and seeking input from partner organizations in order to develop tools and resources to increase whole community resilience and measure success. The Investment Strategy encourages the whole community, including individuals, to invest in pre- and post-disaster mitigation by adopting the Investment Strategy's three shared goals:

- **Show how mitigation investments reduce risk**
- **Coordinate mitigation investments to reduce risk**
- **Make mitigation investments standard practice**

This portfolio showcases mitigation projects to provide practitioners with examples of activities that integrate the Investment Strategy's goals and reflect the guiding principles of the Disaster Recovery Reform Act of 2018 (DRRA). Beginning in 2020, the Building Resilient Infrastructure and Communities (BRIC) grant program, which was created as part of DRRA, is funded by a six percent set-aside from federal post-disaster grant expenditures.

HMA grant programs such as Building Resilient Infrastructure and Communities (BRIC), Flood Mitigation Assistance (FMA), and Hazard Mitigation Grant Program (HMGP)/Hazard Mitigation Grant Program Post Fire (HMGP Post Fire), promote funding for mitigation measures that reduce or eliminate long-term risk to people and property from future disasters. These grant programs allow communities across the nation to enhance mitigation and take steps that will foster greater resilience and reduce disaster suffering. BRIC is a competitive grant program that provides funding for mitigation projects to reduce the risks from disasters and natural hazards. The program was designed to foster innovation and provides a yearly grant cycle offering applicants a consistent source of funding. The HMGP provides funding to rebuild communities in a way that mitigates future disaster losses in those communities. Funding is made available after the President issues a major disaster declaration. The HMGP Post Fire program provides funding after a Fire Management Assistance Grant is declared, and helps communities implement hazard mitigation measures after wildfire disasters.

SLTTs are eligible to apply for funding. FMA is a competitive grant program that provides funding to states, local communities, tribes, and territories. Funds can be used for projects that reduce or eliminate the risk of repetitive flood damage to buildings insured by the National Flood Insurance Program.

Through various HMA programs, FEMA is investing in a wide variety of mitigation activities, including community-wide public infrastructure projects. Moreover, FEMA funds projects that demonstrate innovative approaches to partnerships, such as shared funding mechanisms and/or project design. For example, an innovative project may bring multiple funding sources or in-kind resources from a range of private and public sector stakeholders. It also may offer multiple benefits to a community in addition to risk reduction.

Ultimately, HMA programmatic funding is not able to meet all mitigation needs across the nation. Rather, in order to achieve the full intent of the Investment Strategy, HMA programs must also look to public partners at the state, local, tribal, and territorial levels and in the private sector to share responsibility in amplifying the impact of federal investment in mitigation by coordinating and connecting funding and resources to move resilience projects forward.

Each year, FEMA develops an annual Notice of Funding Opportunity (NOFO) for the BRIC and FMA programs. HMGP and HMGP Post Fire do not use a NOFO. These programs may be available after a community receives a major disaster declaration or a Fire Management Assistance Grant. Both programs utilize specific procedures under HMGP's authorities. Technical assistance and additional implementation materials are available under eligible HMA programs so that state, local, tribal, and territorial partners have the information they need to submit successful applications aimed at hazard mitigation that create more disaster-resilient infrastructure and communities. Additional information on HMA grant opportunities is available online at <https://www.fema.gov/grants/mitigation>.

Purpose and Intended Use of this Mitigation Action Portfolio

This portfolio showcases an array of eligible hazard mitigation activities that may benefit stakeholders under one of the HMA programs. While some of the projects in the portfolio demonstrate potential eligible mitigation activities, not all components of these highlighted projects may be eligible under one of the HMA programs. Please note that FEMA will evaluate any subapplication submitted to an HMA grant program pursuant to all programmatic requirements, including program-specific eligibility requirements. For nearly 30 years, FEMA has provided almost \$2.901 billion in pre-disaster mitigation funds, supporting and implementing numerous hazard mitigation projects to address all types of natural hazards spanning all levels of government, including tribal and territorial governments. FEMA developed project descriptions, guidebooks, and other informational documents to describe hazard mitigation projects, these are available at <https://www.fema.gov/hazard-mitigation-assistance>. Rather than include all HMA-eligible project types, this portfolio presents innovative hazard mitigation projects for a variety of hazards that could potentially be funded under one of the HMA programs.

FEMA hopes these project examples inspire stakeholders to think big and bold in addressing natural hazards, while also considering additional benefits that can be achieved beyond reducing economic and human costs from disasters. For example, project design should consider how community lifelines, such as safety and security, transportation, and energy, can be incorporated in the implementation and outcome of the hazard mitigation project. In addition, certain HMA programs support eligible projects that utilize nature-based solutions to reduce risk and produce environmental and community benefits.

Projects highlighted in this portfolio are meant to exemplify successful hazard mitigation that also enhances a culture of preparedness and holistic disaster resilience.

This portfolio is a resource to help applicants and subapplicants (SLTTs) apply for grants under the HMA grant programs. In addition, it may generate ideas and be useful for stakeholders that are considering new mitigation projects or for other mitigation-focused, federal funding opportunities through the Department of Housing and Urban Development, the Department of Energy, and the National Oceanic and Atmospheric Administration.

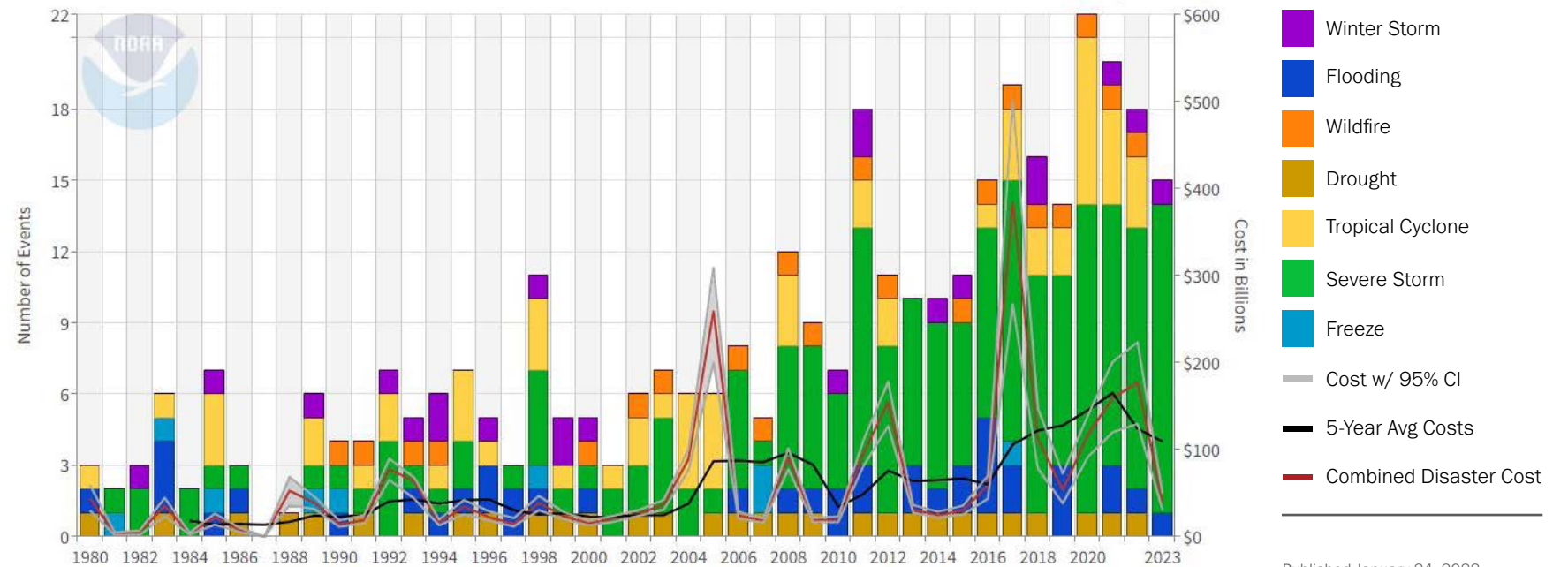
Other private and non-governmental partners in the hazard mitigation community may find this resource helpful, particularly in brainstorming opportunities to collaborate with the public sector to create more disaster resilient communities

and infrastructure. This portfolio highlights partnerships to emphasize the importance of collaboration across and between governments, private sector entities, and non-governmental organizations towards achieving effective hazard mitigation and disaster resilience.

Through the mitigation planning process and beyond, we encourage you to imagine what is possible to increase disaster resilience in your communities and to view relevant case studies in consideration of activities that could be designed and/or implemented to address local hazards.

1980 to 2023 Year-to-Date U.S. Billion-Dollar Disaster Event Cost (CPI-Adjusted)

The number (bars, left axis), type (colors), and annual cost (right vertical axis) of U.S. billion-dollar disasters from 1980 to 2023. Combined disaster cost (red line), along with the 95% confidence interval, and 5-year average costs (black line). The number and cost of disasters are increasing. Severe storms (green bars) and tropical cyclones (yellow bars) are making in increasingly large contribution to the number of U.S. billion-dollar disasters.

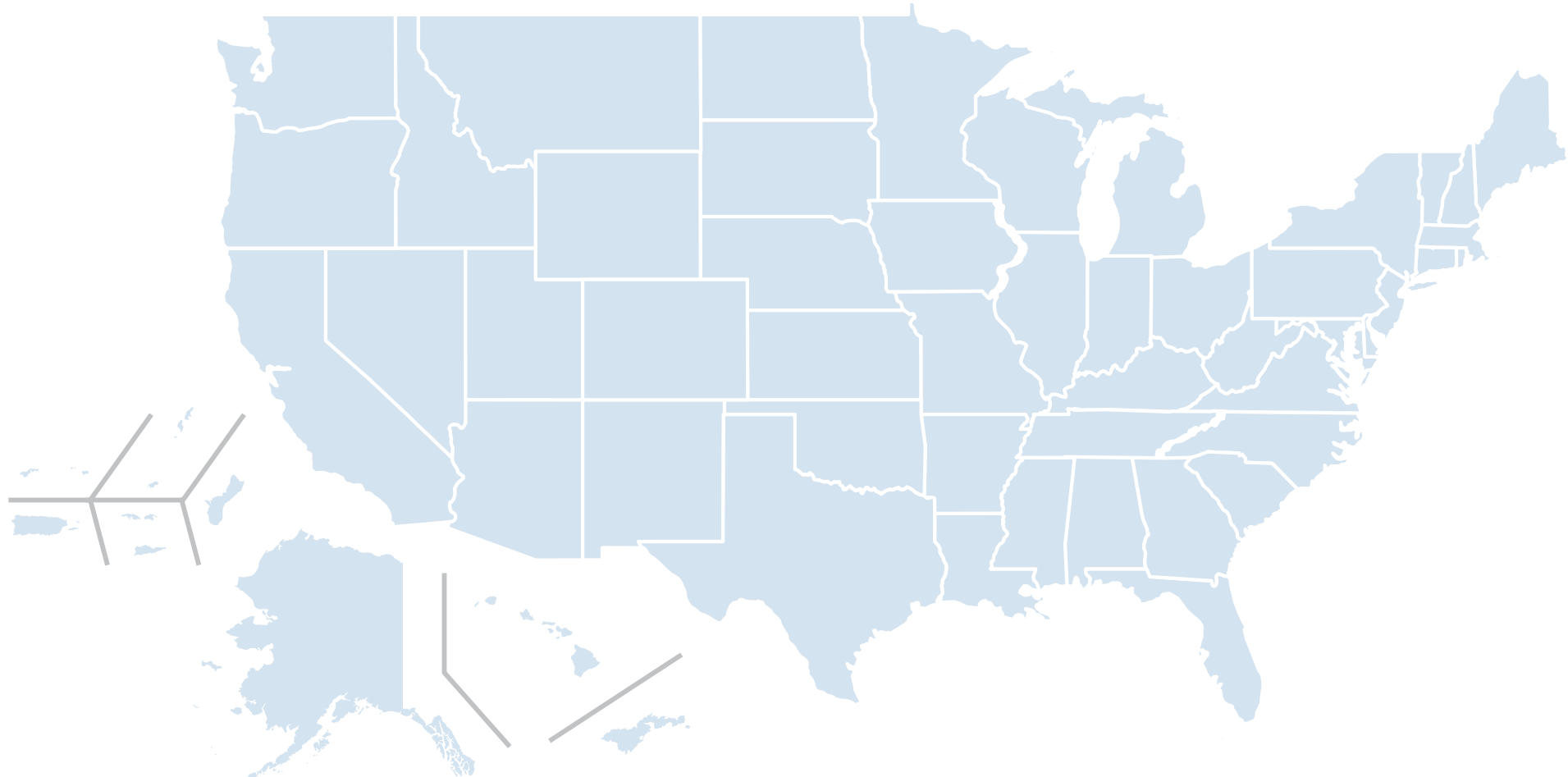


Source: NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2023). <https://www.ncei.noaa.gov/access/billions/>, DOI: 10.25921/stkw-7w73

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Hazards

From 1980 to 2022, the United States experienced 348 weather and climate disasters that reached or exceeded \$1 billion in overall damage/costs. Beyond property damage and insurance claims, there were thousands of deaths, as well as injuries, displacements, and livelihood disruptions. The average annual cost of these events was \$18 billion in the 1980s growing to \$79.1 billion in for 2018-2020. With the continued increase in extreme events in recent years, 2022 represented a higher than average year with 18 events totaling a cost of \$165.0 billion and 496 deaths. Not all hazards impact equally. Different hazards are responsible for disparate consequences and there is significant variation in the geography of where hazards occur. This map displays the geographic distribution of the 10 most impactful hazards, based on financial damage. Icons are placed where significant events have occurred in the past, but do not represent locations where those hazards are limited to.



Hover over each hazard icon on the map to learn more.

References for the information on this page can be found at the end of this document.



Wildfires

From 1980 to 2022, 21 wildfires were responsible for more than \$135.9 billion in damage and 435 deaths.



Earthquakes

Of the 10 costliest earthquake events in the U.S. between 1980 and 2022, 6 were in CA and the others were in WA, AK, VA, and PR. The damage caused by these earthquakes ranged from \$132 million to \$31.2 billion in insured losses (in 2022 dollars).



Drought

From 1980 to 2022, 30 droughts were responsible for more than \$336.6 billion and 4,275 deaths.



Inland Flooding

From 1980 to 2022, 40 flood events were responsible for over \$186.6 billion in damage and 701 deaths.



Tornadoes

More than 26,000 tornadoes occurred in the U.S. from 2000 to 2021 and resulted in 1,645 deaths, for an annual average of 74 deaths per year.



Hurricanes

From 1980 to 2022, hurricanes caused the most damage (more than \$1 trillion) and caused the most deaths (6,890) for which NOAA reports billion-dollar events. Each event averages \$22.8 billion in damage.



Coastal Flooding

Coastal floods are caused by events such as high tides, storm surges, strong waves, and heavy precipitation. The average frequency of high-tide flooding is already 50% greater than 20 years ago and 100% greater than 30 years ago.



Tsunamis

Since 1800, tsunamis have caused more than 700 deaths and ~\$2 billion in damage to U.S. coastal states and territories.



Winter Storms

From 1980 to 2022, 21 winter storm events were responsible for more than \$95.4 billion in damage and 1,401 deaths.



Landslides

Landslides are estimated to cause an average of \$2 to \$4 billion in damage and kill 25 to 50 people every year in the U.S. They affect all 50 states and U.S. territories.



Extreme Temperatures

Across the U.S., more than 700 people die from extreme heat every year. Average annual heat-related deaths are up 95% in the U.S. from 2010 to 2022. From 2012 to 2022, an average of 39 people die from cold-related deaths each year.

Community Lifelines

To help communities better monitor disruptions to critical services and systems following a disaster and reduce cascading impacts across government and business functions, FEMA launched the community lifelines framework. This framework has served as a driving force behind two of the agency’s strategic goals: lead whole community in climate resilience; and promote and sustain a ready FEMA and prepared nation.

Since the seven community lifelines and their respective components, as graphically shown on this page, were introduced, they have resonated strongly in response and recovery circles to organize both day-to-day operations and strategic planning after a disaster. Community lifelines can also be a powerful tool for SLTTs to use in evaluating risk and developing strategies to reduce hazard impacts. However, the use of community lifelines has not been fully integrated into all phases of the emergency management cycle. As FEMA conducted stakeholder engagement sessions through the summer of 2019, it was discovered that the connection between community lifelines and hazard mitigation, particularly pre-disaster risk reduction activities, is not widely understood.

Each HMA program offers a unique opportunity for FEMA to apply its community lifelines concept to hazard mitigation practices so that communities can build resilience to both the direct and cascading impacts of a disruptive event. This portfolio is a useful resource to inspire change by profiling a broad spectrum of activities ranging from small-scale projects to large-scale initiatives. These demonstrate how one project or activity can have community-wide disaster resilience benefits and mitigate risk across multiple community lifelines.

Leveraging community lifelines in hazard mitigation planning and project implementation can be transformational in terms of a community’s ability to respond to and recover from the impacts of natural hazards and ensure long-term resilience outcomes.

“A lifeline enables the continuous operation of critical business and government functions and is essential to human health and safety or economic security.”

FEMA Community Lifelines

Source: [fema.gov/media-library/assets/documents/177222](https://www.fema.gov/media-library/assets/documents/177222)



Hazard Mitigation: Reducing Risk and Increasing Resilience

One of FEMA’s primary objectives is to support risk reduction and increase community resilience through funding of hazard mitigation projects and activities. An HMA-eligible project that is effective at reducing risk and improving long-term resilience to disasters requires a thorough and thoughtful development process.

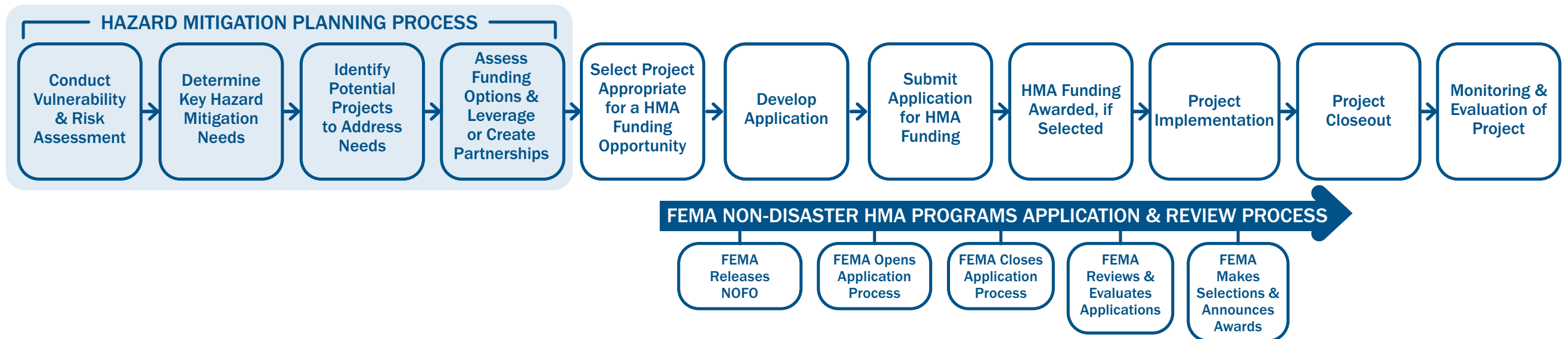
Project development should identify hazards that need to be addressed, local partners and funding opportunities, and specific

options to address specific needs. Furthermore, projects should attempt to maximize benefits, both hazard mitigation and broader community, economic, and environmental benefits. The graphic below provides a simplified version of the general steps an applicant or subapplicant might take, from hazard mitigation project development to a HMA program application submittal, to implementation of a project, if awarded. The arrow below the top row signifies the general programmatic flow of FEMA’s actions and engagement during the application and review process for HMA programs. Please note HMGP and HMGP Post Fire are disaster specific programs and are subject to different application and review processes.

HMGP is authorized through a major disaster declaration and HMGP Post Fire assistance is available following a Fire Management Assistance Grant declaration. For HMGP, the application period ends 12 months after the declaration date. For HMGP Post Fire, the application period ends six months after the close of that fiscal year. The applicant will solicit and submit subapplications throughout the application period. Subapplications are reviewed on a continuous basis and awarded if eligible.

Numerous actions can be taken, and hazard mitigation interventions put in place, to minimize the impacts of natural hazards and reduce the overall risk of disasters, while also increasing community resilience.

Some actions cut across multiple hazards; others are uniquely designed to address a single hazard. Hazard mitigation projects can come in the form of a plan or an ordinance, coastal wetland protection, or an engineered and built structure. Furthermore, hazard mitigation projects can come in different sizes. Actions can be very localized to address a targeted issue, such as an enlarged culvert to allow for greater waterflow or an individual safe room to provide shelter from a tornado; but projects can also have a wider geographic impact, such as a hazard mitigation plan, city ordinance, or flood mitigation action that reduces area-wide flooding. Building codes, when properly enforced, are uniquely effective at reducing impacts and losses from all types of hazards. Municipalities and states have taken different steps to ensure base-level hazard risk reduction through adopting building codes as a hazard mitigation intervention, as described in the next section.



Building Codes: Low-Cost, High- Impact Hazard Mitigation

Many states and communities regulate the construction of buildings by adopting and enforcing building codes that set forth the minimum acceptable requirements necessary for protecting the public health, safety, and welfare in the built environment. Communities with up-to-date and enforced building codes have demonstrated fewer devastating losses in terms of both property and human life.

A study, ***Building Codes Save: A Nationwide Study of Loss Prevention***, that culminates a decade of research and quantifies the physical and economic losses that were avoided due to buildings being constructed according to modern, hazard-resistant building codes and standards was released in 2020. This study found that adopting international model building codes can avoid losses to buildings because of specific design requirements that strengthen buildings. In addition to reducing physical damage, these codes also reduced economic impacts, such as lost rent and relocation costs, and reduced indirect disaster costs such as lost productivity and impacts on health, education, and the environment. More information is available at: <https://www.fema.gov/emergency-managers/risk-management/building-science/building-codes/save-study>.

The results clearly demonstrate the effectiveness of modern building codes in reducing damage: (1) average annual avoided losses related to flooding were estimated to be \$484 million (based on 786,000 parcels); (2) average annual avoided losses related to hurricanes were estimated to be \$1.1 billion (based on 9.2 million parcels); and (3) average annual losses avoided related to seismic activity were estimated to be \$60 million (based on 2.4 million parcels). Another resource covering benefits of going beyond code requirements is FEMA's Mitigation Saves Fact Sheet available at https://www.fema.gov/sites/default/files/2020-07/fema_mitsaves-factsheet_2018.pdf.

Although most locally adopted building codes in the United States are based on model building codes or templates such as International Building Code (IBC) and International Code Council (ICC), states and local jurisdictions often incorporate amendments and revisions to address local hazards. For example, the Florida Building Code (FBC) contains separate (more stringent) wind, structural, and testing requirements for a special zone called the High-Velocity Hurricane Zone (HVHZ) in order to better protect buildings constructed in this hurricane-prone area.

Lack of code enforcement often leads to building performance that is less robust than anticipated. FEMA's Mitigation Assessment Teams (MATs) conduct building performance studies after disasters and routinely conclude that damage observed after disasters is partly attributable to lack of sufficient building code enforcement and implementation. As a part of the effort to reform federal disaster programs and build the nation's capacity to better mitigate the impacts of catastrophic events, HMA programs such as BRIC and HMGP are uniquely positioned to encourage building code adoption and enforcement.



Hurricane destruction surrounding a standing house

Source: Jocelyn Augustino / FEMA / Public domain, https://upload.wikimedia.org/wikipedia/commons/5/55/Hurricane_Ike_Gilchrist_damage_edit.jpg

Damage in Texas after Hurricane Harvey (2017) clearly demonstrated the advantage of adopting local floodplain management regulations:

- **For buildings built BEFORE adoption:
365 buildings had average claim of \$175,028**
- **For buildings built AFTER adoption:
308 buildings had average claim of \$86,870**

Recent BRIC Project Examples

The following are examples of projects awarded under the BRIC National Competition. These represent a variety of hazard mitigation and disaster resilience projects including elevation, flood control, safe room/shelter, utility and infrastructure protection, and wildfire management. As BRIC projects are completed, full case studies will be completed.

For more information please refer to:

BRIC webpage at

<https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities>

Program resources at

<https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities/resources>

BRIC application status at

<https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities/after-apply/previous-subapplication-status>

 Nature-Based Solution

Wildfire Resilient Sonoma County

Sonoma County, CA

FEMA Region 9

Type of Project

 Wildfire protection

Addressed Hazards

Wildfire



Large scale wildfire protection including property owner's involvement. This project will support wildfire planning and wildfire mitigation activities, including hardening structures and critical facilities, fuels management, and establishing defensible spaces, such as natural community buffers. The project is among the first of its kind in the country and is likely the largest nature-based solution for wildfire mitigation ever proposed.

Blue/Green Storm Water Flood Mitigation in Southwest DC

Washington, DC

FEMA Region 3

Type of Project

Flooding

Addressed Hazards

Inland Flooding, Hurricanes



Flooding in Southwest Washington, D.C. regularly results in localized structural damage and impacts to critical facilities. This project will incorporate subsurface (blue) and landscape (green) mitigation strategies to create a greenway corridor between two parks that collects, treats, and moves water away from the low-lying areas, thereby enhancing the parks' public amenities and diverting sewer overflow. The resulting co-benefits will include a local reduction of heat and a heat island effect; the enhancement of the park's public amenities; opportunities to raise public awareness of stormwater mitigation; and the diversion of sewer overflow that impacts the Chesapeake Bay.

St. Elizabeth's Hospital & DC Communications Microgrid

Washington, DC

FEMA Region 3

Type of Project

Microgrid

Addressed Hazards

All Hazards




This project will construct a microgrid at the Saint Elizabeth's Hospital Campus to provide resilient power to the Unified Communications Center—which provides vital communication, including 911 service, to the area—as well as the existing Saint Elizabeth's behavioral health hospital and other essential loads on the campus. The microgrid will provide a redundant and resilient power source and reliable access to health care and emergency services for DC residents, including disadvantaged populations.

Recent BRIC Project Examples

The Middle Branch Resiliency Initiative (MBRI)

Baltimore, MD
FEMA Region 3

Type of Project

 Critical infrastructure protection, living shoreline, and stormwater management

Addressed Hazards

Coastal Flooding



The MBRI is a comprehensive set of shoreline protection, marsh re-establishment, and stormwater management projects located throughout the Middle Branch shoreline in Baltimore City. The MBRI will generate community resilience to climate change and sea level rise in several neighborhoods in South Baltimore, which have complex histories fraught with environmental and economic challenges. The project will also generate significant water quality and habitat improvements while providing opportunities for recreation and education.

Copeland Creek Detention Basin

Rohnert Park, CA
FEMA Region 9

Type of Project

 Detention basin

Addressed Hazards

Inland Flooding




Flooding events have previously impacted more than 100 county transportation lifelines and an estimated 2,100 business and residential properties. A multipurpose off-channel detention basin along Copeland Creek is proposed to detain peak stormwater flows and mitigate 10-year flood events. Additional benefits will include groundwater recharge, fish passage and salmonid habitat creation, and energy conservation due to the reduced need for pumping and importing water.

SAFER Bay Project

Menlo Park, CA
FEMA Region 9

Type of Project

 Stormwater management-floodgates and marsh restoration

Addressed Hazards

Coastal Flooding




This is a large-scale infrastructure project that proposes a continuous earthen levee with a living shoreline side, and floodwalls with gates to protect 3.7 miles of infrastructure and an electrical substation. The project will reduce risk to almost 300,000 customers impacted by a loss of function of the substation due to flooding. It will create about 30 acres of tidal marsh transition zone and a resilient, high-quality habitat. Additionally, it will provide nearly five acres of western snowy plover breeding habitat. The snowy plover is listed as an endangered species.

Town of Princeville Relocation Project

Princeville, NC
FEMA Region 4

Type of Project

 Relocation of critical lifeline utilities and creation of floodable greenspace

Addressed Hazards

Coastal Flooding



Incorporated in 1885, the historic Town of Princeville, N.C., is the oldest community chartered by African Americans in the U.S. Located in the 100-year floodplain of the Tar River, Princeville, like many economically disadvantaged communities in the U.S., was built in a high-risk area for flooding. This project will mitigate repetitive loss of infrastructure by relocating critical lifeline utilities, emergency support services, and 54 units of affordable housing outside of the Special Flood Hazard Area. This project will also create over five acres of green open space in perpetuity - making this a nature-based solution that utilizes vegetation and permeable soils to assist detention basins to better hold stormwater runoff.

Recent BRIC Project Examples

NYCHA - Breukelen Houses Stormwater Protection

New York, NY
FEMA Region 2

Type of Project
 Flood control

Addressed Hazards

Flooding



New York City is embracing an innovative design solution to utilize existing urban amenities and places to serve multi-functional roles. These places will provide subsurface space to manage rainfall runoff with inclusion of nature-based solutions such as green infrastructure, resilient planting and community spaces that can provide relief from impacts of extreme heat during summer for its residents and community. This project will install a cost-effective stormwater management system that includes nature-based solutions with multi-functional benefits that will improve the overall resiliency of Breukelen Houses and surrounding areas.

