What is Natural Infrastructure?

"Natural infrastructure" consists of natural or nature-based systems that provide essential services and benefits to society, such as flood protection, water purification, and carbon storage. Such systems can be natural ecosystems, like forests, floodplains, beaches, and grasslands, or they can incorporate engineered features that use natural materials and are designed to mimic the functioning of natural ecosystems. A natural infrastructure project centers around the conservation, restoration, or emulation of an existing local natural ecosystem—the ecosystem is the infrastructure.

Conventional thinking confines the benefit of natural areas to conservation or recreational purposes. This thinking fails to capture the protective role of nature, where healthy ecosystems provide critical protection against inland and coastal flooding in vulnerable regions such as the Greater Houston Area and the Texas Gulf Coast.

Natural infrastructure projects provide the following key benefits:

Effectiveness: A large and growing body of evidence indicates natural infrastructure is equally or more effective at flood mitigation and protection from storm surge than conventional approaches.

Affordability: The positive benefit-cost ratio of natural infrastructure projects is well-documented with many projects paying for themselves multiple times over in their lifespan.

Co-benefits: Natural infrastructure offers numerous additional benefits to society, from provision of food and clean water for people and habitat for fish and wildlife, to recreational opportunities, cultural fulfillment, and overall improved health for nearby residents.

Accrued Benefits: Natural infrastructure projects can be deployed quickly to protect communities and provide additional co-benefits. These features strengthen over time in ways that conventional infrastructure projects simply do not.

Longevity: The lifespan of natural infrastructure projects is generally much longer than engineered solutions; in addition, they are more adaptable to climate change and other environmental stressors—making them more durable and cost-effective than their gray infrastructure counterparts.

Framing is key to properly valuing natural infrastructure. Starting flood mitigation planning or a particular project with the conservation, preservation, and enhancement of already existing ecosystems is essential. Adding natural features, such as trees or lakes, to projects that primarily rely on conventional approaches such as dikes, levees, or stormwater sewers, does not transform the project into natural infrastructure.

Natural Infrastructure is an Umbrella Term

While the concept of 'ecosystem as infrastructure' is gaining increasing traction, the diversity of typology and terminology has often led to vague definitions, particularly at the policy level, which may make it challenging to apply such approaches in on-the-ground management. Among the various terms and usages are:

Natural systems: intact or restored ecosystems, such as wetlands, forests, and coral reefs.

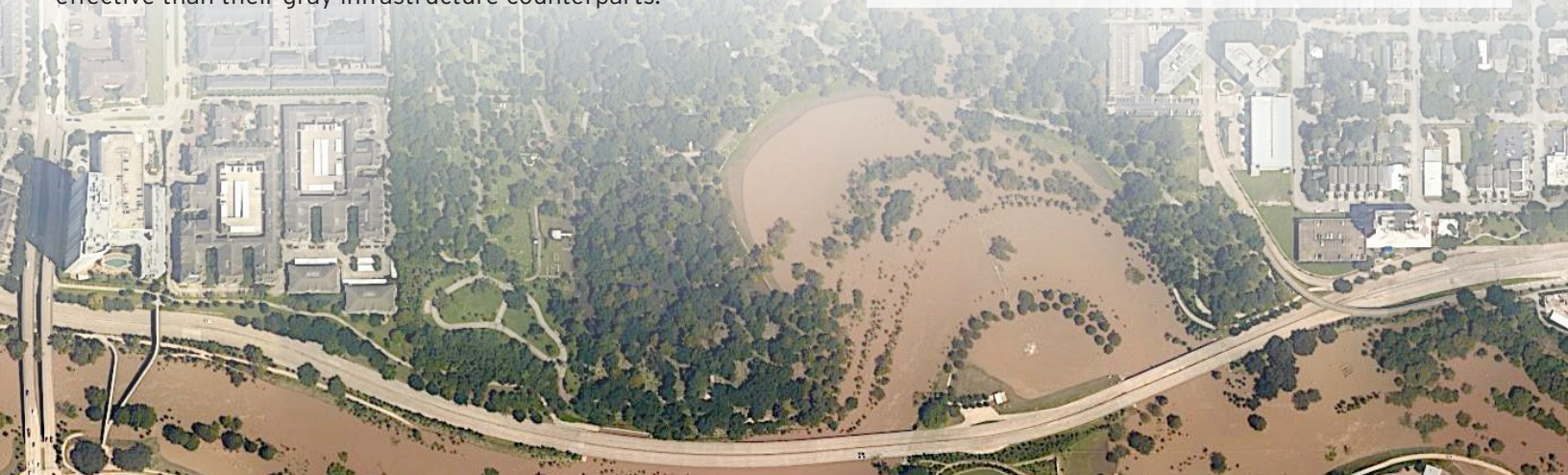
Nature-based: approaches that mimic natural systems but are designed and constructed by people.

Ecosystem services: the multiple benefits that people obtain from ecosystems, including but not limited to provisioning services, such as food and water; regulating services, such as flood risk reduction; cultural services, such as wetland recreation and historical symbolism; and supporting services, such as oxygen production and carbon sequestration.