Papio WP-4 Project

Omaha, NE
FEMA Region 7

Type of Project
Flood control, dam

Addressed Hazards

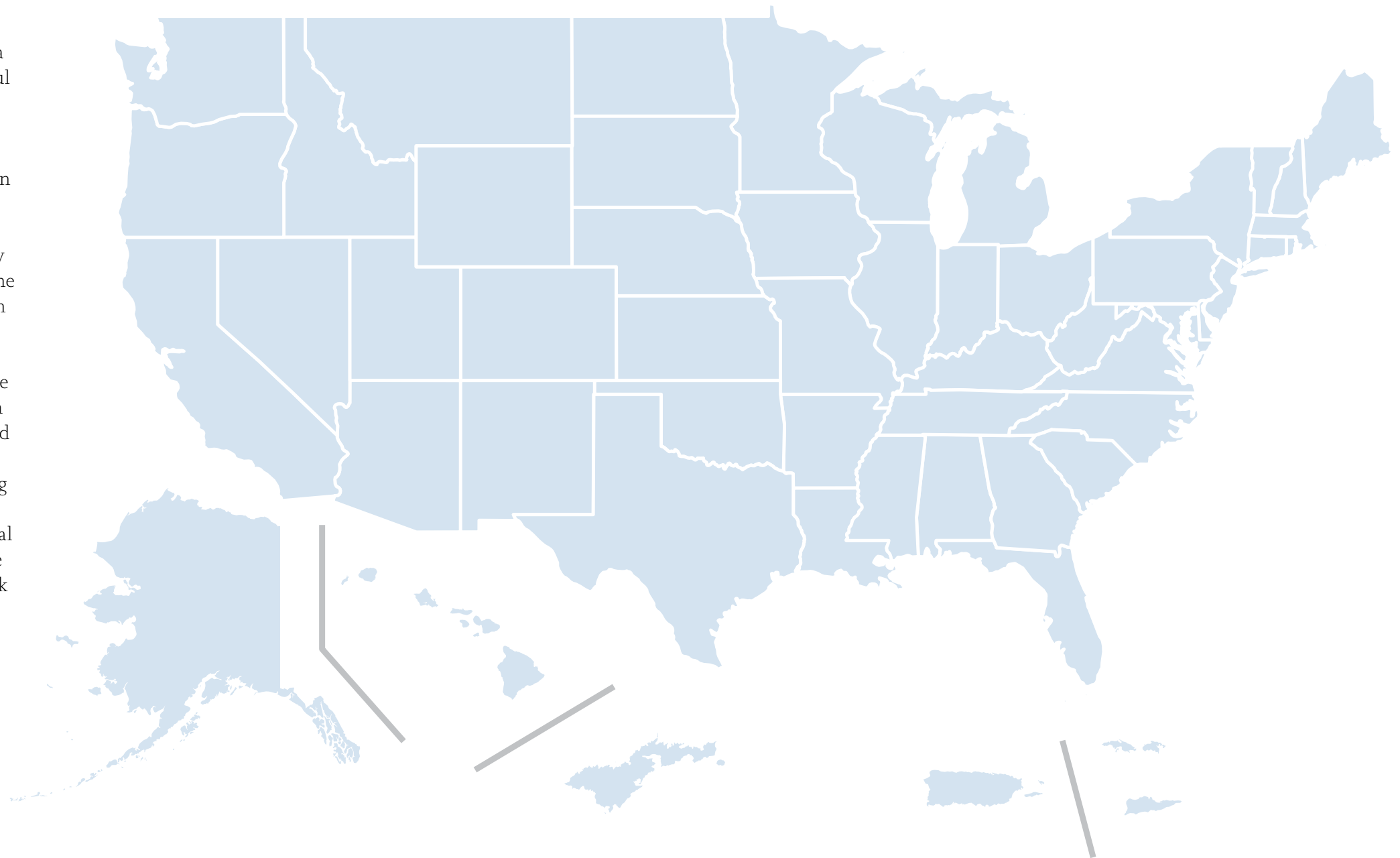
Flooding



The Papio WP-4 Project includes the construction of a dam (an earthen embankment) along the Wehrspann Creek and creation of a flood storage area. The project is intended to provide environmental benefits to 48 acres of land and reduce risk to nine structures, including commercial and residential. WP-4 is one of 14 structures that, once constructed, will contribute to collective flood control benefits throughout the watershed by protecting homes, businesses, industries, and providing additional benefits of water quality improvement, streambank stabilization, and recreational opportunities throughout the Omaha-metro area.

Case Study Geography

The projects showcased in this portfolio are just a small subset of the tens of thousands of successful hazard mitigation projects implemented by communities to increase community resilience. Projects were sought out that met key criteria related to HMA goals. All of the hazard mitigation projects selected achieve, or are designed to achieve, hazard risk reduction; however, each project also addresses one or multiple community lifelines and improves the disaster resilience of the community in which it is located. Projects shown here are also meant to exemplify risk reduction activities that can produce value beyond their primary hazard mitigation purpose, and to inspire stakeholders to replicate or tailor activities shown to be applicable and possible for their relevant and local context. Projects selected have been funded from a range of sources, including federal funding from agencies such as FEMA or Housing and Urban Development (HUD), as well as non-federal funding, like states or municipalities. In all, these projects are examples of HMA's ambition to think holistically and at scale when it comes to hazard mitigation and disaster resilience.



Hover over each hazard icon on the map to learn more. Click on the icon to go to that case study's page.

Case Study Guide

Highlight Section
This section features primary highlights from the project, including unique or exemplary components and quantitative and qualitative impacts.

Details Section
This section presents several project details, including who owns the project, such as a local government body or a specific organization, and what type of project it is. The area of impact represents the total geographic area that the project encompasses, such as a building, a neighborhood, or a city. When available, the number of people impacted is also presented here.

Benefits
Primary and secondary benefits of the project are presented here. This includes both benefits to the community, as well as to any local infrastructure.

Timeline
This section lists the project timeline, including the start date, current status, and completion date. If the project is still in progress, an anticipated completion date is presented if known.

Project Description
This section provides an overview of the case study project.

Partnerships
A list of partners involved in the project is presented here.

Addressed Hazards
This highlights the primary hazard that the project addresses, as well as any secondary hazards addressed or potentially addressed by the project, if applicable. Potential hazards addressed by case studies include wildfires, earthquakes, drought, inland floods, tornadoes, hurricanes, coastal floods, tsunamis, winter storms, and landslides. For projects intended to address multiple hazards at once, there is an all-hazards designation.

Community Lifelines
This shows the FEMA Community Lifelines that are addressed by the project. The highlighted lifeline is considered the primary lifeline and includes a brief description as to why it's considered primary.
Hover over the Primary Lifeline to learn more.

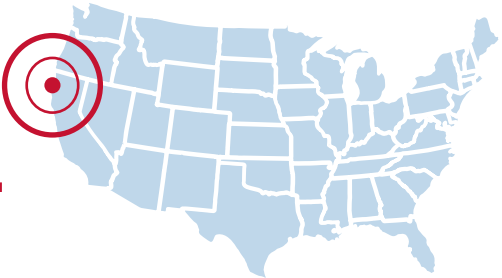
Cost and Funding
These sections provide information on the overall cost of the project. Sources of funding are also provided when available, as well as any details on how much each source contributed.

Challenges Faced
This section presents challenges faced during project planning, implementation, and follow up. Challenges were identified by using public project documents and are only presented when available.



All Hazards

Blue Lake Rancheria Tribe Microgrid



Humboldt Bay, CA
FEMA Region 9

The Blue Lake Rancheria (BLR) is a Native American reservation located in an area subject to heavy rainstorms, forest fires, and frequent power outages. The reservation constructed a low-carbon community microgrid in 2017 to bolster its resilience to these outages. It helps power government offices, economic enterprises, and several Red Cross safety shelter-in-place facilities. The BLR microgrid integrates a solar array, battery storage, and control systems to allow the Rancheria campus to operate in tandem with, or islanded from, the main utility grid. This provides resiliency to the community because if the main grid experiences a power outage, the microgrid will automatically disconnect and go into island mode.

The system prioritizes clean generation, but if needed it will bring a 1-megawatt isochronous backup generator online to support the photovoltaic (PV) array and battery. The solar array also generates renewable energy regardless of whether or not it is in island mode, providing both carbon emission and electricity cost savings. The microgrid is projected to save \$150,000 a year and reduce 150 tons of carbon dioxide emissions annually.

Innovative Energy Solution Tested and Proven in 2019
When a nearby wildfire caused a power outage in October 2019, the microgrid successfully islanded and kept the facilities from experiencing a blackout. During the outage, the microgrid served 10,000 people, about 10 percent of the county’s population, and is credited with saving four lives.

Leveraging Partnerships for Tribal Lifeline Resilience
By leveraging public and private partnerships, this project utilizes the latest in microgrid technology to mitigate cascading impacts to an entire tribal community.



Workers installing the racking for the Blue Lake Rancheria’s 500-kilowatt solar system in June 2016. The solar system is a cornerstone of the tribe’s low-carbon community microgrid project.

Source: U.S. Department of Energy Flickr <https://www.flickr.com/photos/37916456@N02/27365396111>

Community Lifelines

 Hover over the Primary Lifeline to learn more.



Safety & Security



Food, Water, Sheltering

Addressed Hazards

 **PRIMARY HAZARD**
All Hazards

 **Inland Flooding**

 **Wildfires**

Details

Project Owner

The Schatz Energy Research Center and the Blue Lake Rancheria Tribe

Type of Project

Microgrid

Area of Impact

Over 10 percent of Humboldt County, CA
(Total Pop: 136,754 in 2017)

Cost

Total Project Cost

\$6.3 million

Funding Sources

Non-Federal Funding

- California Energy Commission R&D grant through Electric Program Investment Charge (EPIC) Program: \$5 million
- The Blue Lake Rancheria: \$1.3 million

Benefits

Primary

- Less frequent physical damage to system components, less frequent system outages from natural hazards, and better overall system performance and resiliency
- Targets a low-income community facing impacts from future conditions

Secondary

- Lower costs for meter reading and usage monitoring, social benefits associated with more reliable electric power, and better business continuity following major disasters that typically would have caused outages for several days or weeks

Partnerships

- The California Energy Commission (major funder)
- The Blue Lake Rancheria (site host and major funder)
- Humboldt State University's Schatz Energy Research Center
- Pacific Gas & Electric (local utility)
- Siemens (Microgrid Management System [MGMS])
- Tesla (battery energy storage system)
- Idaho National Laboratory (testing and simulation)
- Robert Colburn Electric (electrical contractor)
- REC Solar (turnkey PV system)
- McKeever Energy & Electric (PV installation)
- GHD, Inc. (electrical engineering)
- Kern Construction (civil construction for the project)

Project Timeline

Start Date

100 percent design completed September 15, 2016; granted full permission to operate July 26, 2017

? Challenges Faced

- Challenges with installing new microgrid infrastructure over an existing built environment
- Need for electricians with institutional knowledge of existing systems

Resources & References

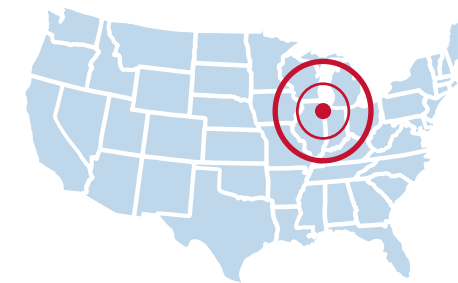
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Maloney, Peter. 2019. "Life Won Thanks to the Blue Lake Rancheria Microgrid," *Microgrid Knowledge*, November 11, 2019, <https://microgridknowledge.com/blue-lake-rancheria-microgrid-outages/>.

Duke Energy. 2017. Blue Lake Rancheria Native American Reservation Microgrid Goes Live. April 27, 2017. https://bluelakerancheria-nsn.gov/wp-content/uploads/2017/08/SiemensUSAMultimediaNewsroom_BlueLakeRancheriaNativeAmericanReservationmicrogridgoeslive.pdf.

Schatz Center. 2020. "Blue Lake Rancheria Microgrid." Accessed March 16, 2020. <https://schatzcenter.org/blrmicrogrid/>.

Bronzeville Microgrid Project



Chicago, IL
FEMA Region 5

The Bronzeville microgrid is a pilot project implemented by Illinois' Commonwealth Edison Company (ComEd) to keep power flowing in the event of an emergency and provide support for solar infrastructure for residents of the historic Bronzeville neighborhood in Chicago's South Side, including its vulnerable populations. The project includes 1,000 residences, businesses and public institutions. The Bronzeville Microgrid project is part of ComEd's broader Community of the Future initiative.

This project:

- Improves energy security, resilience to future conditions, and sustainability
- Provides grid modernization and "smart city" technologies to improve community livability
- Includes extensive stakeholder outreach and engagement within the Bronzeville community

Technology-Driven Resilience Creates Community-Wide Benefits

A modern energy grid that uses "smart city" technology to mitigate risk across multiple community lifelines, and will reduce vulnerability for an entire neighborhood and the surrounding economy.



Bronzeville, Chicago metro stop station
Source: Shutterstock



Bronzeville, Chicago
Source: Shutterstock

Addressed Hazards



Community Lifelines

 Hover over the Primary Lifeline to learn more.



Safety & Security



Food, Water, Sheltering



Transportation



Communications

Bronzeville Microgrid Project

Details

Project Owner

Commonwealth Edison Company

Type of Project

Microgrid

Area of Impact

1,000 residences, businesses and public institutions

Cost

Total Project Cost

\$29.6 million

Funding Sources

Non-Federal Funding

Commonwealth Edison Company

Federal Funding

Federal grant funding of more than \$4 million to date from U.S. Department of Energy

Benefits

Primary

- Reduces system outages from natural hazards
- Improves overall system performance, reliability, and resilience for customers within the service area, and potentially neighboring customer areas
- Provides more reliable electric service to the target customers, but also can provide better resiliency to neighboring customer areas that have not had microgrid systems installed

Secondary

- Enhances community livability associated with increased reliability in electric power
- Improves business continuity resulting from reduced outages and disruptions in electric power

Partnerships

- Chicago Housing Authority (manages Dearborn Homes Community in Bronzeville)
- Illinois Institute of Technology
- Argonne National Laboratory

Project Timeline

Start Date

Plan approved by Illinois Commerce Commission on February 28, 2018

Project Completion Date

Completed first quarter of 2022

? Challenges Faced

- Securing regulatory and stakeholder approval
- Ongoing community outreach to identify priorities and opportunities to leverage smart grid technology, address challenges and enhance quality of life
- Meeting requirements for a solar installation with a generation capacity of 750 kilowatts at Chicago's first public housing community

Resources & References

Cohn, Lisa. 2019. "Solar Housing Linked to Bronzeville Microgrid Provides Social Justice, Technology Research." **Microgrid Knowledge**. June 14, 2019. <https://microgridknowledge.com/bronzeville-microgrid-social-justice-solar/>.

Cohn, Lisa. 2022. "Here comes the future: Bronzeville 'microgrid cluster' set to begin operating this year." **Microgrid Knowledge**. January 24, 2022. <https://microgridknowledge.com/bronzeville-microgrid-cluster-lessons-comed/>.

Marotti, Ally. 2016. "ComEd gets \$4 million to build microgrid in Bronzeville," **Chicago Tribune**, January 26, 2016, <http://www.chicagotribune.com/bluesky/ct-comed-smart-grid-bronzeville-bsi-20160126-story.html>.

Massachusetts State Hazard Mitigation and Climate Adaptation Plan



State of
Massachusetts
FEMA Region 1

The 2018 State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) is Massachusetts' first all-hazard mitigation plan that fully integrates climate adaptation. In addition to being compliant with federal standards for hazard mitigation plans, this fulfills Governor Baker's Executive Order 569 and comprehensively integrates climate change impacts and adaptation strategies. As part of the plan, an extensive risk-assessment process was undertaken for the state, using downscaled climate data in a GIS spatial analysis as well as a State Agency Vulnerability Assessment Survey Tool, as two of the many tools used to capture and address the state's vulnerability to natural hazards. It takes projected changes in precipitation, temperature, sea-level rise, and extreme weather into account when evaluated all risks. A "prioritization tool" was also developed to weight and score hazard mitigation/climate adaptation actions for the plan.

The plan is a "living document" that is being continually updated as new information comes available. The plan has received awards from both the Massachusetts chapter of the American Planning Association and the Climate Change Business Journal.

The planning process was managed through the Executive Office of Energy and Environmental Affairs (EOEEA), the Executive Office of Public Safety and Security (EOPSS), and the Massachusetts Emergency Management Agency (MEMA), and involved a Project Management Team composed of several key state agencies. The plan also includes five overarching goals, including investing in performance-based solutions, and 108 specific hazard mitigation and climate adaptation "actions" stemming from each of the five goals. The online portal for the plan offers an "Action Tracker" tool designed to allow the public to track progress on each of the 108 actions proposed as part of the plan's implementation.

First Plan of Its Kind

This is the first of its kind where the plan comprehensively integrates future condition impacts and adaptation strategies with hazard mitigation planning. It also complies with federal requirements and maintains Massachusetts' eligibility for federal disaster recovery and hazard mitigation funding under the Stafford Act.

Addressed Hazards



PRIMARY HAZARD

All Hazards



Coastal Flooding



Winter Storms

Community Lifelines



Hover over the Primary Lifeline to learn more.



Food, Water,
Sheltering



Health &
Medical



Energy
(Power & Fuel)



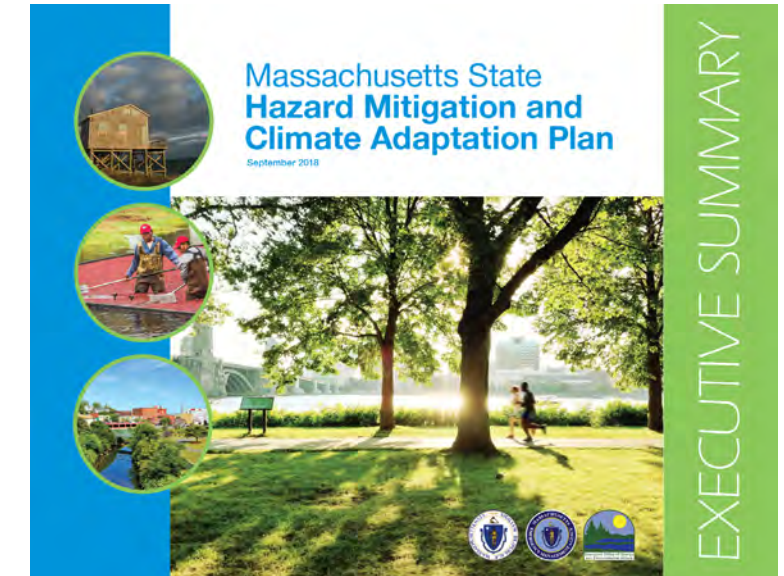
Communications



Transportation



Hazardous
Material



Online plan document

Source: <https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf>

Details

Project Owner

Commonwealth of Massachusetts

Type of Project

Hazard Mitigation and Climate Adaptation Plan

Area of Impact

Entire Commonwealth of Massachusetts
(Total Pop: 6.9 million in 2017)

Cost

Total Project Cost

\$479,340 (plan contract)

The cost of developing new plans includes community staff time and any outside consultants to provide technical support and associated analysis. For this plan for statewide mitigation and climate adaptation, adding new local requirements may increase initial project costs, but will result in lower long-term costs for many projects due to increased resiliency and lower maintenance and repair costs.

Funding Sources

Non-Federal Funding

Massachusetts state funding

Benefits

Primary

- Allows the state to evaluate relative risk geographically and between hazards to cover all major concerns for the state
- Leverage opportunities to address current and future concerns within planning and project efforts

Secondary

- Provides a platform for state and local communities to coordinate activities, host periodic meetings, conduct monitoring, and update the list of possible activities which can all in turn facilitate the grant application and project implementation process

Partnerships

- Executive Office of Energy and Environmental Affairs (EOEEA)
- Executive Office of Public Safety and Security (EOPSS)
- Massachusetts Emergency Management Agency (MEMA)

Project Timeline

Start Date

Plan adopted on September 17, 2018

? Challenges Faced

- Constantly changing climate science and projections
- Recognized obstacles to overcome to further increase state and local capacity to address future conditions and natural hazards
- Robust and extensive stakeholder engagement

Resources & References

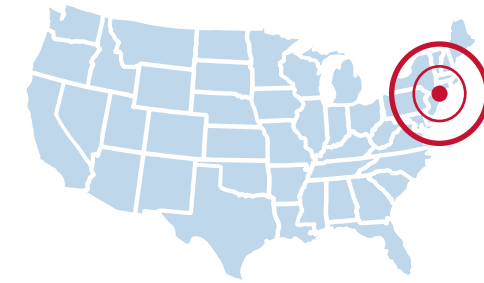
Massachusetts Emergency Management Agency. 2018. "Massachusetts State Hazard Mitigation and Climate Adaptation Plan." September 2018. <https://www.mass.gov/files/documents/2018/10/26/SHMCCAP-September2018-Full-Plan-web.pdf>.

Resilient Massachusetts. 2020. "Massachusetts State Hazard Mitigation & Climate Adaptation Plan: A First-of-its-Kind Integrated State Plan." Accessed March 16, 2020. <http://resilientma.org/shmccap-portal/index.html#/>.



Coastal Flooding

LaGuardia Airport Flood Control



New York City, NY
FEMA Region 2

Flooding from Superstorm Sandy in 2012 forced LaGuardia airport in New York City to shut down for three days, which resulted in 3,300 canceled flights and impacted 250,000 passengers. The airport handles between 20 and 30 million passengers yearly, is a hub for Delta Airlines, and serves as a major economic engine for the region. In addition to \$9 million in capital funding from the Port Authority, the State of New York received over \$28 million in Hazard Mitigation Grant Program (HMGP) funding in 2015 for retrofits and upgrades to protect the airport from the impacts of future storms. The overall airport renovation project will also include many other non-flood-related improvements, including creating a new central terminal, combining two existing terminals currently serving Delta Airlines, and adding additional concourses and gates, among others.

Improvements include a floodwall around the airport's west end substation, gravity drainage systems, upgrades to the airport's backup electrical substations, and the installation of larger, more efficient backup power generators throughout the airport. Project designs follow the climate resilience standards first established by the Port Authority in 2009 (updated in 2015 and 2018). These standards take into account FEMA base flood elevations, sea level rise projections, and future increases in precipitation intensity and quantity to establish the design flood elevations of structures and the drainage capacity requirements for flood and stormwater infrastructure. Technological innovation, while addressing flood hazards, is a key focus of not only this project, but the ongoing massive redevelopment of the entire airport. These innovations including the following:

- New approaches to construction phasing with building on top of current facilities to create a single, unified terminal
- More resilient electrical power generation, usage, and backup systems
- Major improvements to airport access, which is undergoing public input and consideration in March 2022

Retrofits to Safeguard Community Lifelines & Jobs

Improvements to reduce LaGuardia's vulnerability to future storms, such as fortifying on-site energy systems, will allow the airport to continue serving travelers following severe weather events and in turn minimize impacts to the livelihoods of the airport's thousands of employees.



Aerial image of LaGuardia Airport
Source: Patrick Handrigan / CC BY-SA (<https://creativecommons.org/licenses/by-sa/4.0>)

Community Lifelines



Hover over the Primary Lifeline to learn more.



Safety & Security



Energy (Power & Fuel)

Addressed Hazards



PRIMARY HAZARD
Coastal Flooding



Hurricanes



Winter Storms

LaGuardia Airport Flood Control

Details

Project Owner

Port Authority of New York and New Jersey

Type of Project

Flood Mitigation Infrastructure

Area of Impact

Potential impacts to a significant percentage of Queens residents (Total Pop: 2.3 million in 2017)

Cost

Total Project Cost

\$37.5 million (flood control measures – overall renovation estimated at \$8 billion+)

Funding Sources

Federal Funding

FEMA HMGP: \$28.1 million

Non-Federal Funding

Port Authority of New York and New Jersey: \$9 million

Benefits

Primary

- Reduces costs caused by the loss of function associated with airport closure, canceled flights, and potential loss of service for the businesses that operate in the airport
- Avoids physical damage to airport facilities and equipment

- Reduces loss of service from canceled flights and airport closure; loss of service would be expected for all businesses associated with the airport, including those located off-site, such as shuttle and bus services
- Offers project effectiveness for smaller, more frequent events as well as larger, less frequent events such as Superstorm Sandy
- Although the project's focus may be to address larger, less frequent events in the future, even small drainage improvements could provide fewer delays from more frequent storm events
- These smaller reductions from more frequent events tend to be a main source of the benefits in a benefit-cost analysis

Secondary

- Provides benefits to businesses that rely on regular airport function, especially the tourism and financial sectors
- Reduces closure times, which benefits areas in the vicinity of the airport, where many airport workers live
- Reduces congestion to other NYC area airports and area transportation systems (railways and subways) that could be caused by increased traffic from a prolonged airport closure

Partnerships

- State of New York
- State of New Jersey
- Port Authority of New York and New Jersey
- FEMA

Project Timeline

Start Date

Planning began in 2013; funding awarded in 2015

Project Completion Date

Construction expected to be completed by 2022

Challenges Faced

Complex project, involving flood mitigation measures as well as other major upgrades

Resources & References

Barone, Vincent and Lauren Cook. 2019. "LaGuardia Airport construction explained: Renovation plans, timeline, funding and more." AMNY. September 2019. <https://www.amny.com/transit/laguardia-airport-construction-explained-renovation-plans-timeline-funding-and-more-1-12268455/>.

Freedman, Andrew. 2013. "U.S. Airports Face Increasing Threat From Rising Seas." Climate Central. June 18, 2013. <https://www.climatecentral.org/news/coastal-us-airports-face-increasing-threat-from-sea-level-rise-16126>.

Hampton, Deon J. 2013. "LaGuardia to get \$37.5M in storm protection aid." Newsday. November 17, 2013. <https://www.newsday.com/news/new-york/laguardia-to-get-37-5m-in-storm-protection-aid-n19840>.

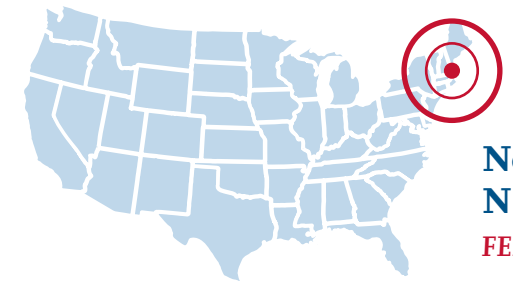
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The Port Authority of NY&NJ. 2018. "Climate Resilience Design Guidelines." June 1, 2018. <https://www.panynj.gov/business-opportunities/pdf/discipline-guidelines/climate-resilience.pdf>.

Schifman, Gerald. 2016. "How many travelers pass through NYC-area airports and what's the economic impact." Crain's New York Business. April 29, 2016. <https://www.crainnewyork.com/article/20160429/TRANSPORTATION/160429894/city-area-airportlaguardia-jfk-and-newark-employ-over-70-000-workers-and-have-aneconomic-impact-in-the-bi>.

A Whole New LGA. 2022. "A Whole New Airport for New York." Accessed April 12, 2022. <https://www.anewlga.com/>.

Lubberland Creek Restoration and Coastal Flood Risk Mitigation



Newmarket, NH
FEMA Region 1

Lubberland Creek flows through one of coastal New Hampshire’s most intact natural landscapes and supports an abundance of fish and wildlife resources. It crosses under Bay Road, a local road that has a history of flooding in as little as a 5-year storm event. That was, until a group of partners came together to address the multiple opportunities and benefits that this problematic road-stream crossing had to offer.

Bay Road provides an alternate emergency access route to points north of the Town of Newmarket, so mitigating its flood risk was important given the flood susceptibility of the area. In addition to addressing flooding at this site, the project offered tremendous ecological benefits. Bay Road is a head-of-tide crossing with a perched culvert that blocked diadromous fish passages and that restricted the natural ebb and flow of tides.

After years of planning, the pre-existing 3-foot-diameter metal culvert was replaced with a 16-foot-wide by 8.5-foot-tall concrete box culvert in 2019. The replacement structure is designed to accommodate the 1 percent annual flood event during the highest projected tides at a 75-year design lifespan. The new concrete box culvert fully restored the fish passage, granting thousands of American eels amassing in the downstream pool access to pristine upstream habitat.

Addressed Hazards

 **PRIMARY HAZARD**
Coastal Flooding

 Hurricanes

 Winter Storms

Reduced Flood Hazards, Increased Ecological Benefits

The Lubberland Creek Restoration project addressed a critical flood hazard for the Town of Newmarket, while providing important ecological benefits, including fish and wildlife passage and a suitable salt marsh migration pathway.

Strong Partnerships Led to Success

This project was a success thanks to a strong partnership between federal, state, local, and non-governmental organizations.



Pre-construction fish monitoring under high tide conditions
Source: Peter Steckler, use by FEMA is permitted



Installation of the last wingwall of the replacement structure
Source: Peter Steckler, use by FEMA is permitted



Post-construction high-tide conditions
Source: Peter Steckler, use by FEMA is permitted

Community Lifelines

 *Hover over the Primary Lifeline to learn more.*



Safety & Security



Food, Water, Sheltering



Health & Medical



Energy (Power & Fuel)

Lubberland Creek Restoration and Coastal Flood Risk Mitigation

Details

Project Owner

Town of Newmarket

Type of Project

Transportation Infrastructure

Area of Impact

Great Bay Estuary (Emergency access for 10,000 residents)

Cost

Total Project Cost

\$450,000

Funding Sources

Federal Funding

NOAA funding passed through the New Hampshire Department of Environmental Services (NHDES) Coastal Program: approximately \$175,000

Non-Federal Funding

NHDES Aquatic Resources Mitigation Fund, Town of Newmarket, The Nature Conservancy: \$275,000

Benefits

Primary

- Reduced damage to stormwater and flood infrastructure, including culvert and road
- Maintained access for residents, emergency responders, and evacuation
- Enabled the upstream passage of diadromous fish previously blocked at this road crossing

Secondary

- Project design incorporated projected sea level rise, lengthening useful lifetime of the structure
- Provided environmental benefits including unrestricted movement in critical coastal salt marshes and use of widened road crossing by terrestrial wildlife, such as bobcat and deer
- Created demonstration project for the area that allows project partners to show best practices for coastal resilience to members of the public and decision makers at state and local levels

Partnerships

- Town of Newmarket
- The Nature Conservancy
- NHDES Coastal Program
- NHDES Aquatic Resources Mitigation Fund
- New Hampshire Fish and Game Department
- University of New Hampshire Cooperative Extension/Sea Grant
- U.S. Fish and Wildlife Service
- Wright Pierce Engineers

Project Timeline

Start Date

2015

Project Completion Date

2019

? Challenges Faced

- Securing a construction easement from an abutting private landowner delayed the project
- Funding the project from multiple grant programs was time and resource intensive
- Delays during construction created challenges for the local community because of detours due to road closure

Resources & References

Ropeik, A. 2019. “‘Climate-Ready’ Great Bay Culvert Shows Possibility, Challenge of Coastal Resilience.” September 25, 2019. New Hampshire National Public Radio (nhnpr). <https://www.nhpr.org/post/climate-ready-great-bay-culvert-shows-possibility-challenge-coastal-resilience#stream/0>.

The Nature Conservancy. 2020. “The Freedom of Flow.” Last Updated November 18, 2020. <https://www.nature.org/en-us/about-us/where-we-work/united-states/new-hampshire/stories-in-new-hampshire/journey-of-the-glass-eel/>.

Mexico Beach Recovery and Resiliency Partnership

In 2018, Hurricane Michael slammed into Mexico Beach, FL, causing widespread damage and destruction. Three people were killed, and more than three-quarters of the homes in Mexico Beach were destroyed or severely damaged. In 2019, the City of Mexico Beach teamed up with the U.S. Environmental Protection Agency (EPA) and FEMA, as part of the Recovery and Resiliency Partnership Project (RPP), to help the community develop a vision for a more sustainable future, through better stormwater management and urban design, resulting in the Recovery and Resiliency Partnership Stormwater Management and Greenspace Project for Mexico Beach.

To develop this vision, the City and the RPP initiated a significant public engagement process, and then undertook existing conditions and needs/opportunities analyses in order to establish the framework for the six design projects proposed as a result of the engagement process. The proposed projects include creating a regional stormwater detention network, utilizing existing wetlands; establishing several wetland parks; converting an existing canal to a stormwater pond; extending an existing greenway; creating a greenway-blueway trail system throughout the city; and restoring a local park that was partially destroyed during Hurricane Michael. Although the outcomes of these proposed projects are not yet known, the process has produced a variety of implementable projects that community stakeholders can support.

Addressed Hazards



Community-Driven Plan for Action

This effort brought together community stakeholders to collaboratively develop creative nature-based solutions for stormwater management. The wide range of implementable and scalable projects proposed focus on leveraging existing conditions to reduce flood risk while creating open space and improving recreational amenities.



Damage caused by Hurricane Michael in Mexico Beach, FL
Source: Shutterstock



Mexico Beach, FL
FEMA Region 4

Community Lifelines

 Hover over the Primary Lifeline to learn more.



Food, Water, Sheltering



Transportation

Mexico Beach Recovery and Resiliency Partnership

Details

Project Owner

City of Mexico Beach

Type of Project

 Nature-Based Solution:
Stormwater Management Plan

Area of Impact

Has potential to impact all of Mexico Beach (Total Pop: 1,198 in 2017)

Cost

Total Project Cost

The cost of developing new plans, codes, or ordinances include community staff time and any outside consultants to provide technical support and associated analysis. Changes will typically include economic analyses looking at construction components, practices, and short- and long-term maintenance costs.

Funding Sources

Federal Funding

FEMA's Public Assistance Grant Program: \$2.7 million

Benefits

Primary

- Reduces physical damage to buildings and infrastructure from stormwater and flood events
- Reduces loss of service to infrastructure, especially roads and other transportation systems

Secondary

- Reduces associated loss of service to businesses and other organizations from short-term road closures
- Offers social benefits of providing the surrounding community with a park for recreation and green space

Partnerships

- FEMA
- City of Mexico Beach
- U.S. EPA

Project Timeline

Start Date

Stakeholder and community engagement process began in September of 2019

Project Completion Date

Final report released December 2019

Resources & References

Allen, Greg. 2019. "Recovery Is Slow In The Florida Panhandle A Year After Hurricane Michael." October 10, 2019. **NPR**. <https://www.npr.org/2019/10/10/768722573/recovery-is-slow-in-the-florida-panhandle-a-year-afterhurricane-michael>.

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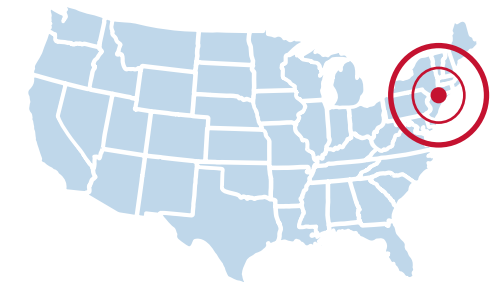
Haughey, John. 2019. "Florida to use \$633 million federal 'disaster mitigation' grant for resilience planning." **The Center Square**. October 18, 2019. https://www.thecentersquare.com/florida/florida-to-use-million-federal-disaster-mitigation-grantfor-resilience/article_5dc147fc-f1ce-11e9-9e77-432ad7c92799.html.

Recovery and Resiliency Partnership. 2019. "Mexico Beach Stormwater Management and Greenspace Project." December 2019. <https://mexicobeach.skeo.com/wp-content/uploads/2020/02/Mexico-Beach-Report-Final.pdf>.



Damage caused by Hurricane Michael in Mexico Beach, FL
Source: Shutterstock

NYU Langone Medical Center Flood Resilience Projects



New York City, NY
FEMA Region 2

New York University's (NYU's) Langone main hospital campus was forced to evacuate over 300 patients as a result of Hurricane Sandy devastating New York City, including many in critical care. The hospital's main campus was engulfed by more than 15 million gallons of water, which disrupted services and destroyed critical facilities, equipment, and research. The damages were estimated to be \$1.4 billion. It took the hospital months to resume full care services.

Following Sandy, NYU Langone Health has been restoring and upgrading its facilities to build resilience. As the first line of defense, NYU installed a flood barrier with both horizontal and vertical mitigation measures protecting the envelope of all campus buildings. These were built to bridge the gaps between buildings where a flood barrier is not a part of the building's structural wall system. As a second line of defense, NYU has installed internal layers of protection around critical building systems and specialized equipment. This includes building compartmentalization, emergency power, and elevation of critical elements. Several critical utilities, communication networks, and clinical and research programs were raised above vulnerable levels as well. All gaps along the perimeter of the hospital campus were also filled and walls were reinforced to protect the building. They have also developed a robust emergency management and continuity planning process.

The medical center is also aiming to mitigate the project's impact on climate change by seeking Leadership in Energy and Environmental Design (LEED) and WELL certification and reducing its carbon emissions and water consumption.

The primary hazard this project addressed was flooding, specifically storm surge and smaller stormwater flood events. The elements of the project that address backup power generation can be considered all hazards, since this backup capacity can provide electrical power regardless of what hazard may cause a power outage.

Award-Winning Upgrades Safeguard Critical Systems

Recognizing system vulnerabilities and leveraging various types of mitigation measures to keep critical infrastructure and specialized equipment operational during a flood earned the Langone Medical Center the Practice Greenhealth Climate and Health Innovation Award.



NYU Langone Medical Center Generators
Source: FEMA

Community Lifelines

 *Hover over the Primary Lifeline to learn more.*



Safety & Security



Food, Water, Sheltering



Energy (Power & Fuel)

Addressed Hazards



PRIMARY HAZARD
Coastal Flooding



Hurricanes

Details

Project Owner

New York University

Type of Project

Flood Protection

Area of Impact

Has potential to impact a significant percentage of the population of the borough of Brooklyn (Total Pop: 2.6 million in 2017)

Cost

Total Project Cost

\$1.13 billion

Funding Sources

Federal Funding

FEMA

- Public Assistance (\$150 million)
- Section 428 Capped Grant (\$411 million for repair/restoration; \$589 million for hazard mitigation)

Other Federal Agencies

National Flood Insurance Program

HHS Social Services Block Grant Program

Non-Federal Funding

Ronald O. Perelman

Benefits

Primary

- Avoidance of physical damage to the hospital building and contents such as large medical equipment
- Life-safety benefits, including a reduction in potential injuries/deaths for hospital patients
- Reduction/elimination of the need to relocate patients during disaster events

Secondary

- Social benefits of providing a place from which to mobilize resources during a disaster
- Reduction in stress on staff and patients, potentially resulting in faster patient recoveries and a reduction in disaster-related or exacerbated medical conditions

Partnerships

Partnership helped align funding from FEMA (Public Assistance and Section 428 grant), HHS Social Services Block Grant Program, and Ronald O. Perelman.

Project Timeline

Status

In progress

Project Completion Date

On target to be completed by August 2021

? Challenges Faced

The need to equip Langone to manage its typical patient load, as well as an influx as a result of a natural disaster

Resources & References

FEMA. 2017. "NYU Langone Medical Center." Last modified February 11, 2021. <https://www.fema.gov/node/483697>.

Healthcare Without Harm. 2018. "Safe haven in the storm: Protecting lives and margins with climate-smart health care." January 2018. https://noharm-uscanada.org/sites/default/files/documents-files/5146/Safe_haven.pdf.

Healthcare Without Harm. 2019. "NYU Langone Health protecting patients by investing in resilience." Last modified June 18, 2019. <https://noharm-uscanada.org/articles/news/us-canada/nyu-langone-health-protecting-patients-investing-resilience>.

Oyster Lake Outfall Improvement



Walton
County, FL
FEMA Region 4

Oyster Lake is a coastal dune lake, which creates a unique interchange between a natural storm water lake and the Gulf of Mexico. When a coastal dune lake reaches a high water level, flow breaks through the dune system forming a channel between the lake and the Gulf. Oyster Lake's outfall is critical for regulating water levels and mitigating flooding. This outfall became severely degraded over time and the overall health was strained from major storms and urban growth.

Walton County and other state agencies wanted to reinforce the outfall while preserving the natural vegetation. The channel measures 12 feet deep with sides sloped at a gradient of 3 Horizontal: 1 Vertical (3H:1V). Soil in the channel is composed of fine sand. The length of the channel is 500 feet.

More than 2,000 square yards of an Engineered Earth Armoring System (EEAS) consisting of High Performance Turf Reinforcement Mat (HPTRM) and Engineered Earth Anchors (EEA) was installed along the channel. This system was selected because it provides slope stabilization and erosion control while promoting vegetation growth. During installation, 2,000 sea oats were planted within the HPTRM.

Addressed Hazards



Protecting the Existing Ecosystem

The EEAS was selected because it provides resilient and environmentally friendly slope stabilization and erosion control while promoting vegetation growth. An important concern for the project was the impact the reinforcement solution would have on the ecosystem, which is home to several endangered species.

Hurricane Proof

After installation, Hurricane Michael (Category 4) made landfall 60 miles east of Oyster Lake, causing winds up to 80 mph, storm surge, and significant rainfall and flooding at the project location. The vegetated slopes of the outfall withstood the extreme conditions, protecting several homes, Highway 30A, and a bridge.



Erosion and sedimentation caused by previous storms and urban growth were straining Oyster Lake's outfall

Source: Propex GeoSolutions, <https://propexgeosolutions.pixieset.com/oysterlakestabilization/>

Community Lifelines



Hover over the Primary Lifeline to learn more.



Safety & Security



Food, Water, Sheltering

Oyster Lake Outfall Improvement

Details

Project Owner

Walton County

Type of Project

 Nature-Based Solution: Vegetated Shoreline Support System

Area of Impact

52 acres protected along Highway 30A in Santa Rosa Beach

Cost

Total Project Cost

\$809,830 (overall), \$90,000 (EEAS project)

Funding Sources

Federal Funding

FEMA Public Assistance: \$241,750

Non-Federal Funding

North West Florida Water Management District, Florida Division of Emergency Management, Walton County Commission: \$568,080

Benefits

Primary

- Significantly decreases the potential for physical damage to outfall and channel due to scour and blockages
- Reduces maintenance and repair costs following flood events

Secondary

- Environmental benefits include use of vegetated solution to preserve the natural beauty of Oyster Lake through green infrastructure supported by EEAS usage
- Increased design useful lifetime with higher factor of safety of EEAS versus bare soil channel
- During construction, lessened site impacts from fewer number of trucks and machines required to install EEAS versus traditional rock riprap solution

Partnerships

- Northwest Florida Water Management District
- Walton County
- U.S. Army Corps of Engineers
- U.S. Fish and Wildlife Services
- Department of Environmental Protection
- Propex GeoSolutions
- Dewberry Engineering
- RBM Contracting

Project Timeline

Start Date

November 2017

Project Completion Date

December 2017

? Challenges Faced

- Identifying an environmentally sensitive solution to preserve the rare ecosystem of a coastal dune lake, which is only found in a handful of locations worldwide

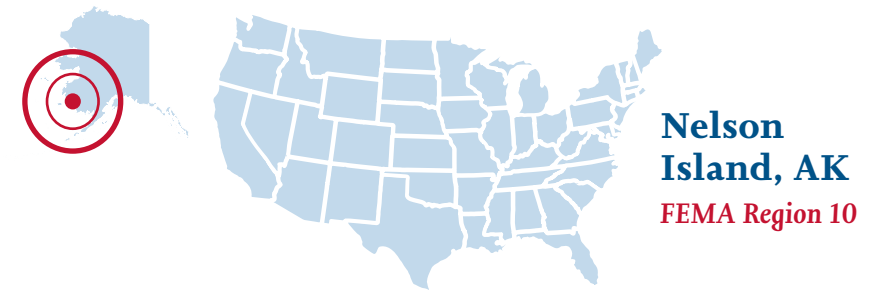
Resources & References

Loizeaux, D. 2021. Stabilizing Oyster Lake's outfall. Geosynthetics. February 1, 2021. <https://geosyntheticsmagazine.com/2021/02/01/stabilizing-oyster-lakes-outfall/>.



Multiple beach front homes are located at the mouth of the outfall
Source: Propex GeoSolutions, <https://propexgeosolutions.pixieset.com/oysterlakestabilization/>

Relocation of Newtok Village



Progressive shoreline erosion along the Ninglick River, combined with permafrost degradation and seasonal storm flooding, began to seriously threaten the very land on Nelson Island that the Village of Newtok, AK (with a population of 354 persons as of the 2010 Census) sits on. Erosion studies done for the Village found no permanent/cost-effective solution that would allow the village to remain in its current location. Therefore, in 2006, the Village formed a planning group to initiate the process of relocating the Village to higher ground. The new site, called Mertarvik, is nine miles upriver from Newtok. The Village already owned the land, which was acquired in a land swap with the U.S. Fish and Wildlife Service in 2003.

Construction on basic infrastructure at Mertarvik was completed in 2014. In lieu of building brand new housing, the Village decided to retrofit old military barracks from Joint Base Elmendorf-Richardson in Anchorage to serve as housing. In October of 2019, the first residents from Newtok moved into their new homes in the Village of Mertarvik. A total of 130 people have relocated thus far.

Community-Scale Relocation Reduces Vulnerability

This holistic approach to community relocation will ensure that people, property, and tribal resources are protected from natural hazard risk. This project provides a unique approach to acquisitions that embraces managed retreat rather than the traditional model of single-parcel buyouts that often results in checker-boarding.



Shoreline changes over 12-year period
Source: AECOM

Community Lifelines

 [Hover over the Primary Lifeline to learn more.](#)

Addressed Hazards



Safety & Security



Health & Medical



Energy
(Power & Fuel)



Communications



Transportation

Relocation of Newtok Village

Details

Project Owner

Village of Newtok, AK

Type of Project

Managed Retreat/Relocation

Area of Impact

Impacts all of Newtok Village (Total Pop: 354 in 2010)

Cost

Total Project Cost

\$150 million +

Funding Sources

Non-Federal Funding

State of Alaska: \$10.8 million

Federal Funding

- Bureau of Indian Affairs: \$5.1 million
- Denali Commission: \$4.7 million
- FEMA: \$3 million
- U.S. Department of Housing and Urban Development (HUD): \$2.3 million
- The total additional funds needed to develop Mertarvik is approximately \$130 million.

Benefits

Primary

- Reduces or eliminates potential physical damage to all structures and infrastructure in the village from future storms/flooding and offers associated life-safety benefits
- Affords greater effectiveness than alternatives that only repair/strengthen existing buildings or infrastructure in place, as erosion conditions/hazard risks continue to worsen

Secondary

- Maintains the social fabric of the village (social and cultural benefits), rather than allowing a slow decline, or even eventual total abandonment, of the community

Partnerships

- State of Alaska
- Bureau of Indian Affairs
- Denali Commission
- HUD
- FEMA

Project Timeline

Start Date

2006

Status

Ongoing

? Challenges Faced

- Estimated \$130 million in additional funding needed as of December 2017
- Multiple stakeholders from local, state, and federal government

Resources & References

Alaska Department of Commerce, Community, and Economic Development Division of Community and Regional Affairs. 2020. "Newtok Planning Group." Accessed March 16, 2020. <https://www.commerce.alaska.gov/web/dcra/PlanningLandManagement/NewtokPlanningGroup.aspx>.

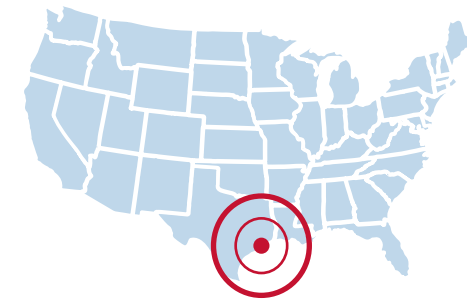
Kim, Greg. 2019. "Newtok moves first families into new homes in Mertarvik." *Alaska Public Media*. October 16, 2019. <https://www.alaskapublic.org/2019/10/16/newtok-moves-first-families-into-new-homes-in-mertarvik/>.

Newtok Village Council. 2017. "Newtok to Mertarvik Relocation." December 2017. <https://www.congress.gov/116/meeting/house/108887/witnesses/HHRG-116-II24-Wstate-JordanJ-20190212-SD001.pdf>.

Waldholz, Rachel. 2017. "Newtok says state agency blocked access to disaster funding." *Alaska Public Media*. October 20, 2017. <https://www.alaskapublic.org/2017/10/20/newtok-says-state-agency-blocked-access-to-disaster-funding/>.

Waldholz, Rachel. 2018. "Newtok to Congress: thank you for saving our village." *Alaska Public Media*. March 27, 2018. <https://www.alaskapublic.org/2018/03/27/newtok-to-congress-thank-you-for-saving-our-village/>.

Virginia Point Wetland Protection Project



Galveston
County, TX
FEMA Region 6

The 3,000-acre Scenic Galveston Coastal Preserve is one of the largest privately owned contiguous nature preserves on the upper Texas coast. Since the 1960's the northern shore of the bay, including at Virginia Point, has experienced shoreline erosion between 7 to 10 feet per year. This continued erosion has also impacted the fragile estuarine habitat along the shoreline, which is home to many different species of birds, as well as a rich benthic community of shrimp, different species of fish, and blue crabs.

This project restored roughly 10,000 feet of the Virginia Point shoreline and 25 acres of marsh in Galveston Bay. The project installed rock breakwaters to protect the shoreline and encourage sediment accretion and restored 25 acres of marsh through the planting of native seedlings and other plant material. This project helps to provide additional protection for Galveston County, and serves as a second line of defense for the existing hurricane levee that wraps around the city. The restored wetland also helps serve as a "buffer zone" for the Galveston Causeway, and helps protect the Bayport Industrial Wastewater Treatment Facility located nearby. The 3-year monitoring report, completed in October 2019, showed that the project has successfully mitigated shoreline erosion, and the accumulation of sediment is occurring as intended. In 2019, the Virginia Point Wetland Protection Project received the "Best Restored Shore" award from the American Shore & Beach Preservation Association.

A study by two University of California, San Diego economists, released in March of 2020, has found that natural buffers like wetlands should be valued at an average of \$1.8 million per square-kilometer, based on the protections they provide for people and property against hurricane/storm damage.

Addressed Hazards



Award-Winning Nature-Based Mitigation Measure Shows Results

Despite the devastating impacts of Hurricane Harvey, this large-scale project remained intact and earned it an award from the American Shore and Beach Preservation Association in 2019. By incorporating nature-based solutions, the project was able to provide additional environmental benefits and recreational amenities.



West Galveston Bay Shoreline
Source: AECOM

Community Lifelines

 Hover over the Primary Lifeline to learn more.



Transportation



Energy
(Power & Fuel)


Virginia Point Wetland Protection Project

Details

Project Owner

Texas General Land Office

Type of Project

 Nature-Based Solution: Marsh/Wetland Restoration

Area of Impact

Has the potential to serve much of the Galveston County population (Total Pop: 342,139 in 2019)

Cost

Total Project Cost

\$4.6 million

Funding Sources

Federal Funding

- National Fish and Wildlife Foundation (NFWF): \$2,000,000
- Texas General Land Office's Coastal Erosion Planning and Response Act: \$675,000

Non-Federal Funding

Scenic Galveston, Inc., Texas Parks & Wildlife Department, Texas Commission on Environmental Quality: \$1.8 million

Benefits

Primary

- The state benefit cost analysis that found the project benefit-cost ratio to be 12.5 included economic and financial benefits associated with commercial and recreational fishing, tourism, and ecotourism (wildlife viewing)
- Also included economic benefits based on improved water quality, carbon sequestration, beach recreation, and storm protection

Secondary

- Analysis accounted for out-of-state spending associated with the project, including spending by visitors from outside the state associated with tourism

Partnerships

- U.S. Fish and Wildlife Service
- Texas Parks & Wildlife Department
- National Oceanic & Atmospheric Administration
- Scenic Galveston, Inc.
- Texas Commission on Environmental Quality

Project Timeline

Start Date

Funding received 2014

Project Completion Date

Construction completed 2016
3-year monitoring completed 2018

? Challenges Faced

- Shoreline restoration projects can sometimes require complex and/or conflicting permit processes

Resources & References

American Shore & Beach Preservation Association. 2020. "Winners of inaugural Best Restored Shore award illustrate innovation in successful coastal restoration." Accessed March 16, 2020. <https://asbpa.org/2019/09/09/winners-of-inaugural-best-restored-shore-award-illustrate-innovation-in-successful-coastal-restoration/>.

National Fish and Wildlife Foundation. 2020. "Virginia Point Shoreline Protection and Estuarine Restoration." Accessed March 16, 2020. <https://www.nfwf.org/sites/default/files/gulf/Documents/tx-virginia-pt-14.pdf>.

Roston, Eric. 2020. "Wetlands Prevent Hurricane Damage. Economists Now Know How Much." **Bloomberg**. March 2, 2020. <https://www.bloomberg.com/news/articles/2020-03-02/wetlands-prevent-hurricane-damage-economists-now-know-how-much>.

Texas General Land Office. 2019. "Coastal Erosion Planning and Response Act: A Report to the 86th Legislature." <https://glo.texas.gov/coast/coastal-management/forms/files/cepra-report-2019.pdf>



Virginia Point Wetland Restoration Project, aerial view
Source: AECOM



 **Drought**

Salinas Aquifer Storage and Recovery

Puerto Rico was experiencing severe drought in 2015 when the Salinas aquifer water level dropped to the lowest level on record. The Town of Salinas' 31,000 residents, industries, farms, schools, hospitals, and the Camp Santiago National Guard training base all exclusively rely on this aquifer for their water supply. Following this, the Town of Salinas was awarded a FEMA Pre-Disaster Mitigation Grant in 2017 to fund its Aquifer Storage and Recovery Program.

The program proposes to divert water from the nearby Patillas Reservoir (that normally goes directly into the sea) and store it in an existing aquifer. In order to accomplish this, they plan to create a canal system to transport the water. The water captured in the aquifer would be used for both agriculture and municipal drinking water. Once the project is in operation, the average recharge volume should provide the aquifer with twice as much water as is currently withdrawn, supporting the rehabilitation of the local economy and community. It will also provide additional water storage in case of drought, but it will make the water supply for the Salinas municipality more resilient to other types of hazards, such as hurricanes and flooding.

Addressed Hazards



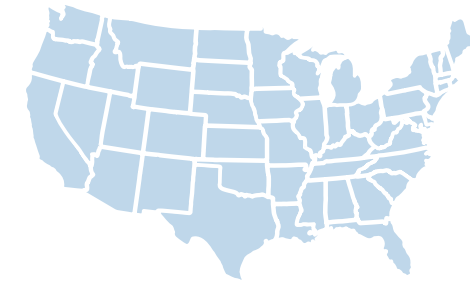
Maximizing Existing Resources to Protect Water Supply

Creating a new cost-effective water recharge system to protect water resources will ensure that critical community lifelines are not adversely impacted in a severe weather event and that cascading impacts to nearby military and agricultural operations and surrounding communities are mitigated.



The Aquifer Storage & Recovery project will divert overflow water from the Patillas Reservoir, about 20 miles east of Salinas. The diverted spillover will be directed via canals to the Salinas area to recharge the aquifer.

Source: <https://toolkit.climate.gov/case-studies/aquifer-storage-and-recovery-strategy-long-term-water-security-puerto-rico>



Salinas,
Puerto Rico
FEMA Region 2



Community Lifelines

 Hover over the Primary Lifeline to learn more.



Safety & Security

Salinas Aquifer Storage and Recovery

Details

Project Owner

Town of Salinas

Type of Project



Nature-Based Solution: Water Supply System Design and Construction

Area of Impact

Project serves all residents of the Salinas municipality (Total Pop: 31,039 in 2017)

Cost

Total Project Cost

\$2.85 million



Funding Sources

Federal Funding

FEMA PDM: \$2.1 million

Non-Federal Funding

Puerto Rican government: \$714,053

Benefits

Primary

- Reduced loss of function of the potable water system from pre-mitigation conditions versus post-mitigation conditions with additional water supply and storage
- Reduced loss of economic value associated with loss of water services to residential customers

Secondary

- Reduced loss of function for businesses and government agencies dependent on the same water sources
- Reduced losses to the tourism sector and other industries highly reliant on water supply

Project Timeline

Status

Received funding in August 2017

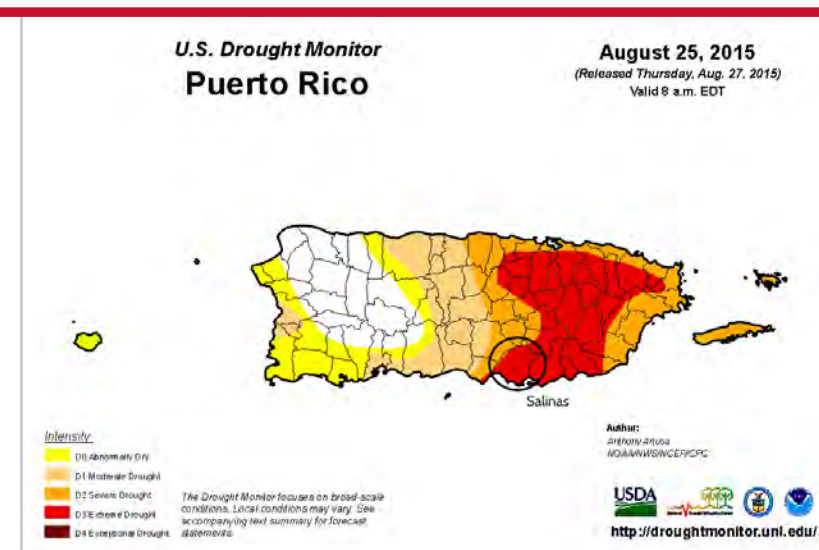
? Challenges Faced

- Careful planning to avoid the possibility of contaminants in the aquifer, such as arsenic and nitrates, and to meet safe drinking water standards

Resources & References

FEMA. 2015. “Aquifer Storage and Recovery Climate Resilient Mitigation Activities.” Accessed March 16, 2020. https://www.epa.gov/sites/production/files/2016-04/documents/fema_aquifer_storage_recovery_fact_sheet-sept_2015.pdf.

United States Global Change Research Program. 2019. “Aquifer Storage and Recovery: A Strategy for Long-Term Water Security in Puerto Rico.” U.S. Climate Resilience Toolkit. Last modified October 28, 2019. <https://toolkit.climate.gov/case-studies/aquifer-storage-and-recovery-strategy-long-term-water-security-puerto-rico>.