Green infrastructure: an initially broad term now narrowly focused on stormwater management, including use of plant or soil systems, permeable surfaces, and other approaches to reduce flows to sewer systems or other surface waters.

Non-structural: approaches to hazard risk reduction that do not rely on construction of artificial structures. Examples include buyouts, regulations, zoning, and legal protections. When managed for conservation, these programs can lead to natural infrastructure.

Image: Buffalo Bayou effectively capturing flood waters in downtown Houston after Hurricane Harvey. (National Oceanic & Atmospheric Administration)



Existing Natural Infrastructure Projects in Greater Houston

EXPLORATION GREEN

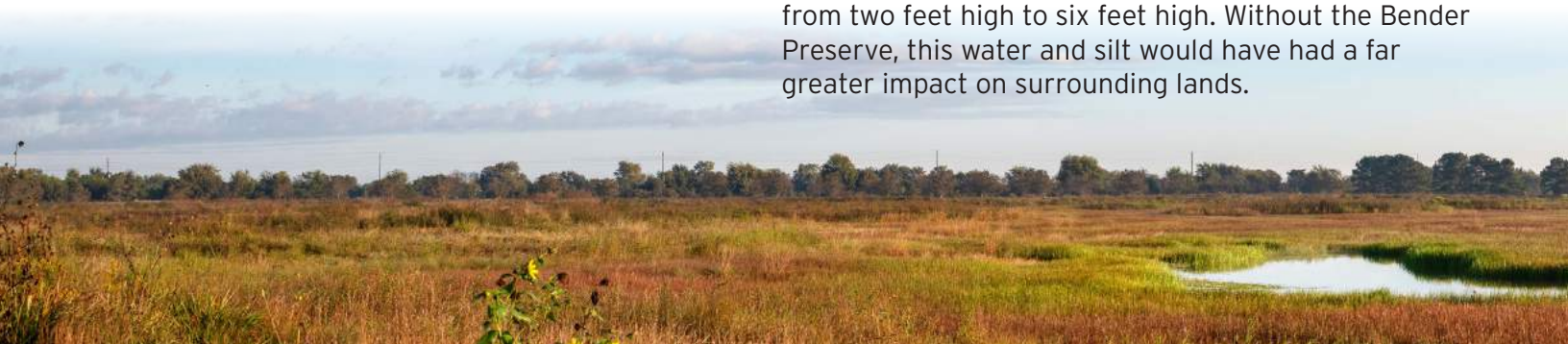
Exploration Green is a former golf course converted into a permanently protected 200-acre urban wetland and natural habitat. It is designed to detain floodwaters and clean the runoff from 95% of the storms that occur in the community. The project's first phase, when just 80% complete, acted as a sponge during Hurricane Harvey, detaining over 100 million gallons of stormwater and protecting residents and their homes from potentially deadly flooding. Once complete it will have a storage capacity of more than 547 million gallons.

THE WOODLANDS

The Woodlands is a 44 sq. mile master-planned community widely lauded as an early pioneer of "designing with nature." Its incorporation of features such as drainage swales, natural bank ponds, forested wetlands, and preserved habitat allows for numerous benefits including: reduced stormwater runoff during 100-year storms, lower nutrient loadings, reduced forest fragmentation, lower land surface temperature, higher walkability, and pedestrian access to open space.

BENDER PRESERVE

Bender Preserve is a 44-acre preserve adjacent to the confluence of Spring Creek and the West Fork San Jacinto River. This forested riparian area, preserved by the Bayou Land Conservancy, is completely within the floodway and contains old oxbows of Spring Creek connected by cypress sloughs. Its unique position allows it to provide ecosystem services at all times. During normal rain events, the oxbows and sloughs help to clean water that enters Spring Creek. During flood events, the land absorbs floodwaters and silt. During Hurricane Harvey, the preserve filled with over ten feet of water which left behind silt mounds that ranged from two feet high to six feet high. Without the Bender Preserve, this water and silt would have had a far greater impact on surrounding lands.