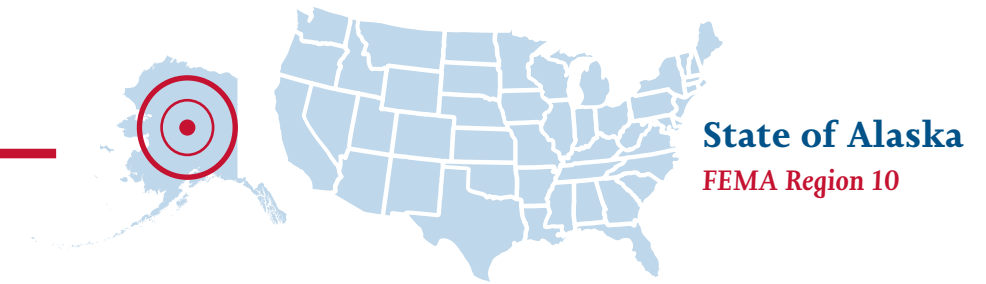
This map from the U.S. Drought Monitor shows that much of eastern Puerto Rico—including Salinas—was experiencing extreme drought in August 2015.

Source: <https://toolkit.climate.gov/case-studies/aquifer-storage-and-recovery-strategy-long-term-water-security-puerto-rico>



Earthquakes

Alaska Building Codes



Alaska averages 40,000 earthquakes a year of various scales, with more large quakes than all other 49 states combined. Following the 1964 earthquake, which was the most powerful on record in the United States, the State of Alaska adopted stricter building codes. These codes outlined specific measures so buildings would be designed to resist possible ground motion determined by location and earthquake histories. Beams, columns, and other structural connections must be reinforced to resist damage from shaking.

When the 7.0-magnitude quake hit in 2018, the Anchorage area experienced extreme shaking and suffered major damage to roadways. However, no large buildings collapsed and only a small handful of structural fires had to be put out. Many homes and businesses suffered damage, but there was no loss of life. Experts credit this minimal damage to the effectiveness of the building codes at withstanding earthquake and aftershock conditions. The costs and benefits of seismic building codes and seismic retrofits have been well-documented. In 2000, FEMA conducted a study that estimated that the U.S. loses an estimated \$4.4 billion every year to repairing and replacing buildings and their contents, as well as in economic losses, to earthquake events. Stronger building codes with seismic requirements, such as the State of Alaska's, could help prevent a significant percentage of those losses.

Proactive Statewide Building Standards Increase Earthquake Resilience

Continual updates to statewide building codes demonstrate Alaska's commitment to resilience. Indeed, these modern disaster-resistant building codes were credited with mitigating damage and cascading impacts when the state was hit by a 7.0-magnitude earthquake in 2018.



Aerial view of Anchorage, Alaska
Source: Shutterstock

Community Lifelines

 Hover over the Primary Lifeline to learn more.



Safety & Security

Addressed Hazards



PRIMARY HAZARD
Earthquakes

Alaska Building Codes

Details

Project Owner

State of Alaska

Type of Project

Building Codes

Area of Impact

Building code applies to the entire state of Alaska (Total Pop: 737,000 in 2017)

Cost

Total Project Cost

The cost of developing new plans, codes, or ordinances include community staff time and any outside consultants to provide technical support and associated analysis. Changes will typically include economic analyses looking at construction components, practices, and short- and long-term maintenance costs.

Benefits

Primary

- Reduces associated reduced injuries and deaths from earthquake events with little to no advanced notice
- Reduces physical damage to structures and their contents
- Addresses a wide range of construction practices that encourage the use of non-structural practices that can reduce or minimize damage, depending on earthquake severity

Secondary

- Addresses ways that different infrastructure systems can be designed with features (i.e., break-away connections) that can lessen damage and associated costs (and possible injuries)
- Reduces social impact/trauma from earthquakes and the need to temporarily or permanently relocate due to building damage

Project Timeline

Status

Implemented after 1964 earthquake

? Challenges Faced

- Development community pushback on more restrictive statewide building codes and potential increased cost of compliance

Resources & References

D'Oro, Rachel and Mark Thiessen. 2018. "Strict building codes helped Anchorage withstand quake." *Associated Press News*. December 1, 2018. <https://apnews.com/018a78f7cfb646b8a6653766a953cacd>.

Lukasik, Tara. 2018. "Alaska hails building codes after quake." *Building Safety Journal*. December 12, 2018. <https://www.iccsafe.org/buildingsafety-journal/bsj-dives/alaska-hails-building-codes-after-quake/>.

Berkeley Seismic Vulnerability Retrofits



Berkeley, CA
FEMA Region 9

In 2018, the City of Berkeley received a \$1.2 million Hazard Mitigation Grant Program (HMGP) grant from FEMA to create a grant program for building owners to retrofit seismically vulnerable buildings to better withstand earthquake impacts. The program provides grants, paid out as reimbursements, for upgrades for certain types of commercial and multi-family residential buildings (including buildings with nonductile concrete, tilt-up, soft story, and unreinforced masonry).

The program is designed to encourage property owners to be proactive, rather than reactive, in implementing seismic retrofits by offering direct compensation for a large percentage of total costs incurred to the building owner. Grants from the program pay for up to 75 percent of design and 40 percent of construction costs, depending on the project. If implemented properly, this program could not only prevent serious property damage from earthquakes, but also prevent injuries and even loss of life due to structures not being properly secured against earthquake impacts. To date, the program has contributed to seismic retrofits of 48 buildings containing over 400 apartment units.

Incentivizing Retrofits to Reduce Vulnerability

By leveraging federal funds, this program incentivizes proactive mitigation measures for commercial and multi-family building owners who want to make their buildings safer and more resilient to earthquakes.



Berkeley, CA
Source: Shutterstock

Community Lifelines

 Hover over the Primary Lifeline to learn more.



Safety & Security

Addressed Hazards



PRIMARY HAZARD
Earthquakes

Berkeley Seismic Vulnerability Retrofits

Details

Project Owner

City of Berkeley, CA

Type of Project

Building Retrofits

Area of Impact

Program eligibility encompasses the City of Berkeley (Total Pop: 122,324 in 2017)

Cost

Total Project Cost

\$1.2 Million

Funding Sources

Federal Funding

FEMA HMGP

Non-Federal Funding

California Governor's Office of Emergency Services

Benefits

Primary

- Reduced damage to structural and non-structural components and contents of buildings, and associated reduction in injuries and deaths
- Varying levels of reduction in damage, depending on the severity of the earthquake

Secondary

- Buildings that provide better shelter during earthquakes
- Potential reduction in damage to infrastructure attached to structures
- Potential reduction in emergency services costs for responding to incidents involving larger structures

Partnerships

- FEMA
- City of Berkeley
- CA Governor's Office of Emergency Services

Project Timeline

Start Date

Grant program began in 2018

Property owners had to apply for grants by June 25, 2018

? Challenges Faced

- Providing adequate public outreach to ensure that property owners are aware that these resources are available to them
- Continuing the program after grant funding runs out

Resources & References

Black, Margaret. 2018. "New grant gives Berkeley \$1.2 million to retrofit seismically vulnerable buildings." *The Daily Californian*. June 22, 2018. <https://prod.dailycal.org/2018/06/21/new-grant-gives-berkeley-1-2-million-retrofit-seismically-vulnerable-buildings>.

City of Berkeley Building and Safety Division. 2020. "Retrofit Grants." Accessed March 16, 2020. <https://berkeleyca.gov/construction-development/seismic-safety/funding-seismic-retrofits/retrofit-grants>.

City of Berkeley. 2020. "Retrofit Grants for Seismically Vulnerable Buildings." Accessed March 16, 2020. <https://berkeleyca.gov/construction-development/seismic-safety/funding-seismic-retrofits#:~:text=You%20can%20get%20a%20grant,be%20selected%20to%20receive%20funding>.

Earthquake Safety Retrofits at Good Samaritan Hospital

The Good Samaritan Hospital is a first-tier hospital in the National Disaster Medical System, meaning the staff are trained to receive and treat victims of mass casualty events, such as an earthquake. However, the hospital itself, particularly the essential medical equipment and critical support systems that are needed to treat survivors, is susceptible to damage caused by earthquakes or earthquake related vibrations and need protection as well.

The Good Samaritan Hospital was awarded funding through FEMA's Hazard Mitigation Grant Program (HMGP) to complete non-structural bracing and anchoring of medical equipment, communications hardware, and supporting infrastructure essential to ensure continued post-earthquake operations. Installation of bolts, straps, anchors, hangers and similar reinforcements has enabled Good Samaritan to continue the provision of critical services to surrounding communities in their greatest times of need.

Addressed Hazards



PRIMARY HAZARD
Earthquakes

Building Resilience in the National Disaster Medical System

The proposed retrofits will protect sensitive medical equipment, improve the hospital's resilience to earthquakes and lead to more reliable patient care during and following seismic activity.



Good Samaritan Hospital, Los Angeles, CA

Source: Shutterstock



Los Angeles, CA
FEMA Region 9

Community Lifelines



Hover over the Primary Lifeline to learn more.



Safety & Security



Food, Water, Sheltering

Earthquake Safety Retrofits at Good Samaritan Hospital

Details

Project Owner

Good Samaritan Hospital

Type of Project

Hospital Retrofits

Area of Impact

Hospital facility

Cost

Total Project Cost

\$2.3 Million

Funding Sources

Federal Funding

FEMA HMGP: \$1.7 Million

Non-Federal Funding

Non-federal sources: \$600,000

Benefits

Primary

- Reduces damage to non-structural components and high-value contents, such as medical equipment and communications hardware
- Provides additional life-safety benefits, including reduced injuries or deaths, due to disabled or unusable medical equipment

Secondary

- Reduces impact injuries during earthquake event as a result of bracing and anchoring of non-structural components and other contents
- Reduces emergency services costs from need to use other emergency facilities

Partnerships

- California Governor's Office of Emergency Services (Cal OES)
- The City of Los Angeles

Project Timeline

Start Date

Project funds awarded January 2020

Resources & References

FEMA. 2020. "FEMA Funds Earthquake Safety for Los Angeles Hospital." <https://www.fema.gov/press-release/20210318/fema-funds-earthquake-safety-los-angeles-hospital#:~:text=The%20%242.3%20million%20project%20will,sources%20covering%20the%20remaining%20%24600%2C000.>



Hurricanes

Strengthening Florida's Building Codes



The State of Florida's coasts are extremely vulnerable to impacts from hurricanes and strong storms and will only become more vulnerable as sea levels continue to rise. In 2002, the state adopted a statewide building code that enacted strict standards for buildings to withstand hurricane impacts. According to an analysis done by the Wharton School at the University of Pennsylvania, homes built in the state since the building code's adoption drove total losses to hurricanes down by 72 percent relative to the homes built in the decade prior to implementing the new code.

Requirements vary throughout the state, depending on where peak winds tend to be strongest. For instance, Miami-Dade and Broward Counties, which have experienced substantial damage from past hurricanes, are part of a "High-Velocity Hurricane Zone," meaning that their local codes require that the entire building envelope be wind-resistant. According to the Insurance Institute for Business & Home Safety, Florida has the strongest residential building code out of 18 other coastal states, including Virginia, South Carolina, and New Jersey.

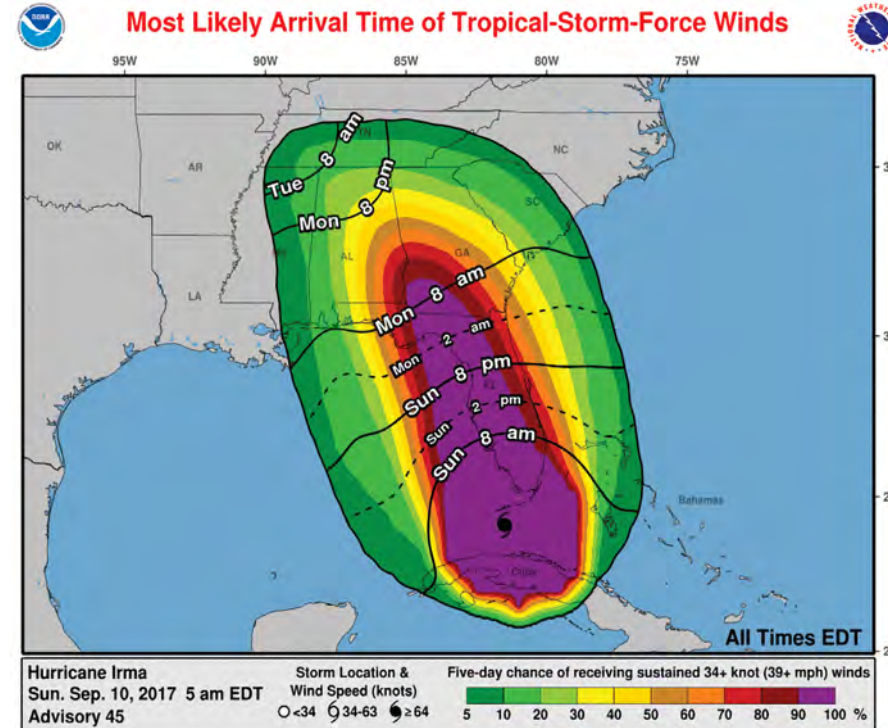
Addressed Hazards



PRIMARY HAZARD
Hurricanes

Statewide Adoption of Building Codes Enables Stronger Local Codes

By having a base statewide building code, communities can then develop building standards that are tailored to mitigate their location-specific risk. For example, Miami-Dade and Broward Counties have instituted hazard-specific codes to reduce hurricane damage.



Florida regularly sustains storm force winds, as projected here during Hurricane Irma in September of 2017.

Source: NOAA NHC

Community Lifelines



Hover over the Primary Lifeline to learn more.



Safety & Security

Strengthening Florida's Building Codes

Details

Project Owner

State of Florida

Type of Project

Building Codes

Area of Impact

Entire State of Florida population (Total Pop: 21.3 million in 2018)

Cost

Total Project Cost

The cost of developing new plans, codes, or ordinances include community staff time and any outside consultants to provide technical support and associated analysis. Changes will typically include economic analyses of construction components, practices, and short- and long-term maintenance costs.

Benefits

Primary

- Reduced physical damage to structures and their contents from both wind and flood, and the associated life-safety benefits of reduced injuries and deaths
- Reduced damage to utility infrastructure

Secondary

- Reduced loss of function and downtime associated with business and government services following a hurricane event
- Reduced short- and long-term shelter needs and the social aspects of reduced need to relocate temporarily or permanently

Partnerships

- State of Florida
- Florida Building Commission

Project Timeline

Start Date

Adopted 2002

? Challenges Faced

- Additional development costs of applying stronger standards, especially an issue for affordable housing

Resources & References

Henson, Bob. 2018. "South Florida's Hurricane Building Code is Strong—And North Florida's Could Be Stronger." *Weather Underground*, October 16, 2018. <https://www.wunderground.com/cat6/South-Floridas-Hurricane-Building-Code-Strong-And-North-Floridas-Could-Be-Stronger>.

Martin, Susan Taylor. 2018. "Florida leads other hurricane-prone states in quality of its building codes." *Tampa Bay Times*, April 25, 2018. https://www.tampabay.com/news/business/realestate/Florida-leads-other-hurricane-prone-states-in-quality-of-its-building-codes-_167654069/.

Simmons, Kevin M., Jeffrey Czjowski, and James Done. 2017. "Economic Effectiveness of Implementing a Statewide Building Code: The Case of Florida." (May 2017): 1-64. <http://dx.doi.org/10.2139/ssrn.2963244>.



Two properties side-by-side that show how stronger building codes can protect properties

Source: Shutterstock

Lightning Point Restoration Project



Mobile
County, AL
FEMA Region 4

The seafood capital of Alabama, and a town steeped in southern history with a dash of French and even Southeast Asian influence, Bayou La Batre is an American landmark under threat from intensified storm activity. The Lightning Point restoration project was designed to protect and revitalize the locally important waterfront area by restoring and enhancing the shoreline habitats and providing improved community access for recreation and fishing opportunities.

The Lightning Point project is intended to achieve multiple restoration goals for the Bayou La Batre coastline and its community.

- **Shoreline Protection:** Constructed 1.5 miles of overlapping, segmented breakwaters along the shoreline to provide a buffer from storms, waves, and boat wakes. Constructed two jetties (700-800 foot long) at mouth of channel to maintain access to the navigation channel.
- **Habitat Creation:** Added approximately 40 acres of marsh, tidal creeks, and upland habitats that support wildlife and also serve as a first line of defense against storms.
- **Managed Access:** Designed a low-impact parking lot employing green infrastructure techniques, such as pervious pavers, bioretention cells, and bioswales, to aid in stormwater management and to improve water quality in the area.
- **Beneficial Use Of Dredged Material:** Utilized more than 240,000 cubic yards of dredge material beneficially to create marsh habitat and use thin-layer deposition to build and nourish the marsh for decades to come.

Addressed Hazards



Lightning Point Restoration Project Success

The newly constructed restoration project survived its first coastal storm season in 2020. After construction was complete in July 2020, the project experienced four storms (Cristobal, Sally, Delta, and Zeta) and extreme water levels (4.1 feet, 3.3 feet, 4.4 feet, and 7.8 feet, respectively). No significant impacts occurred.

Wetlands Restoration

The west side of the channel included a former U.S. Army Corps of Engineers dredge spoil disposal area no longer in use, but still under an easement by the Corps. This easement was released before restoration construction began so the highly disturbed wetlands could be restored and reconnected to adjacent tidal marshes.



Aerial overview looking west across the Lightning Point Restoration site on June 1, 2020

Source: Moffatt & Nichol

Community Lifelines

 [Hover over the Primary Lifeline to learn more.](#)



Safety & Security



Newly installed black needlerush plugs on edge of the eastern lagoon on Lightning Point Restoration site

Source: Mary Kate Brown, The Nature Conservancy

Lightning Point Restoration Project

Details

Project Owner

The Nature Conservancy

Type of Project

 Nature-Based Solution: Green Coastal Infrastructure, Habitat Creation

Area of Impact

Bayou La Batre, AL
(2,500 citizens, 10,000 boats/year)

Cost

Total Project Cost

\$21.25 million

Funding Sources

Federal Funding

Gulf of Mexico Energy Security Act (GOMESA): \$150,000

Non-Federal Funding

National Fish and Wildlife Foundation (NFWF); Gulf Environmental Benefit Fund (GEBF); Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act (RESTORE Act); Alabama Power; Partners for Environmental Progress (PEP): \$21,100,000

Benefits

Primary

- Reduced flood event damages to shorelines, within new marsh areas, and in parking areas using green infrastructure
- Improved water quality from marshes and parking lot green infrastructure
- Decreased costs and habitat creation associated with reuse of dredge materials that would otherwise require traditional disposal
- Reduced displacement and business disruption after flood events

Secondary

- Habitat creation to accommodate sea level rise and adjust to marsh migration rate at a slower pace
- Improved managed access for the community to embrace the environment and enhance their livelihoods
- Expanded marsh habitats for fish and wildlife important to commercial and recreational fisheries and ecotourism

Partnerships

- Alabama Department of Conservation and Natural Resources: State Lands, Marine Resources, Wildlife and Freshwater Fisheries
- Forever Wild Land Trust
- City of Bayou La Batre
- Mobile County
- Alabama Power
- NFWF
- Moffatt & Nichol
- Dauphin Island Sea Lab
- Alma Bryant High School
- Partners for Environmental Progress
- Restore America's Estuaries
- Citgo
- GOMESA
- Coastal Conservation Association

Project Timeline

Start Date

Acquisition: May 2016, Construction: September 2019

Project Completion Date

July 2020

? Challenges Faced

- Completing the project within a set budget while having contingency funds to cover uncertainties and potential damage from storms
- Coordinating with multiple landowners from public to private and establishing landowner and access agreements with different timelines
- Ensuring the project complied with all public interest requirements throughout permitting process, including cultural protection

Resources & References

Moffatt & Nichol. 2019. Final Design Report - Lightning Point. Produced for the Nature Conservancy. June 2019. <https://tnc.app.box.com/s/7el6oqnoyow95wiglhqz497ebqw7kw>.

The Nature Conservancy. n.d. Alabama's Lightning Point. Brochure. <https://www.nature.org/content/dam/tnc/nature/en/documents/lightningpoint.pdf>.

NY Rising Community Reconstruction: Path to Park Project

In June 2013, the Governor’s Office of Storm Recovery (GOSR) was established to administer New York State’s recovery and resiliency programs for Superstorm Sandy, Hurricane Irene, and Tropical Storm Lee. Supported by \$4.5 billion in Community Development Block Grant–Disaster Recovery (CDBG-DR) funding from the U.S. Department of Housing and Urban Development (HUD), GOSR— from its earliest days—sought to address immediate rebuilding needs, while also making strategic investments into the long-term sustainability of the State.

As one of the hallmark programs of the GOSR portfolio, the NY Rising Community Reconstruction (NYRCR) Program was rooted in a participatory planning process that engaged 650 New Yorkers on 66 NYRCR Planning Committees across New York City, Long Island, the Hudson Valley, Mohawk Valley, Capital Region, and Southern Tier. These committees developed proposals to enhance recovery and resiliency. Eligible projects prioritized for implementation are now being brought to fruition in partnership with a variety of local subrecipients, including municipal and county governments.

Completed in 2019, the \$3.8 million Path to the Park Project is an example of the NYRCR Program in action—having transformed a beloved stretch of public greenway along the northwestern shoreline of South Valley Stream in Nassau County. Innovative in its ability to effectively marry several goals—improved coastal resiliency, recreational opportunities, and public access—the project blended green and gray infrastructure to create a space that was both resilient and functional. As part of the effort, bioswales and overflow structures were installed to provide stormwater retention, and a new living shoreline was created. The project facilitated the removal of a bridge abutment and the construction of a berm for additional surge protection. A pedestrian pathway was also beautified with educational signage, scenic overlook areas, wild flower plantings, and a pollinator garden.

Not only does the park now serve as a natural coastal buffer to surrounding neighborhoods, but it has also become a destination for visitors and local residents alike.

Building Resilience through Holistic Mitigation Integration

NYRCR Plans can serve as valuable roadmaps for helping communities to mitigate future risks and address vulnerabilities exposed by one of the three covered storms. In Hempstead, green and gray infrastructure were blended to create a space that was both resilient to extreme weather events and functional, providing community and environmental benefits.



Natural coastal buffer designed to reduce erosion and sedimentation and improve wildlife habitat

Source: NYRCR

Addressed Hazards



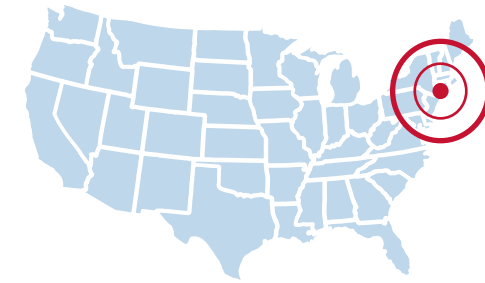
PRIMARY HAZARD
Hurricanes



Inland
Flooding



Coastal
Flooding



Hempstead,
NY

FEMA Region 2

Community Lifelines



Hover over the Primary Lifeline to learn more.



Food, Water, Sheltering



Health & Medical



Transportation

NY Rising Community Reconstruction: Path to Park Project

Details

Project Owner

State of New York

Type of Project

Recovery and Resiliency Initiative



Nature Based Solution: Green Infrastructure and Living Shoreline

Area of Impact

South Valley Stream, Town of Hempstead (Total Pop: 768,103 in 2018)

\$ Cost

Total Project Cost

\$3.8 Million

Funding Sources

Federal Funding

CDBG-DR funds from HUD

Benefits

Primary

- Provision of flood, hurricane, and stormwater control
- Reduction of erosion and sedimentation
- Improvement of wildlife habitat

Secondary

- Creation of a natural coastal buffer for surrounding neighborhoods
- Enhanced community access to the space

Partnerships

- Town of Hempstead

Project Timeline

Start Date

Community Reconstruction Planning Committee formed Fall 2013

Project Completion Date

Project Completion announced by Governor Andrew M. Cuomo in September 2019

? Challenges Faced

- Competing funding sources caused conflicting requirements in reporting and other concerns that took a long time to overcome

Resources & References

Governor Andrew Cuomo. 2013. "Governor Cuomo Designates 102 New York Rising Communities Eligible to Receive More Than \$750 Million for Storm Reconstruction." July 18, 2013.

Governor Andrew Cuomo. 2019. "Governor Cuomo Marks Completion of \$3.8 Million Path to the Park Project in South Valley Stream." September 12, 2019.

New York State Governor's Office of Storm Recovery. 2020. "NY Rising Community Reconstruction Program FAQs." Accessed March 16, 2020. https://stormrecovery.ny.gov/sites/default/files/crp/community/documents/Final%20FAQs_12211.pdf.

New York State Governor's Office of Storm Recovery. 2020. "The Program." Accessed March 16, 2020. <https://stormrecovery.ny.gov/community-reconstruction-program>.

U.S. Department of Housing and Urban Development. 2020. "National Disaster Resilience." HUD Exchange. Accessed March 16, 2020. <https://www.hudexchange.info/programs/cdbg-dr/resilient-recovery/>.



Natural coastal buffer designed to reduce erosion and sedimentation and improve wildlife habitat

Source: NYRCR

Renovation of Alexander Theater

The Saint Croix Foundation (SCF) is planning to renovate the historic Alexander Theater in Christiansted, St. Croix. The renovation will increase its performing arts space and allow it to serve as an emergency shelter for up to 310 people. The renovations will include a safe room that can withstand hurricane force winds. The theater received FEMA Hazard Mitigation Grant Program (HMGP) funding for the renovations in May 2019. The renovated theater will also include space for a job training center for young people who are pursuing careers in hospitality, theater, and video and music production.

There are two phases planned for the project, Phase I: Technical Feasibility Study and Phase II: Theater Restoration. Phase I will include designs and wind and seismic mitigation analyses. Phase II will include the actual renovations to meet FEMA standards, Americans with Disabilities Act (ADA) compliance, and security standards. The final building will have an emergency generator, HVAC unit, and other equipment necessary to fully operate in an emergency.

Addressed Hazards

 **PRIMARY HAZARD**
Hurricanes

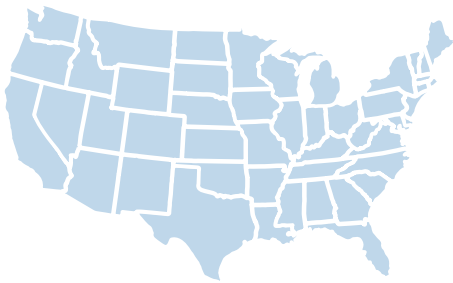
 Earthquakes

Creative Use of Acquired Property Drives Economic Development

On a space-constrained island, students can go without access to formal education for months following a severe storm while their schools are used as shelters. This project capitalizes on an opportunity to build community resilience by revitalizing a historic cultural amenity to foster economic development while creating much-needed shelter space.



Alexander Theater in Christiansted, St. Croix
Source: <http://www.stxfoundation.org/communitydevelopment/the-old-alexander-theatre/>



Christiansted,
St. Croix, U.S.
Virgin Islands
FEMA Region 2



Community Lifelines

 Hover over the Primary Lifeline to learn more.



Safety & Security

Renovation of Alexander Theater

Details

Project Owner

Saint Croix Foundation (SCF)

Type of Project

Emergency Shelter

Area of Impact

Christiansted population (Total Pop: 3,000 in 2017)

Cost

Total Project Cost

\$12.5 million

Funding Sources

Federal Funding

FEMA HMGP: \$12.5 million

Benefits

Primary

- Avoidance of potential physical damage to the theater and its contents
- Life-safety benefits, including a reduction in potential injuries/deaths for those using the theater as a shelter during events
- Reduced emergency response burden for the area

Secondary

- A place to shelter and mobilize resources during disaster events, and decrease the loss of theater downtime, resulting in a reduction of potential lost revenue
- Reduced potential downtime for the job training center being built as part of this project

Partnerships

- FEMA
- Virgin Islands Territorial Emergency Management Agency (VITEMA)
- TALLER LARJAS, LLC

Project Timeline

Start Date

Design begun June 2019

Status

RFP process took place in 2021

? Challenges Faced

- Potential issues associated with rebuilding a historic structure

Resources & References

Clinton Foundation. 2020. "Healing Humanities: Rebuilding with Resiliency in Mind." Clinton Global Initiative. Accessed March 16, 2020.

St. Croix Foundation for Community Development. 2020. "The Alexander Theater: Approved for Renovation & Retrofit!" Accessed March 29, 2022. <http://www.stxfoundation.org/communitydevelopment/the-old-alexander-theatre/>.

Nicklaus Children's Hospital Hurricane Retrofits

In 2000, a resilience assessment of the Nicklaus Children's Hospital showed that it was highly vulnerable to wind speeds associated with a Category 2 Hurricane. The process of retrofitting the hospital to withstand a Category 4 Hurricane began soon after and was completed in 2004. In addition to the funds it had already set aside, the hospital received additional funding for the project through FEMA's Hazard Mitigation Grant Program (HMGP). The hospital is now wrapped in a hurricane-resistant "shell," which encases the entire structure in pre-molded panels of glass fiber-reinforced concrete, which are anchored to the support structure of the original building. The retrofits also included impact-resistant windows and additional roof support. The hospital can now withstand winds of up to 200 miles per hour.

The retrofits have already been successful in the face of Florida's many hurricanes. The hospital did not need to evacuate patients and families during Hurricanes Frances and Jeanne in 2004, and was actually able to host patients evacuated from the Florida Keys. During Hurricane Frances, the hospital sheltered well over 1,000 patients, employees, and family members. During Hurricanes Katrina and Wilma, the hospital again hosted medical evacuees and families who were displaced during and after the storms.

Addressed Hazards



PRIMARY HAZARD
Hurricanes

Hurricane Retrofits Realize Co-Benefits

Innovative building construction techniques were used to fortify the hospital so that it was not only able to remain operational during Hurricanes Frances and Jeanne, but also served as a shelter for patients, families, staff, spouses and families of storm-duty staff, and storm evacuees.



Nicklaus Children's Hospital
Source: Google Earth Pro, used under license



Miami, FL
FEMA Region 4

Community Lifelines

 Hover over the Primary Lifeline to learn more.



Safety & Security



Food, Water, Sheltering

Details

Project Owner

Nicklaus Children's Hospital

Type of Project

Hurricane Retrofits

Area of Impact

Hospital facility (also provided shelter for employees and family members during Hurricanes Frances and Irma)

Cost

Total Project Cost

\$11.3 million

Funding Sources

Federal Funding

FEMA HMGP: \$5 million

Non-Federal Funding

Nicklaus Children's Hospital

Benefits

Primary

- Avoids potential physical damage to the hospital building and contents, such as large medical equipment
- Offers life-safety benefits, including a reduction in potential injuries/deaths for hospital patients
- Reduces/eliminates the need to relocate patients during disaster events
- Enables the hospital to host patients from other hospitals during disaster events, increasing the number of people protected by mitigation actions

Secondary

- Provides social benefits of a place from which to mobilize resources during a disaster
- Reduces stress on staff and patients, potentially resulting in faster patient recoveries, and a reduction in disaster-induced or exacerbated medical conditions

Partnerships

- FEMA
- Miami-Dade County Office of Emergency Management
- Florida Division of Emergency Management

Project Timeline

Start Date

Process begun in 2000

Project Completion Date

Construction completed in 2004

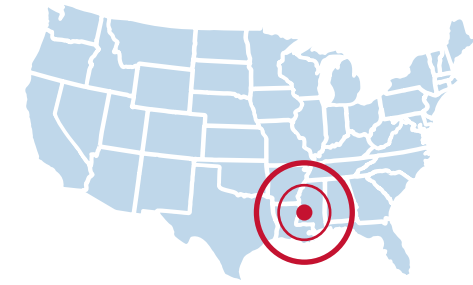
? Challenges Faced

- Undertaking all construction activity without disrupting medical services by working in phases

Resources & References

United States Global Change Research Program. 2020. "Retrofitting a Children's Hospital with a Hurricane-Resistant Shell." U.S. Climate Resilience Toolkit. Last modified February 10, 2020. Accessed March 16, 2020. <https://toolkit.climate.gov/case-studies/retrofitting-childrens-hospital-hurricane-resistant-shell>.

USACE Engineer Research Development Center



Vicksburg, MS
FEMA Region 4

The U.S. Army Corps of Engineers (USACE) discovered that its multi-million dollar Rapid Repair Levee Breach (RRLB) facility was deteriorating due to severe, rain-induced erosion. The RRLB facility, a part of the Engineer Research and Development Center (ERDC), was designed to assist the USACE in determining practical and scientifically accurate engineering methods for evaluating the most challenging applications of flood protection materials.

The USACE decided to use an Engineered Earth Armoring System (EEAS). The Corps was very familiar with this system, as it had extensively installed the EEAS along levees in New Orleans to prevent breaches due to overtopping during hurricane-type conditions. The EEAS consists of High Performance Turn Reinforcement Mat (HPTRM) and Engineered Earth Anchors (EEA) that work together to lock soil in place and protect against hydraulic stresses. It offers resilient flood mitigation for up to 75 years.

More than 5,000 square yards of the EEAS was installed in November 2011. The project only took two days to install, allowing no disturbance to the operation of the ERDC facility. The minimal installation time also cut down on labor costs.

In only two months, thick vegetation had grown throughout the installation site. The testing facility has not had any erosion problems to date, even though heavy mowing equipment is regularly used for upkeep and significant rainfall has occurred.

The Engineered Earth Armoring System was well known by the USACE as it has been tested and approved by the USACE, and has been used to armor more than 100 miles of levees in the New Orleans area.

Prior to the EEAS installation, the USACE experienced severe erosion on the slopes adjacent to their ponds. After installation, the testing facility has not had any erosion problems to date, even though heavy mowing equipment is regularly used for upkeep and significant rainfall has occurred.



Today the site is fully vegetated and maintains its resiliency despite heavy equipment traffic from regular mowing.

Community Lifelines

 Hover over the Primary Lifeline to learn more.



Food, Water, Sheltering



Communications

Addressed Hazards



PRIMARY HAZARD
Hurricanes



Inland Flooding

Details

Project Owner
U.S. Army Corps of Engineers

Type of Project
Infrastructure
 Nature-Based Solution

Area of Impact
USACE's Rapid Repair Levee Breach facility

Cost

Total Project Cost
\$210,000

Benefits

- Primary**
- Permanent erosion mitigation that reinforces vegetation for up to 75 years
 - Withstands hydraulic stresses including high water flows and rapid draw down
 - Promotes infiltration of surface water and pollutant removal
- Secondary**
- Withstands non-hydraulic stresses such as mowing and maintenance equipment
 - Easy and efficient installation reduces project costs

- ## Partnerships
- U.S. Army Corps of Engineers
 - Propex GeoSolutions

Project Timeline

Start Date
November 2011



The USACE Rapid Repair Levee Breach facility was experiencing extreme erosion due to heavy rainfall.

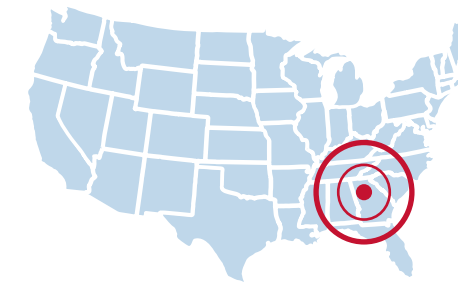


More than 5,000 square yards of an EEAS was installed to provide resilient flood protection.



Inland Flooding

Atlanta Stormwater Ordinance and Green Infrastructure Program



Atlanta, GA
FEMA Region 4

The City of Atlanta's Department of Watershed Management amended its Post-Development Stormwater Management Ordinance to require the use of green infrastructure on new and redevelopment projects in the City. This includes a volume-based runoff reduction requirement, where commercial and single-family residential developments must capture the first one inch of runoff and reduce the volume through on-site infiltration, evapotranspiration, or rainwater harvesting and reuse. Common projects include rain gardens, green roofs, forest conservation, and urban tree preservation. These projects reduce the volume of polluted runoff by approximately 600 million gallons annually. As of February 2022, the City of Atlanta owns and manages 1,900+ acres of protected Greenway and Greenspace properties.

Atlanta has also prioritized and integrated green infrastructure into its work throughout the City. The City is constructing its own projects and working through the City's Green Infrastructure Task Force to support green infrastructure projects by other City departments and partners. One example of a large-scale project is the Capacity Relief Pond at the Historic Fourth Ward Park. This project provides stormwater drainage relief to the area within a 300-acre drainage basin with artistic elements to aerate and recycle pond water instead of drainage pipes. This serves as the park's centerpiece and is surrounded by walking trails, native plantings, and an amphitheater. More projects are available through the City of Atlanta Green Infrastructure Program's interactive site: <https://storymaps.arcgis.com/stories/c41bc3f84d8e4e70bc1672ffcd830f1f>

Integrating Nature-Based Solutions with Development Standards

This program provides a solution for residents by requiring use of nature-based solutions, utilizing quantitative metrics, and incentivizing stormwater management best practices, the City has reduced the volume of polluted runoff by approximately 600 million gallons annually and created mechanisms to mitigate risk from severe rain events.

Community Lifelines

 *Hover over the Primary Lifeline to learn more.*

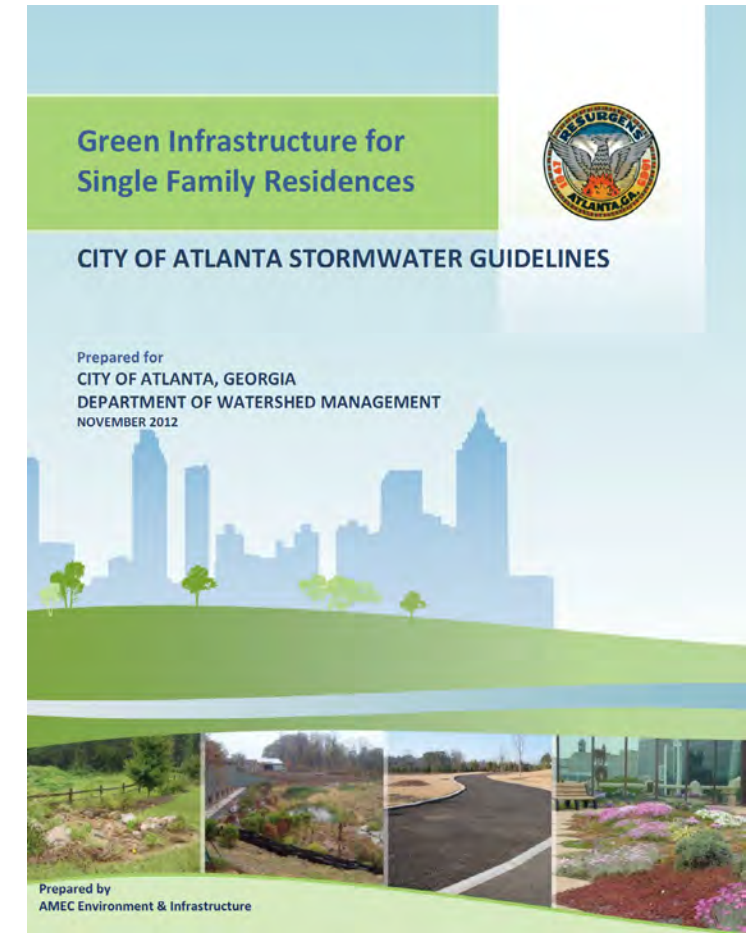


Transportation

Addressed Hazards



PRIMARY HAZARD
Inland Flooding



Atlanta Stormwater Guide
Source: City of Atlanta, Georgia Department of Watershed Management

Atlanta Stormwater Ordinance and Green Infrastructure Program

Details

Project Owner

City of Atlanta Department of Watershed Management

Type of Project

Ordinance

 Nature-Based Solution: Green Infrastructure

Area of Impact

Atlanta population (Total Pop: 486,290 in 2017); 1,900+ acres of protected Greenway and Greenspace properties

Cost

Total Project Cost

The cost of developing new plans, codes, or ordinances includes community staff time and any outside consultants to provide technical support and associated analysis. For this project, the added requirements for green infrastructure may increase initial project costs, but long-term costs will likely be lower because long-term maintenance of large stormwater retention facilities would no longer be needed.

Funding Sources

Non-Federal Funding

City of Atlanta

Benefits

Primary

- Reduced stormwater flows and subsequent physical damage to stormwater and transportation infrastructure
- Decreased damage primarily from more frequent events, and reduced the need to increase storage capacities for existing infrastructure design to handle more infrequent events

Secondary

- Less severe social impact from flood events, such as reduced need for temporary shelters, better water quality protection (and reduced cost for measures to remove pollutants), and more green space, which can help reduce urban heat island impacts on health

Partnerships

City of Atlanta's Environmental and Construction Enforcement Division

Project Timeline

Start Date

Ordinance adopted by Atlanta City Council on February 13, 2013

? Challenges Faced

- Potential for concern about restrictions within the development community

Resources & References

City of Atlanta Department of Watershed Management. 2012. "Green Infrastructure for Single Family Residences: City of Atlanta Stormwater Guidelines." AMEC Environment & Infrastructure. November 2012. https://drive.google.com/file/d/1RsmhfASwRnxsJ_CBjwhSMrFXhRB8YFxi/view.

City of Atlanta Department of Watershed Management. 2018. "Green Infrastructure Strategic Action Plan." 2018. <https://drive.google.com/file/d/1u65BWi5qBFA-iYQmdBLm9wAVE7yHJnyf/view>.

City of Atlanta Department of Watershed Management. 2020. "City of Atlanta Green Infrastructure Program." Accessed March 16, 2020. <https://coadwm.maps.arcgis.com/apps/MapSeries/index.html?appid=db24b57c2d7146c2a3f039d37d539737>.

City of Atlanta Department of Watershed Management. 2020. "Post-Development Stormwater Management Ordinance." Accessed March 16, 2020. <https://www.atlantawatershed.org/stormwaterordinance/>.

City of Atlanta Department of Watershed Management. 2022. City of Atlanta Green Infrastructure Program StoryMap. February 3, 2022. Accessed March 22, 2022. <https://storymaps.arcgis.com/stories/c41bc3f84d8e4e70bc1672ffcd830f1f>.

Bidwell Paiute Tribal Reservation Flood Mitigation Project



Modoc County, CA
FEMA Region 9

The Fort Bidwell Tribal reservation, located in Modoc County, CA, and home to the Bidwell Paiute Tribe, has experienced severe recurrent flooding in recent years. Over time, the flooding has caused serious damage, closing roadways and eroding the earthen hydroelectric dam that sits directly upstream of the reservation. The dam was designed to manage approximately 450,000 cubic feet of water and houses a hydroelectric system and generator to moderate water volume. Heavy rains damaged these systems and disrupted supply lines and access roads leading to the dam.

The Tribal Council applied for and received a FEMA Hazard Mitigation Grant Program (HMGP) grant to address the impacts of heavy rains on the dam. The project placed a concrete gutter to redirect stormwater runoff into nearby Soldier Creek and buried a hydroelectric water supply pipe, which had previously collapsed into Soldier Creek. A timber retaining wall with compacted stone was also constructed, and the earthen ditches on either side of Dam Road were lined with concrete, or replaced with corrugated metal pipes, to prevent further erosion.

Consequently, this project was able to successfully mitigate the risk of further damage to the upstream dam facility and reduce the potential of electricity loss to the community during storm events. It also reduced the risk of damage to supply lines and access roads leading to and from the dam.

Low Cost, Significant Benefits

The Bidwell Paiute Tribe was able to leverage just under \$14,000 in funding to protect its main source of electricity, an earthen hydroelectric dam (along with its supply lines and access roads), avoiding over \$100,000 in future damages, according to a FEMA estimate.



Pit River, Modoc County

Source: https://en.wikipedia.org/wiki/Modoc_County,_California#/media/File:Pit_River_Valley.jpg

Addressed Hazards



PRIMARY HAZARD
Inland Flooding

Community Lifelines

 *Hover over the Primary Lifeline to learn more.*



Safety & Security



Food, Water,
Sheltering



Transportation

Bidwell Paiute Tribal Reservation Flood Mitigation Project

Details

Project Owner

Bidwell Paiute Tribe

Type of Project

Infrastructure Flood Protection

Area of Impact

Entire tribal population (119, according to 2014–2018 American Community Survey Estimates)

Cost

Total Project Cost

\$13,635

Funding Sources

Federal Funding

FEMA HMGP

Benefits

Primary

- Avoids physical damage to earthen dam, culverts and pipes, and roads
- Prevents loss of function to dam (including hydroelectric system) and roads due to flooding impacts

Secondary

- Provides life-safety benefits as a result of a reduction in potential injuries and deaths from possible dam or road failures
- Protects cultural and historical resources and allows the tribe to maintain access to important tribal facilities

Partnerships

- FEMA

Resources & References

FEMA. 2021. “Flood Mitigation Project Protects Bidwell Paiute Tribal Reservation.” Accessed March 29, 2022. <https://www.fema.gov/case-study/flood-mitigation-project-protects-bidwell-paiute-tribal-reservation>.

Wikipedia. 2020. “Fort Bidwell Indian Community of the Fort Bidwell Reservation of California.” https://en.wikipedia.org/wiki/Fort_Bidwell_Indian_Community_of_the_Fort_Bidwell_Reservation_of_California

Buffalo, Wyoming, Flood Control



Buffalo, WY
FEMA Region 8

Since 1980, four flood events have caused damage to Buffalo, WY, with the worst damage in 2015. In June 2015, the community suffered a severe sheet flooding event from high rainfall caused by a sudden thunderstorm. This rain fell west of the city on previously saturated soils, which caused rapid runoff into town, down city streets, and into dozens of structures. Several families required police assistance to leave their properties. Over 400 structures, homes, and businesses were flooded during this event and most local roads had damage as well. The City of Buffalo declared a state of emergency.

In 2017, the City received funding from FEMA to study implementing a project to build an earthen dam and 6-acre detention pond, in order to safely detain and release stormwater runoff away from Buffalo's more densely-populated areas. This project addresses the risk from sheet flooding after major rainfall events in Buffalo. The City's existing stormwater conveyance infrastructure is not sufficient to protect residential and commercial properties from major damage from flooding. Rainfall is channeled through Dump Draw, across the City's golf course, through a 4-foot culvert, under private properties, and then into Clear Creek. In heavy rainfall events, the culvert is overwhelmed, water backs up, and the water flows down city streets into an area of older residences with basements and homes built at ground level.

The Environmental Assessment conducted for the proposed project determined that the potential environmental impacts caused by building the earthen dam and detention pond could be mitigated through the use of best management practices, and the project was allowed to move forward. The project was certified as complete in late 2019.

Updating an Obsolete System

Once completed, this project will greatly improve stormwater management for the City of Buffalo, WY, and protect life and property. The City's current infrastructure is inadequate and outdated, and was overwhelmed during the 2015 flood.

Community Lifelines



Hover over the Primary Lifeline to learn more.



Transportation

Addressed Hazards



PRIMARY HAZARD
Inland Flooding



Landslides



Environmental Assessment

Buffalo Hazard Mitigation Project

Buffalo, Johnson County, Wyoming
August 2017

Prepared by

Booz Allen Hamilton
8283 Greensboro Drive
McLean, VA, 22102

Prepared for

FEMA Region VIII
Denver Federal Center
Building 710, Box 25267
Denver, CO 80225-0267



FEMA

Buffalo, WY Flood Control Project Document

Source: FEMA

Buffalo, Wyoming, Flood Control

Details

Project Owner

City of Buffalo, WY

Type of Project

Flood Mitigation Infrastructure

Area of Impact

52 acres; Buffalo, WY population (Total Pop: 4,584 in 2017)

Cost

Total Project Cost

\$648,291

Funding Sources

Federal Funding

FEMA Pre-Disaster Mitigation Funding: \$486,219

Non-Federal Funding

Local Share: \$162,072

Benefits

Primary

- Reduced physical damage to structures and their contents and associated residential displacement and short-term shelter needs
- Reduced damage to stormwater and flood infrastructure, including road culverts

Secondary

- Reduced loss of function for transportation systems
- Reduced loss of function to non-residential structures and their associated businesses or organizations impacted by road closures
- Decreased need for emergency response during flood events

Partnerships

- FEMA
- City of Buffalo

Project Timeline

Start Date

Received FEMA HMA funds in 2016; project put out for construction bid in January 2019

Project Completion Date

September 2019

Resources & References

Mayor Shane Schrader. 2019. "Public Notice." *Buffalo Bulletin*, January 14, 2019. http://www.buffalobulletin.com/news/public_notices/article_e105bfa0-19b9-11e9-a9ba-3fa0791ef253.html.

Palmer, A. 2019. "Johnson County Year-in-Review 2019: September-December" Sheridan Media. December 30, 2019. <https://sheridanmedia.com/news/8805/johnson-county-year-in-review-2019-september-december/>.

Charlotte-Mecklenburg Flood Mitigation Buyout Program



Mecklenburg County, NC
FEMA Region 4

Local floodplains are meant to flood during heavy rains. It's mother nature's way of slowing down the flow of water to reduce damage caused by raging creeks and rivers. Floodplains also filter stormwater pollutants by temporarily storing floodwater. However, many communities, including Charlotte-Mecklenburg, have allowed development within the floodplain. The development has put homes, businesses, vehicles, and other property in areas meant to flood.

Buying and removing buildings in the floodplain is one of the most cost-effective ways to reduce long-term flood damage. Floodplain acquisitions provide community recreational and open space assets. Over time, the local building stock will shift from older buildings in vulnerable areas, to newer code-compliant buildings in more sustainable locations within Mecklenburg County.

Since 1999, Storm Water Services has purchased hundreds of flood-prone houses, apartment buildings, and businesses that were located in floodplains throughout Mecklenburg County. The reclaimed land is held as open space to provide for natural floodplain function. Storm Water Services estimates these buyouts have avoided \$25 million in losses and will ultimately avoid over \$300 million in future losses.

Addressed Hazards



PRIMARY HAZARD
Inland Flooding



Hurricanes

Floodplain Relocation

Over 400 flood-prone structures housing approximately 700 families and businesses have been relocated outside of local floodplains. Of this land, 185 acres has been "undeveloped" into public open space.

Voluntary Floodplain Buyout

Floodplain buyouts have all been voluntary as owners are not forced to sell. Historically, about 85% of owners who go through the appraisal and offer process, participate in the buyout.

Community Lifelines



Hover over the Primary Lifeline to learn more.



Doral Cavalier Apartments August 2008, Tropical Storm Fay
Source: <https://mecklenburgcounty.exavault.com/share/view/2acba-axeboxusf-erhcklna>



Chantilly Ecological Sanctuary, site of former Doral Cavalier Apartments
Source: <https://mecklenburgcounty.exavault.com/share/view/2acba-axeboxusf-erhcklna>



Chantilly Ecological Sanctuary November 2020, Tropical Storm Eta
Source: <https://mecklenburgcounty.exavault.com/share/view/2acba-axeboxusf-erhcklna>

Charlotte-Mecklenburg Flood Mitigation Buyout Program

Details

Project Owner

Mecklenburg County

Type of Project

Flood Hazard Mitigation

Area of Impact

Mecklenburg County, NC, 546 square miles
(Total Pop: 1.11 million as of 2019)

Cost

Total Project Cost

\$81,464,425

Funding Sources

Federal Funding

FEMA Pre-Disaster Mitigation Funding, Hazard Mitigation Grant Program: \$29,118,731 to date

Non-Federal Funding

North Carolina Hazard Mitigation, local utility fee, local partners: \$52,347,692 to date

Benefits

Primary

- Complete protection from future flood events by removing structures and associated utility infrastructure from high-risk areas
- Improved life safety benefits and reduced emergency response needs with less people in floodplain

Secondary

- Restoration of the natural floodplain to enhance water quality and the ecosystem
- Additional stormwater storage and green space, increased opportunities for recreation and interaction with nature, and improved water quality

Partnerships

- FEMA
- Mecklenburg County
- State of North Carolina
- Local water and sewer authority, parks department, and emergency response agencies

Project Timeline

Start Date

January 1999

Status

In progress

Project Completion Date

Anticipated completion January 2035

? Challenges Faced

- Funding availability drives the annual mitigation planning and limits the amount of mitigation that can be achieved
- Long time spans between significant flood events affects the willingness of individual owners to participate in the voluntary program

Resources & References

City of Charlotte. 2020. Floodplain Buyout (Acquisition) Program Website. <https://stormwaterservices.mecknc.gov/floodplain-buyout-program>.

Cheyenne West Edge District Redevelopment



Cheyenne,
WY
FEMA Region 8

The underutilized West Edge District of Cheyenne (“the District”) became a focus of revitalization for the City of Cheyenne, Laramie County, and the Cheyenne Downtown Development Authority starting in 2011. The District is located within the Lower Capital Drainage Basin, which because of the relatively flat topography, large amount of impervious surface, and rail yard barriers, has been historically challenged by flood risk and stormwater pooling. Flash floods are also not uncommon and have historically caused property damage, injuries, and death in the area. Cheyenne estimated that the next major storm would cost more than \$100 million in damage without improvements. The project’s stormwater conveyance, drainage, and retention upgrades would greatly reduce these risks and associated costs.

A unique characteristic to the District is that it is home to brownfields, or abandoned properties with potentially hazardous contaminants. For this reason, the project also includes redeveloping these brownfields to allow space for new development and activity, while reducing potential environmental contamination and health impacts to residents.

Lastly, this project will also develop new park amenities for Cheyenne residents and visitors. This will contribute to the overall community and encourage people to visit the newly revitalized District, while also offering green space for stormwater management.

Addressed Hazards



PRIMARY HAZARD
Inland Flooding

Diverse Funding

The project team sought diverse funding sources from federal, state, and local governments, as well as targeted funding for the different prongs of the overall project, including brownfields, stormwater, economic development and more. The project team also was able to secure a local 6th Penny Specific Purpose Tax increase, resulting in \$4.8 million.

Community Facility Utilization

The project is pursuing multi-faceted improvements to the District’s stormwater system, including utilizing open space features to create community amenities such as ponds, fountains, pathways, and landscaped areas instead of the traditional storm drains, underground pipes, and stream ways.

Community Lifelines

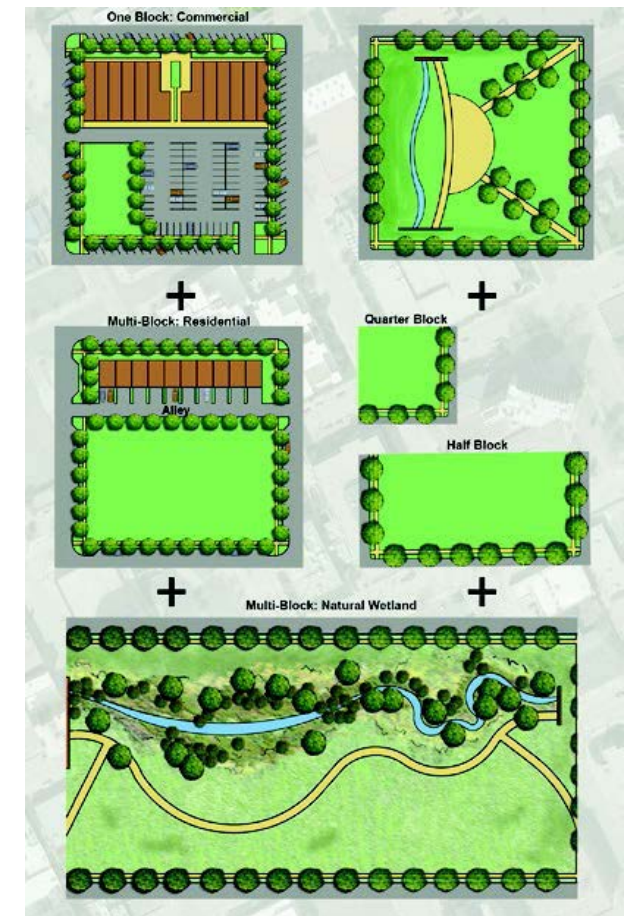
 *Hover over the Primary Lifeline to learn more.*



Health & Medical



Hazardous
Material



Conceptual block diagram used at the second public meeting to visualize the potential of West Edge

Source: http://cheynewestedge.com/wp-content/uploads/2014/04/CheyennePlanningReport_2014-6-4.pdf

Cheyenne West Edge District Redevelopment

Details

Project Owner

City of Cheyenne

Type of Project

Brownfield Redevelopment



Nature-Based Solution: Green Infrastructure, Stormwater Management

Area of Impact

City of Cheyenne, WY (Total Pop: 63,957 as of 2018)

Cost

Total Project Cost

Over \$17 million

Funding Sources

Federal Funding

- FEMA Pre-Disaster Mitigation Program: \$3 million
- U.S. Department of Commerce Public Works and Economic Development Administration (EDA) Program: \$1.7 million
- U.S. EPA Brownfields Coalition Partners Assessment Grant: \$1 million
- U.S. EPA Brownfields Coalition Revolving Loan Cleanup Grant: \$1 million
- U.S. EPA Brownfields Coalition Area-Wide Planning Grant: \$200,000

Non-Federal Funding

- 6th Penny Specific Purpose Tax collection for the brownfield development initiative (City of Cheyenne): \$4.8 million
- Grant award from the Wyoming Mineral Royalty Grant program: \$1,236,866
- Wyoming Business Council Community Development Block Grant Program: \$132,000

Benefits

Primary

- Reduced stormwater runoff flows and associated physical damage to properties and transportation infrastructure
- Greatly lessened potential environmental contamination and associated health impacts from previously unchecked brownfields

Secondary

- Less severe social impacts from flood events, such as reduced need for temporary shelters, better water quality protection, and reduced costs for measures to remove pollutants
- More green space and park amenities, which can have cascading public health impacts for the community
- Economic revitalization of area, including increased property values, job creation, and generation of local property and sales tax revenue

Partnerships

- EPA Coalition (City of Cheyenne, Laramie County, and Cheyenne Downtown Development Authority)
- U.S. Environmental Protection Agency (EPA)
- FEMA
- DHM Design
- Ayres Associates
- Dave Knopick
- MindMixer
- Warehouse Twenty-One

Project Timeline

Start Date

Received first brownfield grant in 2011

Status

Ongoing. Virtual rezoning public meetings being held in 2021

? Challenges Faced

- The District is currently zoned as industrial, which has limited the ability to move forward with the pedestrian-oriented, mixed-use area. The City is looking for a rezoning option that accommodates existing industrial use, but also allows new development.
- COVID-19 disrupted the planned public engagement for 2020. However, the project team was able to overcome this disruption by turning to virtual zoning workshops so as to not lose momentum.

Resources & References

City of Cheyenne. n.d. Cheyenne's West Edge District Website. <http://cheyennewestedge.com/>

City of Cheyenne. 2014. "City of Cheyenne West Edge Visionary Blueprint." November 2014. https://assets.simpleviewinc.com/simpleview/image/upload/v1/clients/cheyenne/2016_westedge_area_wide_plan_f1694001-a907-4c86-9c00-5238d7377444.pdf

Konveio. 2020. "Virtual Workshop for Cheyenne West Edge District." <https://konve.io/case-studies/2020/5/15/virtual-workshop-for-cheyenne-west-edge-district>

Cleveland and Northern Ohio Regional Stormwater Management and Flood Mitigation Program



Cleveland &
Northern OH
FEMA Region 5

The Northeast Ohio Regional Sewer District administers a comprehensive regional stormwater management program for 62 member communities in the Northeast Ohio/Cleveland area region. In addition to administering a stormwater fee credit program for the region, the Sewer District also manages a Community Cost-Share Program to help communities in the region implement stormwater best management practices; a Green Infrastructure Grant program that provides funding for green infrastructure projects to member communities, non-profits, and businesses in the combined sewer area; and a Member Community Infrastructure Program, which provides funding opportunities to member communities for sewer infrastructure repair and rehabilitation. The Sewer District also tracks all stormwater projects approved for construction in its member communities, which keeps communities up-to-date on ongoing projects in neighboring localities, and allows for better collaboration and cooperation across the region.

Regional Partnerships Support Mitigation Actions

This regional effort leverages multiple programs that incentivize residents and communities to implement nature-based solutions based on stormwater management best practices.

Project Tracking System Enables Cross-Jurisdictional Coordination

By tracking stormwater projects across its member communities through a central repository, the Sewer District is able to monitor implementation and facilitate better cooperation across the Region as communities collaborate on resilience measures.

Community Lifelines



Hover over the Primary Lifeline to learn more.

Addressed Hazards



PRIMARY HAZARD
Inland Flooding



Retention pond used to manage stormwater runoff
Source: Shutterstock



Food, Water, Sheltering

Details

Project Owner

Northeast Ohio Regional Sewer District

Type of Project

Regional Stormwater Management Program

Area of Impact

62 communities across the Northeast Ohio Region

Cost

Total Project Cost

The cost of developing new plans, codes, or ordinances include community staff time and any outside consultants to provide technical support and associated analysis. Changes will typically include economic analyses looking at construction components, practices, and short- and long-term maintenance costs.

Funding Sources

Non-Federal Funding
Northeast Ohio Regional Sewer District

Benefits

Primary

- Reduced physical damage to structures and their contents and associated residential displacement and short-term shelter needs
- Reduced damage to stormwater and flood infrastructure, including road culverts
- Increased water reuse and associated decrease in drought risk

Secondary

- Reduced loss of function for transportation systems and water infrastructure
- Reduction in loss of function to non-residential structures and their associated businesses or organizations impacted by road closures and loss of potable water services
- Decreased need for emergency response during flood events

Partnerships

- 62 member communities across the Northeast Ohio Region

Resources & References

Northeast Ohio Regional Sewer District. 2020. "Community Cost-Share Program." Accessed March 16, 2020. <https://www.neorsd.org/community/community-cost-share-program/>.

Northeast Ohio Regional Sewer District. 2020. "Green Infrastructure Grant Program." Accessed March 16, 2020. <https://www.neorsd.org/stormwater-2/green-infrastructure-grant-program/>.

Northeast Ohio Regional Sewer District. 2020. "Regional Stormwater Management Program." Accessed March 16, 2020. <https://www.neorsd.org/stormwater-2/stormwater-management-program/>.

Northeast Ohio Regional Sewer District. n.d. NEORSD Green Infrastructure Grants Program Storymap. Accessed March 23, 2022. <https://neorsd.maps.arcgis.com/apps/Shortlist/index.html?appid=efd0ff60d52f4860978c5bb4098cb3d9>.

Cuyahoga Falls Rain Garden Reserve

The City of Cuyahoga Falls, OH, experienced two major storm events in 2003 and 2004 that caused millions of dollars in damages to properties. The City, in collaboration with FEMA and the Ohio Emergency Management Agency, purchased and demolished four homes that had experienced repetitive flooding losses. The open space left was used to build a 24,000-square-foot municipal rain garden that receives drainage from 3.17 acres. It can hold and filter up to 30,000 gallons of water. The garden now serves the community with walking paths, solar lighting bollards, and endless educational and recreational opportunities.

This project was the first of its kind approved for FEMA Region V. It required extensive public involvement to alleviate concerns about aesthetics and mosquitoes. Neighborhood support was gained through a series of educational series and visualizations.

On May 12, 2014, a storm event dumped four inches of rain within 45 minutes on Cuyahoga Falls. This caused widespread damage across the City; however, there was no reported damage in the neighborhood surrounding the rain garden.

Addressed Hazards



PRIMARY HAZARD
Inland Flooding

Community-Supported Nature-Based Mitigation

This relatively low-cost mitigation project demonstrates a scalable solution that smaller communities could adapt to mitigate against severe rainfall events by removing large amounts of impervious surfaces and creating a rain garden.



Rain Garden Reserve
Photo credit: Alisha Goldstein, EPA



Cuyahoga Falls, OH
FEMA Region 5

Community Lifelines



Hover over the Primary Lifeline to learn more.



Food, Water, Sheltering

Details

Project Owner

City of Cuyahoga Falls, OH

Type of Project

Strategic Buyouts



Nature-Based Solution: Rain Garden

Area of Impact

Neighborhood

Cost

Total Project Cost

\$157,000

Funding Sources

Federal Funding

- FEMA HMGP: \$107,000

Non-Federal Funding

- Donations supported by community organizations, residents, and local businesses: \$50,000 (donated materials)
- Ongoing maintenance is performed by the City (estimated \$700/year)

Benefits

Primary

- Acquisition projects provide complete protection from future flood events by removing structures and associated utility infrastructure from high-risk areas
- Rain gardens reduce stormwater runoff flows, which can cause damage to properties and roads

Secondary

- Additional stormwater storage and green space, and reduction of need for emergency response services during flood events
- Recreational benefits from having more “pocket parks” and less need for costly large parks

Partnerships

- Ohio Emergency Management Agency
- FEMA

Project Timeline

Project Completion Date

April 25, 2008

? Challenges Faced

- Community concerns about aesthetics of the rain garden and the potential for mosquito breeding habitat

Resources & References

Environmental Protection Agency Office of Wastewater Management. 2015. Green Infrastructure for Localized Flood Management. Presentation. Tuesday, December 2nd, 2014. https://www.epa.gov/sites/default/files/2015-10/documents/flood_management_slides_120214_0.pdf.

Naturally Resilient Communities. 2017. “Cuyahoga Falls, Ohio.” <http://nrcsolutions.org/cuyahoga-falls-ohio/>.

Exploration Green Stormwater Park

Houston, TX, has experienced significant flooding and related impacts over the last several decades, most notably from Hurricane Harvey in 2017. However, as a result of the completion of the first phase of the new Exploration Green Stormwater Park just prior to the storm, 150 homes in the area around the park that might otherwise have been flooded were protected.

When the rest of the project is complete, the park will cover 200 acres of what was once a golf course, and will include five large detention basins/ponds, along with a large drainage ditch spanning the length of the property to provide extra storage capacity. In total, the park's detention basins will be able to manage up to 1,680 acre-feet of water. The plan for the five-phase park includes recreational facilities, multi-use paths, nature areas, a visitor's center, and practice fields that will serve neighborhood pools. The project will also restore several former wetland areas, which will provide another means of managing stormwater quality in the area. The park is expected to be completed in 2022.

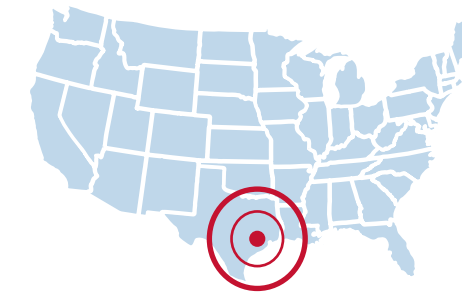
The project is expected to contribute to managing stormwater for an area of approximately 8,000 acres and will reduce flood risk for the approximately 30,000 people who live within one-half mile of the park, in addition to multiple business and community facilities located in the vicinity.

Award-Winning Innovative Stormwater Management

Exploration Green has won nine awards since its inception for its innovative use of stormwater management that has not only significantly reduced flood risk to the community, but has also created multiple recreational and social benefits for Houston residents.



Volunteers planting wetlands vegetation
Photo credit: FEMA. Exploration Green! A Case Study in Effective Floodplain Management.
<https://agrillife.org/gift/files/2019/09/Exploration-Green.pdf>



Houston, TX
FEMA Region 6

Community Lifelines

 Hover over the Primary Lifeline to learn more.



Food, Water, Sheltering



Health & Medical



Transportation

Addressed Hazards



PRIMARY HAZARD
Inland Flooding



Hurricanes

Exploration Green Stormwater Park

Details

Project Owner

Clear Lake City Water Authority (CLCWA)

Type of Project



Nature-Based Solution: Stormwater Park, Wetland Restoration

Area of Impact

Significantly reduces flood risk to approximately 30,000 Houston residents

Cost

Total Project Cost

\$38 Million (estimate)

Funding Sources

Non-Federal Funding

- CLCWA bonds
- Texas Parks and Wildlife
- Multiple private foundations/civic clubs
- Harris County Flood Control District
- City of Houston

Benefits

Primary

- Decreases potential for physical damage to structures and their contents
- Reduces residential displacement and associated short-term shelter needs

- Reduces damage to stormwater and flood infrastructure, including roads and culverts

Secondary

- Reduces loss of function for transportation systems
- Creates additional stormwater storage and green space
- Reduces the need for emergency response services during flood events
- Reduces the potential loss of function to non-residential structures and their tenant businesses and organizations

Partnerships

- City of Houston
- CLCWA
- The Exploration Green Conservancy
- The Galveston Bay Foundation
- Trees for Houston
- Sea Grant Texas at Texas A&M University
- Texas A&M AgriLife Extension
- The Texas Coastal Watershed Program

Project Timeline

Start Date

Golf Course purchased by CLCWA in 2005

Status

In Progress

Project Completion Date

Expected completion by the end of 2023

? Challenges Faced

- This multi-phase project has faced some delays as a result of concerns about its proximity to Ellington Airport; however, those issues have been resolved, and the project is once again moving forward

Resources & References

Aguilar, Jovanna. 2023. "Exploration Green in Clear Lake final phase set for summer completion." Community Impact Newspaper. <https://communityimpact.com/houston/bay-area/development/2023/04/03/exploration-green-in-clear-lake-final-phase-set-for-summer-completion/>.

Exploration Green. 2020. "Exploration Green." Accessed March 29, 2022. <https://www.explorationgreen.org/>.

Ferguson, Colleen and Schafler, Kelly. 2022. "New parks, recreation opportunities to join Bay Area." Community Impact Newspaper. <https://communityimpact.com/houston/bay-area/parks-recreation/2022/01/25/new-parks-recreation-opportunities-to-join-bay-area/>.

FEMA. "Exploration Green prevents flooding, enhances Houston-area community." October 10, 2019. <https://www.fema.gov/press-release/20210318/exploration-green-prevents-flooding-enhances-houston-area-community>.

FEMA. **Exploration Green! A Case Study in Effective Floodplain Management.** Houston: FEMA, 2018. <https://agrifile.org/gift/files/2019/09/Exploration-Green.pdf>.

Magee, Jake. 2019. "Despite hiccups, Exploration Green project on track for 2021 completion." **Community Impact Newspaper.** <https://communityimpact.com/clear-lake-league-city-nassau-bay/development-construction/2019/08/09/despite-hiccups-exploration-green-project-on-track-for-2021-completion/>.

Foster Floodplain Natural Area



Portland, OR
FEMA Region 10

The Foster Floodplain project along Johnson Creek in Portland, OR transformed a flood-prone neighborhood into a beautiful 63-acre natural area. Completed by the City of Portland in 2012, the project was a culmination of a 15-year effort to purchase property through the Willing Seller Acquisition Program and help 60 families move out of Johnson Creek's 100-year floodplain. The newly created natural area now reduces flood risk for surrounding neighborhoods and provides valuable urban habitat for fish and wildlife.

Historically, Johnson Creek flooded streets, businesses, and homes in this area an average of every other year. The project removed more than 100 of the most vulnerable structures from the floodplain and created a natural floodplain area in their place that provides 140 acre-feet of flood storage. The additional flood storage has greatly reduced the risk of flooding to the adjacent neighborhood.

The project was also designed to create and restore habitat for fish. Habitat along more than a half-mile of Johnson Creek was significantly restored and benefits many species, including threatened salmon and steelhead. Pond and wetland enhancements benefit sensitive frogs and salamanders. Hidden in the grasses and shrubs are ground-nesting birds, such as killedeer, and small mammals, including rabbits and skunk. Deer, coyote, hawks, and bald eagles also use the site.

Addressed Hazards



PRIMARY HAZARD
Inland Flooding



Winter Storms

Natural Floodplain Restoration

The Foster Floodplain project used natural floodplain restoration as a flood reduction strategy that simultaneously protected a neighborhood, restored habitat for three Endangered Species Act-listed salmon and steelhead populations, and provided a historically disadvantaged and underserved community with a park.

Successful Floodplain Project

In 2015, 3 years after construction of the project, the largest recorded flood on Johnson Creek tested the project design. The 140 acre-feet of restored flood storage performed better than designed and prevented property damage and critical emergency route closures.



Foster Floodplain Natural Area before (2000) and after (2019) aerial photos

Source: <https://www.flickr.com/photos/besportland/50134363436/in/album-72157714946014123/>

Community Lifelines

 Hover over the Primary Lifeline to learn more.



Safety & Security



Food, Water, Sheltering

Foster Floodplain Natural Area

Details

Project Owner

City of Portland Bureau of Environmental Services

Type of Project

Property Acquisition Program



Nature-Based Solution: Floodplain restoration

Area of Impact

Lents neighborhood, Portland, OR, 4.5 square miles
(Total Pop: 34,953 as of 2018)

Cost

Total Project Cost

Approximately \$13 million



Funding Sources

Federal Funding

FEMA Pre-Disaster Mitigation Funding: \$2.7 million

Non-Federal Funding

Stormwater utility fees: \$10.3 million

Benefits

Primary

- Complete protection from future flood events by removing structures and associated utility infrastructure from high-risk areas
- Improved life safety benefits and reduced emergency response needs with less people in floodplain
- Restored wetland and floodplain habitat, and a half-mile of Johnson Creek for fish and wildlife, including endangered salmon and steelhead

Secondary

- Restoration of the natural floodplain to enhance water quality and the ecosystem
- Additional stormwater storage and green space offer increased opportunities for recreation and community access with nature with installation of foot bridge, walking path, sidewalks, and other amenities

Partnerships

- City of Portland Bureau of Environmental Services
- City of Portland Parks & Recreation
- Prosper Portland (formerly Portland Development Commission)
- Johnson Creek Watershed Council
- Neighborhood Associations
- FEMA
- USACE
- USGS
- METRO regional government
- Local water and sewer authority, parks department, and emergency response agencies

Project Timeline

Start Date

1996

Project Completion Date

2012

? Challenges Faced

- Nature-based solutions take many years to implement
- The project also faced challenges with funding, property acquisition, design, and long-term operations and maintenance

Resources & References

BES Portland. n.d. Foster Floodplain Natural Area Flickr Account. <https://www.flickr.com/photos/besportland/albums/72157714946014123>.

City of Portland. 2021. "Foster Floodplain Natural Area." <https://www.portlandoregon.gov/bes/article/286175>.

Harris County Flood Control District Voluntary Acquisition Program

The voluntary acquisition program for homes at risk for repetitive flood losses in Harris County, TX, has acquired over 3,000 properties since 1995. Since the arrival of Hurricane Harvey, a Category 4 hurricane that struck Texas in 2017, the program has acquired 420 additional eligible properties. The program is managed by the Harris County Flood Control District, which also manages other projects and programs designed to reduce flood risk in Harris County. This highly successful program also faces a challenge of keeping up with demand; the County currently has a waiting list of over 1,000 residents who have applied to have their homes acquired through the program. In 2018, voters approved \$148 million for property acquisition as part of a \$2.5 billion bond measure to finance stormwater and flood protection measures in Harris County.

Addressed Hazards



PRIMARY HAZARD
Inland Flooding



Hurricanes

Protecting Life & Property

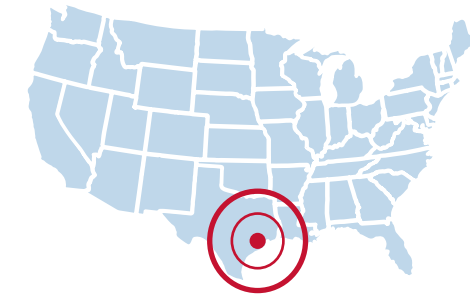
This program provides a solution for residents whose homes are at risk for repetitive flood losses for whom other options to protect their families and property are severely limited.

Restoring the Floodplain

Not only do these home acquisitions protect life and property, but they also allow portions of the natural floodplain to be restored, reducing impervious area and providing other ecosystem benefits.



Hurricane Harvey flood damage to homes in Harris County, TX
Source: Shutterstock



Harris
County, TX
FEMA Region 6

Community Lifelines



Hover over the Primary Lifeline to learn more.



Food, Water, Sheltering

Harris County Flood Control District Voluntary Acquisition Program

Details

Project Owner

Harris County Flood Control District

Type of Project

Property Acquisition

Area of Impact

Over 3,000 properties acquired so far; program open to eligible residents of Harris County, TX (Total Pop: 4.7 million in 2017)

Cost

Total Project Cost

Unknown

Funding Sources

Federal Funding

FEMA Flood Mitigation Assistance (FMA)

Non-Federal Funding

Harris County

Benefits

Primary

- Eliminates physical damage to structures and their contents
- Reduces injuries and deaths (life-safety benefits) for projects that buyout entire neighborhood or area where past emergency response has been required
- Reduces loss of function and downtime for non-residential structures and associated businesses or organizations

Secondary

- Minimizes social impacts of flood events, such as temporary and long-term shelter needs
- Increases green space since acquired properties are required to remain undeveloped, or dedicated as park space
- Improves community resiliency with shortened recovery from flood events

Partnerships

- FEMA
- Harris County Flood Control District

Project Timeline

Start Date

Begun 1995

Status

Program ongoing

? Challenges Faced

- With a waitlist of over 1,000 residents, there is more demand for buyouts than available funding can support

Resources & References

Harris County Flood Control District. 2020. "Home Buyout Program." Last modified January 2020. Accessed March 16, 2020. <https://www.hcfd.org/Hurricane-Harvey/Home-Buyout-Program>.

Weber, Anna. 2019. "Blueprint of a Buyout: Harris County, TX." NRDC, September 17, 2019. <https://www.nrdc.org/experts/anna-weber/buyout-case-study-harris-county-texas>.

Lincoln Wastewater Treatment Plant Flood Mitigation



Lincoln, NE
FEMA Region 7

In 2000, Lincoln, NE's, Theresa Street Wastewater Treatment Plant (WWTP) received a FEMA Hazard Mitigation Grant Program (HMGP) grant to provide flood protection around the electrical substation and transformers required to operate the plant. City officials realized that, without flood protection for this critical infrastructure, recurrent flooding posed a significant threat to the plant's operation during and after severe storms. The HMGP grant contributed to the cost of constructing a 6-foot brick and concrete wall to protect the substation, which was also fitted with an entrance that could be blocked with "stop logs" (removable flood shields) after a flood warning has been issued for the region. The grant also helped pay for the cost of raising the existing electrical transformer by 3 feet above the 100-year flood elevation and helped cover retrofits to the plant's below-grade stairwells to protect them from flooding during storm events.

In the intervening years, these improvements have helped Lincoln's WWTP continue to function, even during severe storms, protecting the health and safety of residents and preventing contamination of local creeks and streams.

Health, Safety, and Environmental Co-Benefits

This project not only helped protect infrastructure critical to the health, safety, and welfare of the residents of Lincoln, but has also helped prevent serious environmental impacts to Salt Creek due to plant failure.



Lincoln, NE's Theresa Street Wastewater Treatment Plant
Source: <https://www.lincoln.ne.gov/city/itu/wastewater/treatment.htm>

Community Lifelines

 Hover over the Primary Lifeline to learn more.



Safety & Security



Food, Water, Sheltering

Addressed Hazards



PRIMARY HAZARD
Inland Flooding



Winter Storms

Lincoln Wastewater Treatment Plant Flood Mitigation

Details

Project Owner

City of Lincoln, NE

Type of Project

Infrastructure Flood Protection

Area of Impact

City of Lincoln, NE population (287,401 as of 2018)

Cost

Total Project Cost

\$230,000

Funding Sources

Federal Funding

FEMA HMGP: \$172,500

Non-Federal Funding

City of Lincoln, NE: \$57,500

Benefits

Primary

- Avoids potential physical damage to WWTP equipment, including electrical supply and control components, from future storms/flooding
- Reduces loss of economic value associated with loss of WWTP services to residential customers
- Curtails the need for repairs to equipment and reduces potential clean-up costs from contamination during flood events

Secondary

- Reduces losses to commercial and industrial sectors highly reliant on wastewater treatment
- Provides environmental benefits by avoiding the release of untreated wastewater into local water bodies during flood events

Partnerships

- FEMA
- City of Lincoln, NE

Project Timeline

Start Date

Received funding 1998

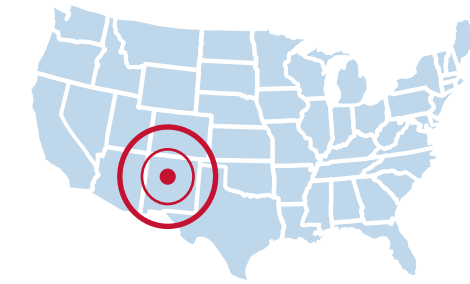
Project Completion Date

Project completed in 2003

Resources & References

FEMA. 2010. "Mitigation of Essential Structures Helps to Keep Water Treatment Plant Open." December 9, 2010. <https://www.hsdl.org/?view&did=13096>.

Lower Arroyo de los Montoyas Stabilization



Rio Rancho, NM
FEMA Region 6

The Arroyo de los Montoyas is a major arroyo that flows after sufficient rain events, eventually discharging into the Rio Grande River. The steep embankments of the arroyo were experiencing scour and erosion after several major flood events. To prevent impact to the Rio Rancho Waste Water Treatment Plant #6 located adjacent to the arroyo, the Southern Sandoval County Arroyo flood Control Authority (SSCAFCA) sought to stabilize the slopes with a permanent erosion solution. Impact to the treatment plant could result in 75% loss of sanitary sewer to the Rio Rancho community.

SSCAFCA wanted a resilient flood control solution to provide protection up to the 100-year storm and allow for ground water recharge to infiltrate the soil instead of running onto concrete. Additionally, the water treatment's water reclamation line needed to be kept in use. Challenges to this project included limited right of way on the left descending side, severe erosion of the existing channel banks and very sandy soils.

An Engineered Earth Armoring System (EEAS) was selected to stabilize the slopes of the arroyo. The system utilizes earth anchors that are designed and tested for performance with high performance reinforcement mat (HPTRM) to improve the factor of safety and significantly reduces the probability of failure in slope applications.

Hard armoring with rock riprap and concrete was considered, but the cost of using rock was high and concrete does not allow water to infiltrate into the ground. The EEAS also helped reduce the amount of space needed for a right-of way-because it provides improved surficial stability on steeper than normal slopes. The HPTRM used in the EEAS is highly UV stabilized, providing up to 75 years of design life, even when directly exposed to the sun.

The EEAS is a recognized nature-based solution with a verified carbon footprint of 2.7 kgCO₂e per 1m² of material. Comparatively, the carbon footprint of concrete-based alternatives are up to 30 times higher. SSCAFCA did not want a hard armoring solution based on its research that hard armoring in arid arroyos limits groundwater recharge. The EEAS helps to decrease sedimentation and pollutants and encourages infiltration of water back into the ground water table. These are two reasons why the EPA has identified systems that utilize HPTRMs as a Best Management Practice (BMP) for improving water quality.



Overview of the Arroyo during installation.
Source: Propex Geosolutions

Community Lifelines

 Hover over the Primary Lifeline to learn more.



Safety & Security



Food, Water, Sheltering

Addressed Hazards



PRIMARY HAZARD
Inland Flooding

Lower Arroyo de los Montoyas Stabilization

Details

Project Owner

Southern Sandoval County Arroyo Flood Control District (SSCAFCA)

Type of Project

Infrastructure

 Nature-Based Solution

Area of Impact

Rio Rancho, NM

Cost

Total Project Cost

\$4.8 million

Funding Sources

Federal Funding

FEMA Pre Disaster Mitigation:
\$3.238 million

Non-Federal Funding

\$1.6 million
State: \$560,000
Local: \$500,000

Benefits

Primary

- Stabilize the arroyo side slopes to prevent future erosion and flooding
- Protect the Rio Rancho Waste Water Treatment Plant #6
- Provide a resilient flood control solution to provide protection up to 100-year storm

Secondary

- Minimize the required right-of-way
- Implement a solution to promote groundwater recharge

Partnerships

- SSCAFCA
- City of Rio Rancho
- USACE Albuquerque District
- New Mexico Department of Homeland Security and Emergency Management
- Private Land Owners
- Propex
- Vital Consulting Group

Project Timeline

Start Date

April 2022

Status

50%

Completion Date

November 2022

? Challenges Faced

- Limited right-of-way
- Severe erosion on the existing channel banks
- Very sandy soil



The Rio Rancho Wastewater Plant is adjacent to the arroyo.

Source: Propex Geosolutions

Minot Water Treatment Plant Floodwall



Minot, ND
FEMA Region 8

In 2011, major flooding devastated parts of North Dakota, including the City of Minot and its water treatment plant. City officials were forced to implement a “boil water” order, causing concern about adverse health impacts from drinking the contaminated water. In 2013, FEMA’s Hazard Mitigation Grant Program (HMGP) awarded the City of Minot with \$2,081,629 to fund the construction of a 14-foot floodwall to protect the water treatment plant. This project was the first permanent floodwall ever erected in Minot and will protect the drinking water from future flooding impacts for years to come. In December 2017, the U.S. Army Corps of Engineers approved a new project as part of Minot’s flood protection plan, the Souris River Flood Protection Project, which will provide flood mitigation benefits to a much larger swath of the City, in addition to the area around the water treatment plant.

Addressed Hazards



PRIMARY HAZARD
Inland Flooding

Catalyzing Other Projects

This project was one of the first in a series of flood mitigation projects in the City of Minot, and its success has helped drive the Souris River Flood Protection Project forward.

Protecting Drinking Water

The Minot Water Treatment Plant Floodwall project will help ensure that the City’s drinking water is safe for residents to consume during and after major flood events.



Water floods a neighborhood in Minot, ND, June 23, 2011.
Source: Staff Sgt. Sharida Jackson of The National Guard, https://commons.wikimedia.org/wiki/File:Aerial_view_of_flooding_in_a_Minot,_N.D.,_residential_area.jpg

Community Lifelines

 Hover over the Primary Lifeline to learn more.



Safety & Security

Minot Water Treatment Plant Floodwall

Details

Project Owner

City of Minot

Type of Project

Flood Mitigation Infrastructure

Area of Impact

Minot population (Total Pop: 47,822 in 2017)

Cost

Total Project Cost

\$2.8 million

Funding Sources

Federal Funding

FEMA HMGP: \$2.1 million

Non-Federal Funding

City of Minot: \$693,876

Benefits

Primary

- Avoids physical damage to potable water treatment facilities and associated large equipment, including electrical supply and control components
- Prevents loss of potable water treatment services associated with physical damage and repair time
- Reduces clean-up costs from possible contamination onsite and downstream

Secondary

- Reduces loss of function for businesses and critical facilities that rely on potable water treatment functionality, especially schools, for which excessive closures can have a ripple effect across all businesses as parents have to handle unexpected work absences

Partnerships

- FEMA
- City of Minot

Project Timeline

Start Date

Project received FEMA funding in 2013

Project Completion Date

Floodwall completed in 2017

Resources & References

Rank, Stephanie. 2017. "Army Corp of Engineers approves permits for Minot's Flood Protection Project." *West Dakota Fox*, December 20, 2017. <https://www.kfyrtv.com/content/news/Army-Corp-of-Engineers-approves-permits-for-Minots-Flood-Protection-Project-465513683.html>.

Skurzewski, Joe. 2017. "State, local leaders celebrate Minot's water treatment plant floodwall." *West Dakota Fox*, August 11, 2017. <https://www.kfyrtv.com/content/news/State-local-leaders-celebrate-Minots-water-treatment-plant-floodwall--439955473.html>.

Souris River Joint Board. 2019. "Mouse River Plan." Last modified 2019. Accessed March 16, 2020. <https://www.mouseriverplan.com/>.

Springgate, Jack. 2019. "Minot flood walls taking shape with first concrete pour." *West Dakota Fox*, May 7, 2019. <https://www.kfyrtv.com/content/news/Minot-flood-walls-taking-shape-with-first-concrete-pour--509619301.html>.

Northwest Resiliency Park

The Northwest Resiliency Park will be the largest park in Hoboken, New Jersey at 5.4 acres, providing the City with recreation and public space. It will have strategic installations of green infrastructure and innovative stormwater management measures to alleviate the strain on the City's stormwater infrastructure system and reduce nuisance flooding. The design has the installation of a rain garden, trees, and lowland gardens as green infrastructure components. Additionally there is a tank and filtration systems built underground that will house one million gallons of rainwater that will be released back into the system after the storm.

The City undertook an extensive community engagement process to ensure the park would be well-adapted to the needs of the surrounding community and the entire City of Hoboken. This engagement included a survey, public participation events, a community design charette, and many public meetings.

Addressed Hazards



PRIMARY HAZARD
Inland Flooding



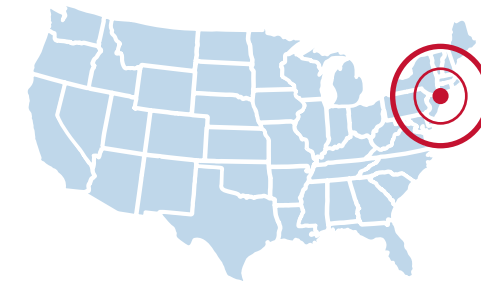
Hurricanes

Innovative Stormwater Solution Incorporates Community Amenities

The Park will be Hoboken's largest park and one of the only resiliency parks in the nation. The Park will manage at least one million gallons of stormwater, greatly minimizing nuisance flooding in the community. Developed through a community design charette, the Park is an example of how to reduce inflows to the combined sewer-stormwater management system while creating a wide range of recreational amenities.



Site of future Northwest Resiliency Park
Source: Google Earth Pro, used under license



Hoboken, NJ
FEMA Region 2

Community Lifelines



Hover over the Primary Lifeline to learn more.



Food, Water, Sheltering



Transportation

Northwest Resiliency Park

Details

Project Owner

City of Hoboken

Type of Project

 Nature-Based Solution: Flood Mitigation Infrastructure

Area of Impact

5.4-acre park and surrounding Hoboken population (Total Pop: 55,131 in 2017)

Cost

Total Project Cost

\$50 million

Funding Sources

Federal Funding

- FEMA Pre-Disaster Mitigation Funding: \$10 million
- U.S. Department of Housing and Urban Development (HUD)

Non-Federal Funding

- City of Hoboken: \$30 million
- Hudson County: \$500,000

Benefits

Primary

- Reduces physical damage to buildings and infrastructure from nuisance flood events
- Reduces loss of service to infrastructure, especially roads and other transportation systems

Secondary

- Reduces loss of service to businesses and other organizations from short-term road closures
- Offers social benefits of providing a park to the surrounding community, including recreation and green space

Partnerships

- City of Hoboken
- Hudson County

Project Timeline

Start Date

Property acquisition began in 2016

Project Completion Date

The City broke ground on the Park in October 2019 with completion anticipated in the fall of 2023

? Challenges Faced

- Robust stakeholder engagement required extensive coordination

Resources & References

City of Hoboken. 2023. "Building the Northwest Resiliency Park." Accessed August 8, 2023. <https://nwpark-cityofhoboken.opendata.arcgis.com/pages/park-construction-updates>.

City of Hoboken. 2020. "Northwest Resiliency Park." Accessed March 16, 2020. <http://nwpark-cityofhoboken.opendata.arcgis.com/>.

Zeitlinger, Ron. 2019. "Hoboken breaks ground on Northwest Resiliency Park." *NJ.com*, October 4, 2019. <https://www.nj.com/hudson/2019/10/hoboken-breaks-ground-on-northwest-resiliency-park.html>.

Petaluma Payran Reach Flood Control and Floodways

Multiple residential neighborhoods in the City of Petaluma, CA, along the Payran Reach, a 3,600-foot reach of the Petaluma River, experienced repetitive flooding and flood losses during the 1980s and 1990s. This flooding repeatedly impacted hundreds of homes and businesses in Petaluma. In 1998, FEMA approved a Hazard Mitigation Grant Program (HMGP) grant to fund a project to protect these neighborhoods from flooding and flood impacts.

This multi-part mitigation project was designed to eliminate potential flood damage within the project area from floods of up to 100-year flood levels. As part of the project, two bridges were replaced at an elevated level, two additional bridges were elevated, and one bridge was relocated. A concrete channel constriction weir was constructed upstream of the project site to reduce the possibility of bank erosion from floodwaters. A total of 3,300 feet of floodwall was constructed (1,650 feet on each side of the Petaluma River). Over 10 acres of plantings were installed at locations along the riverbanks and within the channel, in order to support riparian habit and stabilize banks at risk of eroding. The existing storm drain system was modified to allow for additional flow through the floodwalls, and the pipes were constructed to prevent backflow. A new pump station was also installed upstream as part of the project.

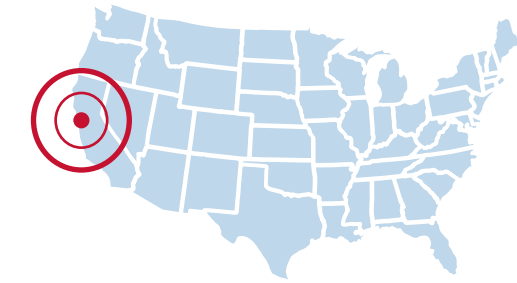
In 2008, FEMA conducted a Loss Avoidance Study, and concluded that \$44,170,317 (in 2008 dollars) in loss of function and emergency management costs were avoided as a result of this project.

Comprehensive Approach Allows Major Losses to be Avoided

The comprehensive approach taken by this project, combining the construction of multiple hard infrastructure interventions and the use of substantial nature-based solutions, allowed significant losses of life and property to be avoided in Petaluma, CA, as a result of flooding impacts.



Northern California Flood Control Mitigation
Source: FEMA. Loss Avoidance Study: Northern California Flood Control Mitigation



Petaluma, CA
FEMA Region 9

Community Lifelines

 Hover over the Primary Lifeline to learn more.



Food, Water, Sheltering



Health & Medical



Transportation

Addressed Hazards



PRIMARY HAZARD
Inland Flooding



Winter Storms

Petaluma Payran Reach Flood Control and Floodways

Details

Project Owner

City of Petaluma, CA

Type of Project

Infrastructure Project



Nature Based Solution: Mitigation Planting for Bank Stabilization

Area of Impact

City of Petaluma, CA (Total Pop: 61,917 in 2018)

\$ Cost

Total Project Cost

\$39.9 million

Funding Sources

Federal Funding

- FEMA HMGP: \$2.9 million
- U.S. Army Corps of Engineers (USACE): \$5 million

Non-Federal Funding

- City of Petaluma, CA: \$32 million

Benefits

Primary

- Significantly reduces the potential for physical damage to river channels and buildings and their contents due to flooding
- Avoids residential displacement/reduced short-term shelter needs
- Reduces potential damage to stormwater and flood infrastructure, including road culverts, due to future flood events

Secondary

- Reduces loss of function to non-residential structures and their associated tenants (businesses and other organizations) due to road closures caused by flood events
- Decreases need for emergency response during flood events
- Offers return on investment of 98% of original mitigation project cost (based on post-project study for losses avoided for single post-mitigation flood event)

Partnerships

- FEMA HMGP
- USACE
- City of Petaluma, CA

Project Timeline

Start Date

HMGP Grant Approved in 1998

Project Completion Date

Project completed in 2004

? Challenges Faced

- This was a high-cost, multi-part project with a long project timeline, which created both funding and coordination challenges for the multiple stakeholders involved

Resources & References

FEMA. 2008. "Loss Avoidance Study: Northern California Flood Control Mitigation." <https://www.fema.gov/case-study/loss-avoidance-study-northern-california-flood-control-mitigation>.



Northern California Flood Control Mitigation

Source: FEMA. Loss Avoidance Study: Northern California Flood Control Mitigation

Resilient Shelby's Greenprint for Resilience



Following a series of severe storms and flooding in 2011, Shelby County, TN applied to the U.S. Department of Housing and Urban Development's (HUD's) Community Development Block Grant-Disaster Recovery (CDBG-DR) funding to improve its resilience. The County was awarded \$60 million for its Greenprint for Resilience Project, which includes three scalable resilience projects along the areas that were hardest hit during the 2011 floods, Big Creek, Wolf River, and South Cypress Creek. These projects are further described below.

- **Big Creek Millington:** This project will build a large floodway between the existing levee and elevated highway to provide a floodplain so floodwaters would bypass the local community. Trees removed for this project will be replaced at a ratio of 4:1. This floodplain will also serve as a recreational area and a sustainable wildlife area with wetlands and natural features. The project will also provide connectivity to greenway trails, walking paths, and ball fields.
- **Wolf River Memphis:** This project features a series of open space and infrastructure upgrades along with wetland reestablishment and preservation to three locations in Memphis. Rodney Baber Park will be raised above the floodplain with added flood storage and recreational facilities. Kennedy Park's wetlands will be expanded and park amenities upgraded. Orchi Road will have a section elevated and will become a Complete Street with bicycle facilities and a new wetland pond.
- **South Cypress Creek Memphis:** This project will "make room for the river" by creating wetlands, stormwater lots, and protective berms; restoring the streams; and buying out vulnerable homes. Vacant lots will be reused to support the community's goals. There will also be new bike lanes and neighborhood trails.

The *Greenprint for Resilience Project* also includes a regional resilience plan to model and plan for flood impacts and other climate risks across the County and tri-state region. The plan was funded through a HUD Sustainable Communities Regional Planning Grant.

Addressed Hazards



PRIMARY HAZARD
Inland Flooding

Three Major Nature-Based Solutions in the FEMA Region IV Memphis Region

All three projects focus on increasing floodwater storage through nature-based solutions, including wetland restoration or establishment and building floodplains and stormwater lots. All will be able to divert floodwaters from neighboring communities in future flood events.

Improved Connectivity and Open Space for Low- to Moderate-Income Communities

All three projects will improve connectivity in the low- to moderate-income communities they serve through greenway trails, walking paths, bicycle facilities, and park upgrades.



2011 flooding in downtown Memphis, TN
Source: Thegreenj / CC BY-SA (<https://creativecommons.org/licenses/by-sa/3.0>)

Community Lifelines



Hover over the Primary Lifeline to learn more.



Food, Water, Sheltering



Transportation

Details

Project Owner

Shelby County Office of Resilience

Type of Project



Nature-Based Solution: Wetland Restoration or Establishment, Building Floodplains and Stormwater Lots

Area of Impact

Greater Memphis metropolitan area population (Total Pop: 1.3 million in 2010)

\$ Cost

Total Project Cost

\$74.7 million



Funding Sources

Federal Funding

HUD CDBG-DR:

- Big Creek – \$25.1 million
- Wolf River – \$7.3 million
- South Cypress – \$8.99 million

HUD Sustainable Communities Regional Planning Grant: \$2.6 million

Non-Federal Funding

State of Tennessee:

- Big Creek – \$6 million

Shelby County:

- Big Creek – \$3 million

City of Memphis:

- Wolf River – \$1.5 million
- South Cypress – \$1.6 million

Benefits

Primary

- Reduces physical damage to buildings and infrastructure from stormwater and flood events
- Reduces loss of service to infrastructure, especially roads and other transportation systems
- Reduces the need to temporarily relocate during flood events (in those areas with at-risk populations)

Secondary

- Offers social benefits of providing the surrounding community with a park for recreation and green space
- Reduces associated loss of service to businesses and other organizations from short-term road closures
- Decreased need for emergency response during flood events

Partnerships

- HUD
- Shelby County
- City of Memphis
- State of Tennessee
- Memphis Metropolitan Planning Organization

Project Timeline

Status

- HUD Funding began being awarded in 2013
- Resilience Plan released December 2019
- Construction on projects has not started

? Challenges Faced

- Extensive public involvement and NEPA processes

Resources & References

Resilient Shelby. 2020. "Overview." Accessed March 16, 2020. <https://resilientshelby.com/overview/>.

Resilient Shelby. 2020. "Resilience Activities." Accessed March 16, 2020. <https://resilientshelby.com/overview/resilience-activities/>.

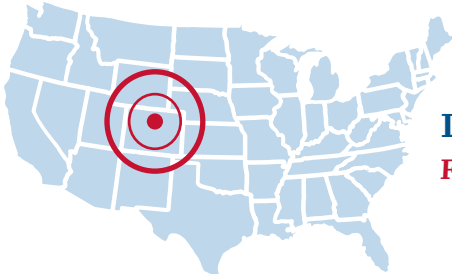
Shelby County Resilience Council. 2019. "Mid-South Regional Resiliency Master Plan." December 2019. https://resilientshelby.com/wp-content/uploads/2020/01/Final_MRRP_Low_Res_Spreads.pdf.

Resilient St. Vrain Nature-Based Flood Protection

In 2013, eight straight days of continual rain damaged hundreds of homes and businesses, blocked streets, and impacted the functioning of critical infrastructure in Longmont, CO. In 2016, the City decided that they needed to switch their focus from recovery and response efforts to more forward-thinking future flood mitigation and resilience planning. Multiple projects resulted from these efforts, but the most notable is the Resilient St. Vrain effort, which aimed to restore the St. Vrain Creek Greenway Trail System, and implement channel improvements to the creek to help mitigate the impacts of future flooding.

The project included physically widening the creek, rebuilding two existing bridges, and replacing a water diversion structure that washed out during the 2013 flooding with nine smaller structures, which created a unique opportunity for recreation for residents and visitors. Called Dickens Farm Nature Area, this section of the creek and the land around it were converted into a nature preserve with kayak launches, shelters, restrooms, and a “nature discovery area” for children. This project not only helped protect life and property, but also created multiple co-benefits for the community, in the form of recreation and environmental benefits.

Award-Winning, Comprehensive Approach to Mitigating Flood Risk
 In 2018, Resilient St. Vrain won the Sustainability Award for a Large Community from the Colorado chapter of the American Public Works Association for its “efficient delivery of infrastructure in an environmentally and socially responsible way,” that achieves multiple co-benefits for the natural environment and surrounding community.



Longmont, CO
FEMA Region 8



Resilient St. Vrain Flood Project
 Source: FEMA

Addressed Hazards



PRIMARY HAZARD
 Inland Flooding



Winter Storms

Community Lifelines

 *Hover over the Primary Lifeline to learn more.*



Food, Water, Sheltering



Health & Medical



Transportation

Resilient St. Vrain Nature-Based Flood Protection

Details

Project Owner

City of Longmont, CO

Type of Project

 Nature-Based Solution: Flood Mitigation Infrastructure

Area of Impact

Potential to benefit entire City of Longmont, CO (Total Pop: 96,577 in 2018)

Cost

Total Project Cost

\$136 million

Funding Sources

Federal Funding

- FEMA HMGP
- Federal Highway Administration (FHWA)
- Community Development Block Grant-Disaster Recovery (CDBG-DR)

Non-Federal Funding

- City of Longmont Storm Drainage Bonds
- Boulder County
- State of CO
- Great Outdoors Colorado (GOCO)

Benefits

Primary

- Reduces physical damage to creek channel, buildings, and infrastructure from stormwater and flood events
- Reduces loss of service to infrastructure, especially roads and other transportation systems
- Reduces the need to temporarily relocate at-risk populations during flood events

Secondary

- Benefits the surrounding community with a green space for recreation and improves water quality
- Reduces associated loss of service to businesses and other organizations from short-term road closures
- Decreases need for emergency response during flood events

Partnerships

- City of Longmont
- Boulder County
- State of Colorado
- FEMA
- U.S. Army Corps of Engineers
- FHWA
- HUD CDBG-DR
- GOCO

Project Timeline

Start Date

Project planning initiated in 2013; construction begun 2016

Status

Future phases of the project remain unfunded, so project end date is unknown

? Challenges Faced

- Future phases of this comprehensive, multi-part project remain unfunded; because the cost to implement the full Resilient St. Vrain plan is so high, attaining enough funding to complete the project has been a significant challenge

Resources & References

Brendza, Will. "From recovery to resilience to recreation." Boulder Weekly, February 22, 2018. <https://www.boulderweekly.com/special-editions/longmont-insider/recovery-resilience-recreation/>.

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Spring Creek Drainage Improvement Project

This project, which included upsizing culverts at various railroad crossings, was initiated in 2012 after a major flood event in 2010 caused extensive damage in Lincoln County, SD. The flood damaged roads, homes, and infrastructure near Spring Creek and Spring Creek Tributary. Hydrological models predict flooding to continue to cause additional damage and erosion in this area in the future. This project was designed to mitigate future flood risk and damage in the most at-risk areas. Several alternatives were considered, but the Environmental Assessment found that upsizing culverts at several railroad crossings in the project area, in conjunction with increasing flow capacity for parts of the existing channel, had the fewest adverse impacts.

A \$1.8 million Hazard Mitigation Grant Program (HMGP) grant from FEMA made this project possible. The project, which altered the floodplain (Letter of Map Revision, effective on August 11, 2017), ultimately removed all homes in the project area from the floodplain.

Addressed Hazards



PRIMARY HAZARD
Inland Flooding

Multi-Hazard Mitigation Activities Reduce Future Flood Risk Without Acquisition

Rather than utilizing traditional acquisition methods to remove homes from the flood plain, Spring Creek developed an engineered solution that reduced flooding vulnerability and protected access to the neighborhoods.



Flooding in southeast South Dakota
Source: Shutterstock



Lincoln County, SD
FEMA Region 8

Community Lifelines



Hover over the Primary Lifeline to learn more.



Transportation

Spring Creek Drainage Improvement Project

Details

Project Owner

Lincoln County

Type of Project

Flood Mitigation Infrastructure

Area of Impact

Six residential subdivisions, covering approximately 320 acres

Cost

Total Project Cost

\$2.4 million

Funding Sources

Federal Funding

FEMA HMGP: \$1.8 million

Non-Federal Funding

Lincoln County: \$683,000

Benefits

Primary

- Reduces physical damage to structures and their contents
- Reduces residential displacement and short-term shelter needs
- Reduces damage to stormwater and flood infrastructure, including road culverts

Secondary

- Reduces loss of function for transportation systems
- Reduces loss of function to non-residential structures and associated businesses or organizations impacted by road closures
- Decreases need for emergency response during flood events

Partnerships

FEMA
Lincoln County

Project Timeline

Start Date

Study/project planning begun in 2012

Project Completion Date

Project completed in 2017

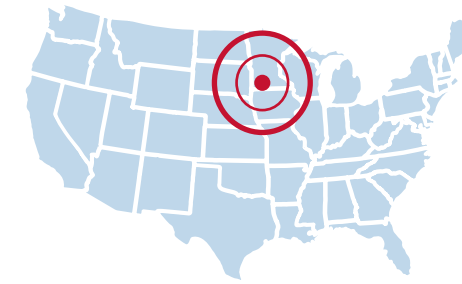
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Worthington County Ditch 12 Flood Mitigation Project



Worthington, MN
FEMA Region 5

The City of Worthington, MN and its surrounding areas have experienced repeated flooding impacts from heavy rains over the past several decades, impacting homes, businesses, and crops. The City itself sits on Okabena Lake, which also floods during prolonged periods of heavy rain. In 2018, Worthington's City Council authorized a \$4.6 million project to create a detention basin west of the Shopko area of the City. The project would also include new, upsized box culverts on several City streets. FEMA provided \$2.5 million in Hazard Mitigation Grant Program (HMGP) funding to help the City plan and implement this project, which should ultimately allow the City to protect hundreds of homes and businesses currently in the flood zone from future flood impacts. The City of Worthington funded the remaining \$2.1 million in project costs from local sources. If the project is implemented as planned, the City should be able to apply for an official Letter of Map Revision from FEMA, which would also substantially reduce flood insurance costs to property owners currently in the flood zone.

Mitigation Solutions To Repetitive Losses

Confronted by decades of flooding impacts, Worthington County developed a series of mitigation solutions that will reduce future flood risk to several hundred homes and businesses currently in the Lake Okabena floodplain. Once complete, these properties will no longer be in the floodplain, thereby reducing the insurance cost burden for the community, yet will maintain the economic tax base that would otherwise be reduced by traditional acquisition and relocation solutions.

Community Lifelines



Hover over the Primary Lifeline to learn more.



City of Worthington, MN, and Okabena Lake in the background
Source: Shutterstock

Addressed Hazards



PRIMARY HAZARD
Inland Flooding



Food, Water, Sheltering

Worthington County Ditch 12 Flood Mitigation Project

Details

Project Owner

City of Worthington, MN

Type of Project

Flood Mitigation Infrastructure

Area of Impact

Worthington population (Total Pop: 13,247 in 2017)

Cost

Total Project Cost

\$4.6 million (estimate)

Funding Sources

Federal Funding

FEMA HMGP: \$2.5 million

Non-Federal Funding

City of Worthington, MN: \$2.1 million

Benefits

Primary

- Reduced physical damage to structures and their contents and associated residential displacement and short-term shelter needs
- Reduced damage to stormwater and flood infrastructure, including road culverts

Secondary

- Reduced loss of function for transportation systems
- Reduced loss of function to non-residential structures and their associated businesses or organizations impacted by road closures
- Decreased need for emergency response during flood events

Partnerships

- FEMA
- City of Worthington, MN

Project Timeline

Start Date

FEMA HMGP funding received in 2017

Status

Project approved by Worthington City Council in April 2018

Resources & References

City of Worthington. 2020. "Engineering Construction Projects." Accessed March 16, 2020. <http://www.ci.worthington.mn.us/biddersinformation>.

Evers-Hillstrom, Karl M. 2018. "Flood mitigation project gets city nod." *The Globe*, April 25, 2018. <https://www.dglobe.com/news/4436317-flood-mitigation-project-gets-city-nod>.

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Steil, Mark and John Enger. 2014. "Across Minnesota, rising waters pose hardships for farmers and residents." *MPR News*, June 17, 2014. <https://www.mprnews.org/story/2014/06/17/minnesota-flooding>.



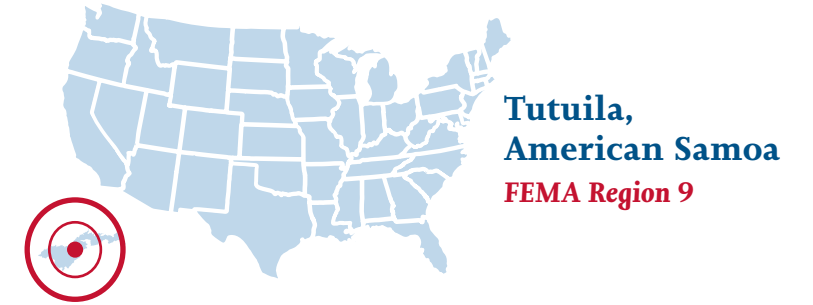
Landslides

American Samoa Rockfall Mitigation Project

In 2015, the American Samoa Department of Public Works received \$3.3 million in FEMA Hazard Mitigation Grant Program (HMGP) funds to implement rockfall mitigation at four locations on Tutuila, where landslides are a persistent problem, particularly along Highway 001, due to steep and rocky slopes. Landslides are a hazard for both pedestrians and vehicles. The project removed loose rocks from the four sites and used wire mesh to stabilize the slopes. Best management practices were used to ensure pedestrian and vehicular safety, and to protect against adverse impacts to the environment, cultural resources, and air and water quality.

Non-Traditional Mitigation Solution to Protect Critical Infrastructure

In American Samoa, landslides are a large threat to the island's transportation network. Throughout the implementation of this project, the Territory utilized best management practices to develop solutions that stabilized the hillsides and ensured pedestrian safety and transportation access while minimizing adverse impacts to the environment, cultural resources, and air and water quality.



Community Lifelines
Hover over the Primary Lifeline to learn more.

Addressed Hazards



PRIMARY HAZARD
Landslides



Earthquakes



Final Environmental Assessment

Rockfall Mitigation Project

FEMA-DR-1859-AS, HMGP 1859-9

Territorial Office of Fiscal Reform
American Samoa Department of Public Works

September 2014



Environmental assessment document for the American Samoa Rockfall Mitigation Project
Source: FEMA



Transportation



Hazardous Material

American Samoa Rockfall Mitigation Project

Details

Project Owner

American Samoa Department of Public Works

Area of Impact

Four sites: Site A (0.50-acre site); Site B (0.45-acre site); Site C (0.60-acre site); Site D (1.32-acre site)

Cost

Total Project Cost

\$3.6 million

Funding Sources

Federal Funding

FEMA HMGP: \$3.3 million

Non-Federal Funding

American Samoa Department of Public Works: \$363,000

Benefits

Primary

- Reduces loss of function of infrastructure systems, such as roads
- Reduces cost for cleanup following rockfall events
- Prevents direct damage to structures in more developed areas
- Provides life-safety benefits associated with reduced injuries and deaths
- Reduces rockfall occurrence and the potential for roadways to be blocked
- Reduces the cost of maintenance

Secondary

- Curtails the necessary cleanup and repair of roadways and vehicles as a result of accidents

Partnerships

- FEMA
- American Samoa Department of Public Works

Project Timeline

Status

Final Environmental Assessment completed in 2014; FEMA funding approved in January 2015

? Challenges Faced

- Phasing the project construction in order to minimize route closures and impacts to residents

Resources & References

FEMA Region IX. 2014. "Final Environmental Assessment for Rockfall Mitigation Project." AECOM. September 2014.

Hartsfield-Jackson International Airport

Hartsfield-Jackson International Airport is the world's busiest airport, accommodating 100 million passengers and more than 950 thousand flights per year. Heavy rainfall was causing severe erosion and slope failure along the fifth runway. If not corrected, the increasing erosion and surficial failures could have grown to create a globally unstable slope. The airport wanted a resilient solution that would stabilize the slope, mitigate erosion, and provide a vegetated outcome that would be easily maintainable.

More than 1,000 square yards of slope needed to be stabilized. However, machines and large equipment could not be used above the slope because of its proximity to an active runway. Transporting and installing traditional armoring solutions such as rock riprap requires large trucks and multiple machines. In contrast, the equipment used to install an Engineered Earth Armoring Solutions (EEAS) is compact and minimal. An EEAS consisting of High Performance Turf Reinforcement Mat (HPTRM) and Engineered Earth Anchors (EEA) was selected to provide surficial stability against a four foot failure.

In addition to being easily transported to areas with access challenges, the components of the EEAS work together to lock soil in place and protect against hydraulic stresses for up to 75 years. It is engineered to promote rapid root development for long-term vegetation, which is another reason it was selected for this project. In addition to providing aesthetic improvements, the vegetation helps improve groundwater quality and has a significantly smaller carbon footprint than traditional armoring solutions.

Installation of the EEAS significantly increased the Factor of Safety (FoS) from 1.0 to more than 1.3. The slope quickly vegetated, and the resilient HPTRM component of the system has withstood routine mowing and maintenance for more than four years. Today, the runway remains stabilized and has had no further issues with erosion.

Heavy rainfall was causing severe erosion and slope failure along the fifth runway. If not corrected, the increasing erosion and surficial failures could have grown to create a globally unstable slope.

Installation of the EEAS significantly increased the Factor of Safety (FoS) from 1.0 to more than 1.3. The system effectively mitigated erosion and will provide resilient slope stability for up to 75 years.



An Engineered Earth Armoring System was used to stabilize the slope and promote vegetation.
Source: Propex Geosolutions



Atlanta, GA

FEMA Region 4

Community Lifelines



Hover over the Primary Lifeline to learn more.



Safety & Security

Addressed Hazards



PRIMARY HAZARD
Landslides



Inland Flooding

Details

Project Owner

Hartsfield-Jackson International Airport

Type of Project

Infrastructure

 Nature-Based Solution

Area of Impact

Fifth runway



Heavy rainfall was causing severe erosion and slope failure along the fifth runway.

Source: Propex Geosolutions

Cost

Total Project Cost

\$110,000

Benefits

Primary

- Provide permanent erosion mitigation and slope stabilization for up to 75 years
- Increased Factor of Safety
- EEAS components are easily transported to locations with limited access and installed with minimal equipment

Secondary

- Provided a vegetated solution that is aesthetically pleasing
- A significantly smaller number of trucks and machines are need to deliver and install an EEAS compared to rock riprap, which reduces the volume of construction traffic and emissions
- The EEAS is an environmentally-friendly solution that's carbon footprint is more than 30 times smaller than rock riprap

Partnerships

- C.W. Matthews Contracting Co., Inc.
- Propex GeoSolutions

Project Timeline

Start Date

September 2016

Status

Complete

Completion Date

September 2016

? Challenges Faced

- Machines and large equipment could not be used above the slope because of its proximity to an active runway

Washington DOT Landslide Mitigation Action Plan and Rail Corridor Improvements

The Washington State Department of Transportation (DOT) 2014 Landslide Mitigation Action Plan was implemented to address landslides along the Pacific Northwest Rail Corridor. In the past, these landslides have interrupted rail service, created issues with traffic congestion, and threatened the safety of passengers and railway employees. This plan lays out mitigation strategies designed to reduce the occurrence and impact of landslides along this route.

In 2016, BNSF Railway and Washington State DOT completed six federally funded projects at several locations near Mukilteo and Everett, WA, to stabilize slopes and add catchment walls, reduce landslide occurrence, and protect the railway tracks. This work included constructing catchment walls to “catch” landslide debris before it hits the tracks, slide detection fences to give early warning of active landslides, improved drainage systems, and erosion control measures. Since the projects were completed in 2016, no landslides have reached the tracks in those locations.

Addressed Hazards



PRIMARY HAZARD
Landslides



Inland Flooding

Mitigation Plan Implementation Protects Critical Community Lifelines

Recognizing that passenger rail service is disrupted for a minimum of 48 hours each time a landslide covers the tracks near the coastal bluffs, the State of Washington developed a mitigation plan that identified rail segments particularly at risk and mitigation measures that would help alleviate the costs and interruption of service. Following the adoption of this plan, the state immediately began implementation of it, completing six landslide mitigation projects in less than two years, securing the rail corridor from future disruptions and damage.



Landslide Mitigation retention wall: The finished metal and concrete landslide retention wall helps keep debris from covering the tracks.

Source: Washington State Dept of Transportation, <https://www.flickr.com/photos/wsdot/19725323513>



State of
Washington
FEMA Region 10

Community Lifelines



Hover over the Primary Lifeline to learn more.



Safety & Security



Hazardous Material

Details

Project Owner

BNSF Railway and Washington DOT

Type of Project

Corridor Improvements and Landslide Mitigation Plan

Area of Impact

Pacific Northwest rail corridor segment in Washington State

Cost

Total Project Cost

\$17.75 million

Funding Sources

Federal Funding

American Recovery and Reinvestment Act Grant Program:
\$17.75 million

Benefits

Primary

- Reduced loss of function of the rail system
- Reduced cost for cleanup following landslide events
- Reduced maintenance costs associated with landslide occurrence and blocked road
- Reduced loss of function will also directly benefit railroad customers

Secondary

- Life-safety benefits associated with a reduction in injuries/deaths to railroad workers and customers in the unlikely, but not improbable, event of a landslide that directly strikes a train or vehicle or the occurrence of an undetected landslide that may cause accidents and/or derailments
- Avoided costs associated with cleanup, rail equipment repair, and potential environmental impacts

Partnerships

- BNSF Railway
- Sound Transit
- Amtrak
- Federal Railroad Administration
- Several municipal and state agencies

Project Timeline

Start Date

Process begun 2012-2013 winter season
Plan adopted 2014

Project Completion Date

Projects completed in 2016

? Challenges Faced

- Coordinating rail closure/track changes during construction
- Multiple partnerships between track owners, service operators, and those who maintain equipment

Resources & References

Washington Department of Transportation. 2014. "Landslide Mitigation Action Plan." 2014.

Washington Department of Transportation. 2020. "Rail Projects." Accessed March 16, 2020. <https://www.wsdot.wa.gov/rail/projects>.



 **Tornadoes**

Mercy Hospital Rebuild

The May 2011 tornado in Joplin, MO, killed 161 people, left approximately 1,371 injured, and destroyed thousands of homes, businesses, and other buildings, including St. John's Regional Medical Center (now called Mercy Joplin), where six people were killed. Although the hospital's outer structure remained relatively intact, the windows shattered during the storm, destroying the building's interior. The hospital's electrical equipment also sustained heavy damage, because it was housed outside the building.

Work on the replacement hospital began in 2012 and was completed in 2015. The new hospital includes two underground levels and eight above-ground levels. One of the key features of the new hospital is windows that are designed to resist 250 mile-per-hour winds. These windows were installed in critical care areas, such as intensive care and neonatal intensive care. Architects also designed the new facility to rely on a stand-alone, hardened central utility plant, which houses two generators that can each independently power the entire hospital. Architects and engineers also included a reinforced building core, with interior stairwells equipped with emergency lighting, multiple elevator banks (which helps reduce the risk of all elevators being disabled during a disaster), and redundant power and water feeds.

In addition to building a new, tornado/high-wind-resistant structure, the hospital also changed some of its day-to-day operations to improve disaster-readiness, including storing supplies on each floor instead of in the basement, so that staff do not have to travel far to get the supplies they might need in an emergency.

Addressed Hazards



PRIMARY HAZARD
Tornadoes

Multi-Lifeline Mitigation Provides Community with a Safe Space

Reconstruction of this major community hospital incorporated significant mitigation solutions designed to reduce risk from future tornadoes, and ensure that the community has a safe haven in case of future events. This project represents a "complete solution" for mitigation; improvements included wind-resistant glass in critical areas, hardened and enhanced power generation systems, and protected water transmission lines. Additionally, operational improvements were incorporated to improve the emergency readiness of the hospital and its staff.



St. John's Regional Medical Center immediately after the 2011 tornado
Source: FEMA P-908, Tornado Outbreak of 2011, Materials Assessment Team Report



Joplin, MO
FEMA Region 7

Community Lifelines



Hover over the Primary Lifeline to learn more.



Safety & Security



Food, Water, Sheltering

Mercy Hospital Rebuild

Details

Project Owner

Mercy Hospital Joplin

Type of Project

Structural

Area of Impact

Entire hospital; has the potential to impact entire Joplin community (Total Pop: 52,288 in 2017)

Cost

Total Project Cost

\$465 million

Funding Sources

Non-Federal Funding

Mercy Hospital Joplin

Benefits

Primary

- Reduces physical damage to the hospital as well as injuries and deaths to hospital occupants (life-safety benefits)

Secondary

- Offers the social benefits of providing a safe place for refuge during a tornado and dual usage of the structure as a safe room and a hospital

Project Timeline

Start Date

Rebuild begun in 2012

Project Completion Date

New hospital completed in 2015

? Challenges Faced

- Tight timeline
- Regular and consistent communication between hospital officials and design team
- Costly hazard-resistant upgrades

Resources & References

DiPietro, Ben. 2017. "Tornado-Ravaged Hospital Took Storm-Smart Approach During Rebuild." *The Wall Street Journal*, August 30, 2017. <https://blogs.wsj.com/riskandcompliance/2017/08/30/tornado-ravaged-hospital-took-storm-smart-approach-during-rebuild/>.

Fentem, Sarah. 2018. "7 years after Joplin tornado, Mercy builds hospitals with disaster in mind." *KCUR 89.3*, June 21, 2018. <https://www.kcur.org/post/7-years-after-joplin-tornado-mercy-builds-hospitals-disaster-mind#stream/0>.

McCarthy. 2015. "Promise of New Mercy Hospital Joplin is Delivered as Hospital Opens in Record Time." March 6, 2015. <https://www.businesswire.com/news/home/20150306005656/en/Promise-of-New-Mercy-Hospital-Joplin-is-Delivered-as-Hospital-Opens-in-Record-Time>.

United States Global Change Research Program. 2019. "Wind-Resistant Construction Key to Rebuilding for Resilience." U.S. Climate Resilience Toolkit. Last modified October 24, 2019. Accessed March 16, 2020. <https://toolkit.climate.gov/case-studies/wind-resistant-construction-key-rebuilding-resilience>.



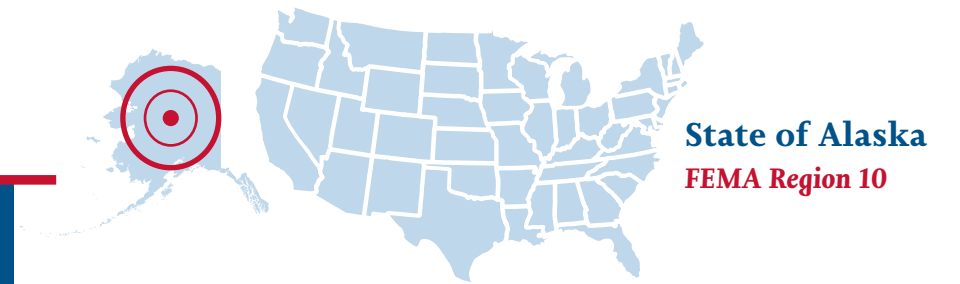
Rebuilt Mercy Hospital as it looks today

Source: U.S. Climate Resilience Toolkit
<https://toolkit.climate.gov/case-studies/wind-resistant-construction-key-rebuilding-resilience>



Tsunamis

Alaska DHS and EM Tsunami Education, Mapping, and Siren Check



With fiscal year 2019 funding from National Oceanic and Atmospheric Administration's (NOAA's) National Weather Service (NWS) Tsunami Activities Financial Assistance, the Alaska Department of Homeland Security and Emergency Management (DHS & EM) conducted community outreach with tsunami education materials, conducted workshops with community leaders and emergency managers, and checked tsunami sirens across the state. The DHS & EM has extensive online resources to help the public with tsunami preparedness, including evacuation maps by community with tsunami potential and siren information, educational materials for schools and educators, as well as extensive materials for individuals (i.e., "Tips for the Elderly").

The University of Alaska Fairbanks (UAF), was the subgrantee of this grant, meaning they received a portion of these funds to work with the Alaska DHS & EM. They conducted high-resolution mapping, modeled tsunami currents, and published technical reports. The UAF's Alaska Earthquake Center has been working in partnership with the DHS & EM and the Alaska Division of Geological and Geophysical Surveys to map tsunami inundation zones along the Alaskan coast since 1998. These maps are now accessible through the new Alaska Tsunami Hazard Map Tool. This tool should help communities understand their risk and better prepare for disasters.

Addressed Hazards



Non-Traditional Mitigation Activities Enhance Community Safety

Utilizing funding from NOAA, the State of Alaska was able to conduct extensive tsunami education and has also significantly upgraded its Tsunami Educational Portal and Hazard Maps. The digital enhancements provide greater access to the information for rural communities, greatly enhancing the state's educational outreach.



Signs like this can be used to make people aware of the risk of tsunamis in their area.

Source: NOAA Flickr Image ID: wea04399, NOAA's National Weather Service (NWS) Collection
Photographer: Dr. John Cloud, Historian, NOAA Central Library

Community Lifelines
Hover over the Primary Lifeline to learn more.



Food, Water, Sheltering



Health & Medical

Details

Project Owner

Alaska Department of Homeland Security and Emergency Management

Type of Project

Information Campaign

Area of Impact

Alaskan population (Total Pop: 737,438 in 2017)

Cost

Total Project Cost

The cost of developing new plans, codes, or ordinances include community staff time and any outside consultants to provide technical support and associated analysis. Changes will typically include economic analyses looking at construction components, practices, and short- and long-term maintenance costs.

Funding Sources

Federal Funding

NOAA/NWS Tsunami Activities Financial Assistance Program (FY19 budget of \$5.36 million)

Benefits

Primary

- Reduces injuries/deaths (life-safety benefits)
- Provides education on what to do during an event to prevent/reduce the possibility of injuries/deaths

Secondary

- Incentivizes community coordination activities, allowing communities to work together on safety measures
- Provides warning system that could potentially be used for other types of risks as well

Partnerships

- UAF

Project Timeline

Status

FY19 NOAA/NWS Tsunami Financial Assistance for the performance period from September 1, 2019, through August 31, 2020

Challenges Faced

- High percentage of rural difficult to reach communities along Alaskan coastline

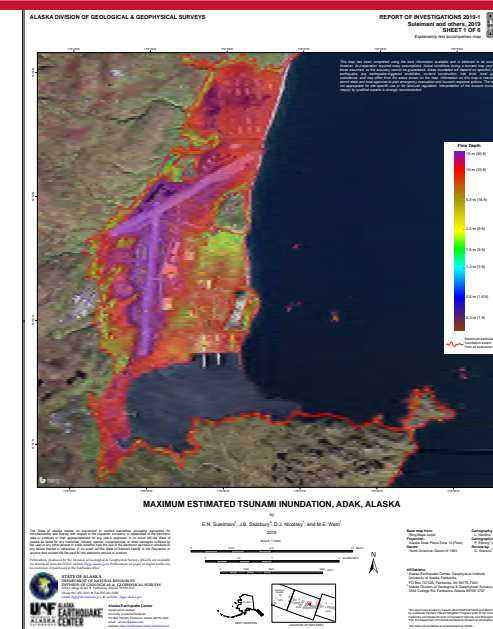
Resources & References

Alaska Division of Homeland Security and Emergency Management. 2020. "Earthquake and Tsunami Preparedness." Accessed March 16, 2020. <https://ready.alaska.gov/Preparedness/Outreach/Eqprep>.

Freudenberger, Fritz. 2019. "New tsunami map tool empowers Alaskans to plan for the worst." **University of Alaska Fairbanks**, September 17, 2019. <https://news.uaf.edu/new-tsunami-map-tool-empowers-alaskans-to-plan-for-the-worst/>.

National Tsunami Hazard Mitigation Program. 2019. "NOAA/NWS Tsunami Activities Financial Assistance." Last modified October 8, 2019. Accessed March 16, 2020. <https://nws.weather.gov/nthmp/grants/2019grants/index.html>.

Suleimani, E.N., Salisbury, J.B., Nicolsky, D.J., and West, M.E., 2019, Tsunami inundation maps for Adak and Atka, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2019-1, 63 p., 6 sheets. <http://doi.org/10.14509/30186>



Tsunami inundation maps for Adak and Atka, Alaska

Source: <http://doi.org/10.14509/30186>

Shoalwater Bay Tribe Tsunami Evacuation Structure

The Shoalwater Bay Tribe is in the process of constructing a tower designed to serve as a tsunami evacuation structure. The 50-foot-high structure will be designed to hold 486 people in the event of a tsunami. The Shoalwater Bay Tribe has 70 official members with a total reservation population of 120, which leaves room for tribal neighbors in the tower. The tribe envisions equipping the tower with solar panels in order to communicate during a long-term event and stocking the tower with emergency supplies. The tribe has received a \$2.2 million Pre-Disaster Mitigation (PDM) grant from FEMA and is contributing \$1 million of its own funds. This will be the second vertical evacuation structure built on the Washington coast.

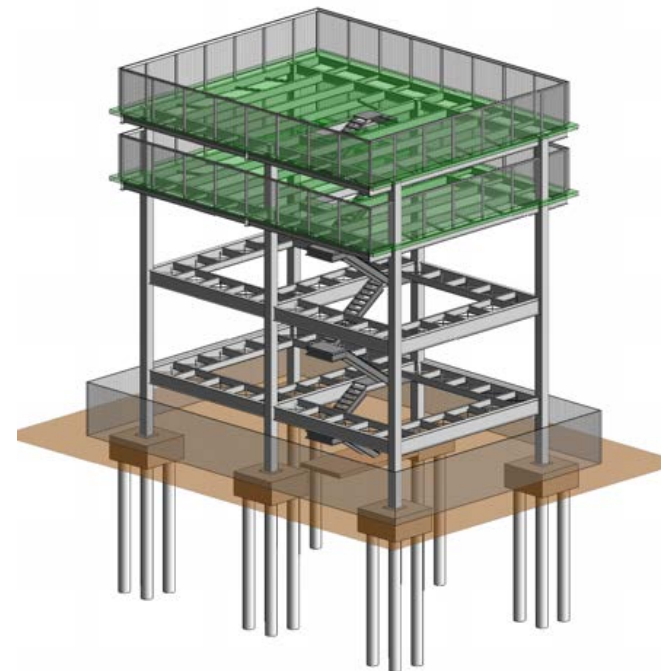
Addressed Hazards



PRIMARY HAZARD
Tsunamis

Tribal-Led Regional Protection

This tsunami mitigation project, currently under construction, demonstrates how a tribe developed a mitigation solution for its population that also provides protection for the wider community. When complete, this tower will be able to serve four times the reservation's population in the event of a tsunami or other major flood.



The Shoalwater Bay tsunami evacuation tower would stand at least 50 feet tall and is designed to hold 486 people.

Source: FEMA News Photo



Tokeland, WA
FEMA Region 10

Community Lifelines



Hover over the Primary Lifeline to learn more.



Safety & Security

Shoalwater Bay Tribe Tsunami Evacuation Structure

Details

Project Owner

Shoalwater Bay Tribe

Type of Project

Safe Shelter/Structure

Area of Impact

Shoalwater Bay Tribe (Total Pop: 120) and neighboring communities

Cost

Total Project Cost

\$3.2 million

Funding Sources

Federal Funding

FEMA's PDM Program: \$2.2 million

Non-Federal Funding

Shoalwater Bay Tribe: \$1 million

Benefits

Primary

- Reduces injuries/deaths (life-safety benefits)

Secondary

- Offers social benefits of providing a safe place of refuge during a Tsunami event, and the potential for dual usage of the structure for emergency services or even recreation

Partnerships

- University of Washington
- Hart Crowser
- Degenkolb Engineers

Project Timeline

Start Date

Received funding in 2018

Status

Construction began in May 2021

Project Completion Date

Construction was completed in 2022

? Challenges Faced

- Zoning concerns about the tower's height exception leading to people building very tall houses
- Potential for seismic impacts to structure and need for additional soil studies

Resources & References

Washington Military Department. 2022. "Celebrating nation's first tsunami vertical evacuation tower." Accessed August 8, 2023. <https://mil.wa.gov/news/celebrating-nations-first-tsunami-vertical-evacuation-tower>.

FEMA. 2021. "Shoalwater Bay Tribe Builds Evacuation Tower to Provide Tsunami Safety for Community" Accessed March 29, 2022. <https://www.fema.gov/blog/shoalwater-bay-tribe-builds-evacuation-tower-provide-tsunami-safety-community#:~:text=The%20tribe%20decided%20they%20needed,earthquake%20shaking%20and%20tsunami%20waves>.

"Lots of hands involved in the Tokeland tsunami tower project." 2019. *The Daily World*. September 18, 2019. <https://www.thedailyworld.com/news/lots-of-hands-involved-in-the-tokeland-tsunami-tower-project/>.

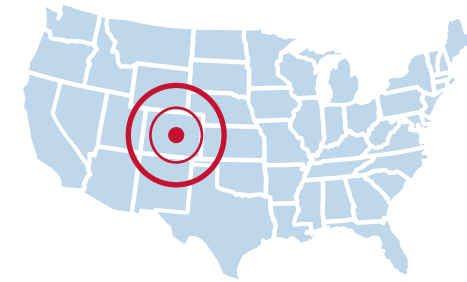
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Wildfires

Cedar Heights Hazardous Fuels Reduction



Colorado Springs, CO
FEMA Region 8

The 2012 Waldo Canyon Fire cost two lives and burned 350 homes in Colorado Springs. One neighborhood within the fire's path emerged unscathed. The Cedar Heights neighborhood had engaged in several mitigation projects before the fire. The Colorado Springs Fire Department had worked closely with residents through their Fire Wise education program. The Fire Wise program emphasized the high-risk of wildfire in neighborhoods that are in the Wildland Urban Interface (WUI). Mitigation strategies are shared, such as creating defensible space around your home by removing flammable materials and vegetation. In addition to public education, the fire department worked with its partners on reducing available fuel for wildfire in nearby natural spaces.

Hazardous fuel reduction involves the removal of highly flammable vegetation, such as dried or dead vegetation, from wildfire prone areas. The Colorado Springs Fire Department worked with its partners to remove vegetation from several areas, including nearby Solitude Park. Fuel reduction efforts focused on removing significant fuel sources, such as dead standing trees and underbrush. This fuels reduction effort is credited with protecting all 250 homes within Cedar Heights during the Waldo Canyon Fire.

The Colorado Springs Fire Department continues to build on the lessons learned from the Waldo Canyon Fire. The Department continues to educate residents on their wildfire risk, the value of defensible space and hazardous fuels reduction, and the need for further mitigation.

Local wildfire mitigation efforts in Colorado Springs spared the Cedar Heights neighborhood during the Waldo Canyon Fire in 2012. 250 homes were spared from the fire because of efforts to remove hazardous fuels in nearby public parkland. The project cost of \$1.34 million helped this community avoid losses greater than \$75 million.

Colorado Springs Fire Department started a proactive public education campaign on wildfire risk and mitigation. These efforts sparked multiple mitigation projects, including defensible space around properties and removal of hazardous fuels on public lands.



This photo shows where the fire bumped into the area treated during the mitigation project

Source: FEMA

Community Lifelines



Hover over the Primary Lifeline to learn more.



Safety & Security

Addressed Hazards



PRIMARY HAZARD
Wildfires

Cedar Heights Hazardous Fuels Reduction

Details

Project Owner

Colorado Springs Fire Department

Type of Project

Hazardous Fuels Reduction

Area of Impact

Cedar Heights neighborhood, Colorado Springs (approximately 250 homes)

Cost

Total Project Cost

\$1.33 million

Funding Sources

Federal Funding

FEMA PDM: \$1 million

Non-Federal Funding

Local Share: \$333,549

Benefits

Primary

- Reduced the available fuel for wildfire and halted the spread
- Provided a fire break between the neighborhood and the Wildland Urban Interface
- Created a safe area for firefighters to stage wildfire fighting activities

Secondary

- Reduced the demand for emergency response efforts in this neighborhood
- Allowed residents to return to their homes after the fire, reducing the need for emergency sheltering
- Preventing wildfire damage also reduced the risk of post-fire flooding and soil destabilization

Partnerships

- City of Colorado Springs
- Colorado Springs Fire Department
- City of Colorado Springs Parks, Recreation and Cultural Services Department
- Local residents and homeowners associations

Project Timeline

Start Date

2007 - Project awarded by FEMA Pre Disaster Mitigation

Status

Completed

Completion Date

2010 - All mitigation work completed

? Challenges Faced

- The project organizers, including the late Christina Randall, former Colorado Springs Wildfire Mitigation Program Administrator, had to build public awareness and support for wildfire mitigation. With more than 24% of the city's population and over 36,000 properties in the Wildland Urban Interface, the City of Colorado Springs had a significant task to raise awareness of wildfire risk and the importance of mitigation. Without this support, this project would not have been successful.

Resources & References

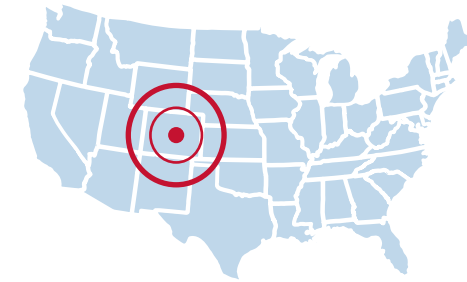
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Colorado Springs Wildfire Mitigation



Colorado Springs, CO
FEMA Region 8

FEMA released a Story Map on Colorado Springs' Wildfire Mitigation in the wake of the 2012 Waldo Canyon Fire. This Story Map provides an interactive summary of the wildfire mitigation activities in Colorado Springs, CO. Prior to the 2012 fire, Colorado Springs used Pre-Disaster Mitigation grants to implement a wildfire mitigation plan, saving an estimated \$75 million and 250 homes. However, even with these efforts, 346 homes were destroyed by the Waldo Canyon Fire. Since then, the community has taken more actionable steps to mitigate against future damage by adopting a stronger fire-resistive building code, mapping wildfire risk, and participating in strategic community engagement.

Wildfire Mitigation Through Education, Planning, and Stronger Building Codes

This innovative educational program, spurred by the adoption of enhanced building code ordinances, has resulted in web-mapping upgrades and the development of outreach and informational campaigns. These non-structural mitigation activities have been credited with saving the community over \$75 million in damage and over 250 families from losing their homes in the 2012 Waldo Canyon Fire.

The City of Colorado Springs Fire Department collaborated with the Colorado Springs Housing and Building Association to identify ways to mitigate the impacts of wildfires on residential buildings. This information led to Ordinance No. 18-50, which amended the International Fire Code to address wildland/urban interface mitigation requirements for high-risk areas. The Story Map covers codes and guidelines for design, construction, and structural elements, including roofing, exterior siding, overhangs and projections, doors and windows, and decks.

Colorado Springs put collaboration at the heart of all wildfire mitigation activities by partnering internally, as well as with residents and business owners. Colorado Springs developed a Wildfire Risk webmap to help residents understand and mitigate their own individual risk. This webmap supports the idea of "sharing the responsibility" that the City keeps central to its work.

Community Lifelines
Hover over the Primary Lifeline to learn more.



19 days duration of burn 18,000+ acres incinerated 345 homes destroyed 2 fatalities



Following the disaster, Colorado Springs Fire Department used Hazard Mitigation Assistance funding to create a Wildfire Mitigation Program and team. They worked to reduce wildfire risk and increase community resilience by providing wildfire mitigation and education. The program continues to expand services and capabilities and also led a process to adopt higher fire-resistant building codes.



Wildfire mitigation flyer
Source: FEMA



Food, Water, Sheltering



Health & Medical

Addressed Hazards



PRIMARY HAZARD
Wildfires

Colorado Springs Wildfire Mitigation

Details

Project Owner

City of Colorado Springs, CO

Type of Project

Informational Campaign
Building Codes

Area of Impact

Colorado Springs population (Total Pop: 464,474 in 2017)

Cost

Total Project Cost

\$1.33 million

Funding Sources

Federal Funding

FEMA PDM: \$1 million

Non-Federal Funding

Local Share: \$330,000

Benefits

Primary

- Reduced physical damage to structures and their contents
- Reduced damage for other types of assets associated with protected infrastructure
- For areas with potential rapid wildfire risk, life-safety benefits, including a reduction in potential injuries/deaths

Secondary

- Retained timber values and reduced fire suppression costs
- As more structures are built with more fire-resistant materials in the area, decreased costs for materials and installation

Partnerships

- City of Colorado Springs Fire Department
- Colorado Springs Housing and Building Association
- FEMA

Project Timeline

Start Date

Ordinance enacted in 2012

? Challenges Faced

- Despite mitigation actions undertaken by the City of Colorado Springs, the Waldo Canyon Fire still caused significant damage in the area

Resources & References

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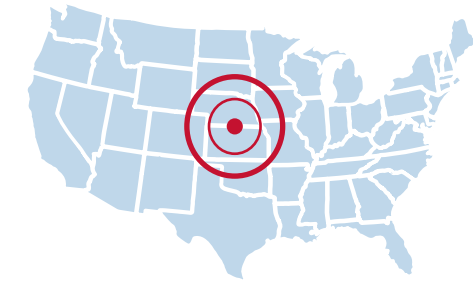
 **Winter Storms**

Nebraska and Kansas Electrical System Ice and Wind Storm Mitigation Projects

The Southwest Public Power District (SWPPD) and the City of Kiowa, KS completed two mitigation projects in the States of Nebraska and Kansas to address the impacts of winter storms/ice on electrical infrastructure. The improvements made in Nebraska included strengthening/replacing single poles and installing stronger conductors on an 11-mile stretch of 69-kilovolt lines along U.S. Highway 61. In Kansas, the City of Kiowa upgraded 15 blocks of power distribution infrastructure that supply power to approximately 1,200 customers. They replaced open conductors with insulated cables and installed lightning arrestors at connection points. In 2008, FEMA completed a study to assess the effectiveness of these projects and found that the infrastructure upgrades helped the states avoid significant losses from physical damage and loss of system function.

Regional Partnership Protects Power Transmission

This multi-jurisdictional approach to mitigation allowed Nebraska and Kansas to cooperatively protect critical energy transmission facilities to ensure uninterrupted power flow during heavy winter storms.



State of Nebraska & Kansas
FEMA Region 7

Community Lifelines



Hover over the Primary Lifeline to learn more.



Safety & Security

Addressed Hazards



PRIMARY HAZARD
Winter Storms



Tornadoes



Ice covers electrical sources

Source: Shutterstock

Nebraska and Kansas Electrical System Ice and Wind Storm Mitigation Projects

Details

Project Owner

SWPPD and City of Kiowa, KS

Type of Project

Infrastructure Improvements

Area of Impact

11-mile stretch of Hwy 61 in Nebraska; 15 blocks within the City of Kiowa, KS

Cost

Total Project Cost

\$1.5 million

Funding Sources

Federal Funding

- NE project: \$482,723 in 2002 dollars or \$556,358 in 2007 dollars
- KS project: \$345,768 in 2006 dollars or \$355,616 in 2007 dollars
- FEMA HMGP

Benefits

Primary

- Avoided physical damage to electric system components including poles, power lines, and transformers
- Reduced loss of service to electric utility customers

Secondary

- Reduced loss of service for potable water and wastewater, since many rural customers rely on wells and septic systems
- Reduced loss of service for business customers
- Life-safety benefits for reduced injury and deaths from cold temperatures during these winter events

Partnerships

- Southwest Public Power District (SWPPD)
- City of Kiowa, KS

Project Timeline

Start Date

Projects begun 2006

Project Completion Date

- Completed in 2007
- Study completed by FEMA in 2008

? Challenges Faced

- Challenges with data for cost avoidance studies, including determining the severity of an event without direct measurements from the field (i.e., ice radius, maximum wind speeds)

Resources & References

FEMA. 2008. "Electrical Transmission and Distribution Mitigation: Loss Avoidance Study." URS Group, Inc. April 2008. https://www.fema.gov/sites/default/files/documents/fema_electrical-transmission-loss-avoidance-study.pdf.



Serious storm damage on a high voltage power line after a strong storm

Source: Shutterstock

Hazard Map References

This table refers to the Hazard Map on page 7.

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Hazard Mitigation Assistance

Mitigation Action Portfolio



FEMA