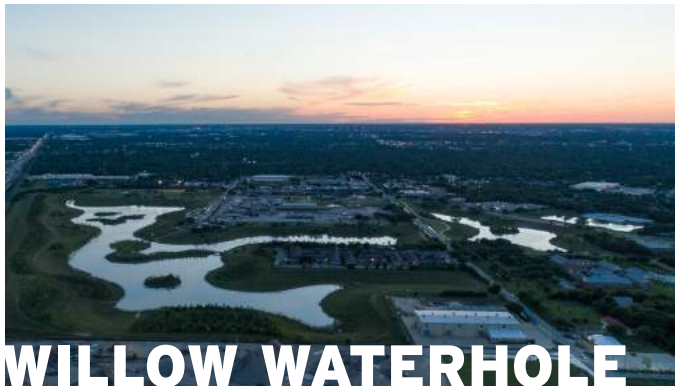


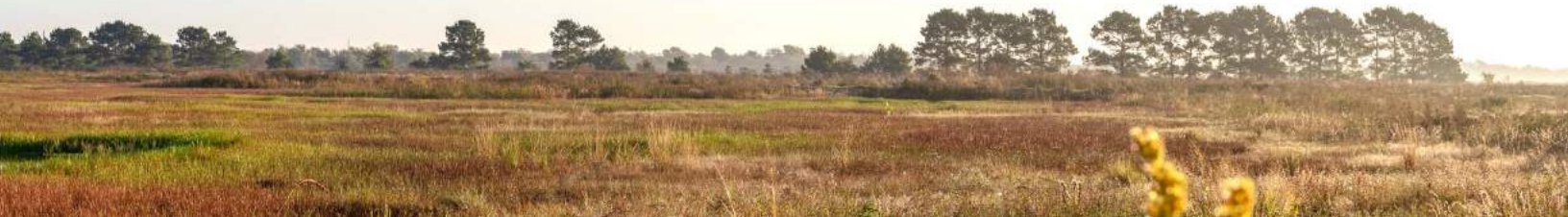
Katy Prairie is a sprawling prairie wetland complex that includes nearly 14,000 acres of grassland and agricultural lands and 5,000 of wetlands. The prairie reduces flooding by absorbing rainfall, slowing runoff, retaining rainwater, increasing retention storage, curtailing peak flows, and increasing detention storage. The prairie provides numerous additional benefits including recreation, tourism, improved air and water quality, local food production, and enhanced habitat for wildlilfe. The Coastal Prairie Conservancy protects over 24,000 acres of this unique ecosystem.

Clear Lake Forest Park is a living shoreline project on Mud Lake spearheaded by the Galveston Bay Foundation for the community of Clear Lake Forest. Living shorelines aim to control erosion by mimicking natural coastal processes through the strategic placement of plants, stone, fill, and other structural and organic materials. Construction of the $120,000 project began in May 2011 and resulted in the protection and growth of 2,000 sq. ft. of marsh vegetation habitat.

Bagby Steet Reconstruction Project is the first Greenroads project in Texas. The project implements low-impact development techniques, with features such as rain gardens, permeable pavers, and native vegetation that help capture water during rain events, filter harmful contaminants before reaching Buffalo Bayou, and provide a beautiful landscape amenity to the surrounding neighborhood and businesses. Bagby Street was a project of the Midtown Redevelopment Authority, with design led by Walter P. Moore Inc.

Willow Waterhole is a 290-acre greenway that offers Houstonians recreational opportunities as well as relief from flooding concerns. Constructed by Harris County Flood Control District, the land includes six stormwater detention basins that mimic natural landscapes with basin sinuosity and wet bottoms that support vegetative shorelines and aquatic life. These interconnected basins hold and filter water during flood events. The land includes a 40-acre native prairie restoration area with an endangered plant species and a greenway that hosts many community events. The Willow Waterhole Greenspace Conservancy is dedicated to creating and maintaining the recreation features in the greenway including miles of trails, gazebos, and a concert pavilion.





Principles for Equitable Flood Mitigation

While many communities are striving to protect all members of their community – historical underinvestment and disinvestment in flood infrastructure has resulted in disparate levels of service across geographies. This means that in order to ensure that all communitie are protected in an equitable manner, investment needs to ensure that those areas that have lower levels of protection are "brought up" to match the protection in areas that have had historical investments.

Do your PAART to ensure equitable flood mitigation when making decisions that impact communities.

Perspective
Work to understand historical injustices that have resulted in underinvestment or disinvestments in a particular community, and how those actions continue to shape current needs and vulnerabilities. Pay acute attention to underserved communities that require greater investments to overcome historical injustice

Agency
Communities have intimate knowledge of what projects they need and where they should go. Place an emphasis on lived experiences and actively support agency through community participation and leadership when decisions are being made that will impact that community. Address barriers to active community participation such as a lack of access to language translations of materials and meeting notices.

Advocacy
Use your power to elevate frontline voices and seek funding opportunities for those communities. Where appropriate, support projects that incorporate natural or nature-based features that can provide multiple benefits to communities affected by various hazards and can improve quality of life for nearby residents. Make investments in sustainable, climate resilient solutions that will continue to protect communities in the face of climate change.

Resources
Resources and technical expertise are valuable and can be shared with communities, as appropriate. Effective equitable mitigation depends on the input and support of community members whose contributions of time and expertise deserve just compensation. Provide communities with access to data and best available science to identify risks, assets, and vulnerabilities. Provide appropriate support and compensation when we seek input from community members.

Transparency
Transparency requires accurately reflecting your intentions and actions, and clearly sharing outcomes - good or bad.Much needs to be done to ensure intentions and actions are truly supportive of frontline community needs. All projects may have unintended consequences that may need to be planned for, including non-structural and nature-based projects. For example, buyouts may be a preferred option for floodplain professionals, but may not be appropriate if there is inadequate support from the community and lack of adequate resources for resettlement. Be transparent about potential consequences and plan for them by seeking community-based solutions.

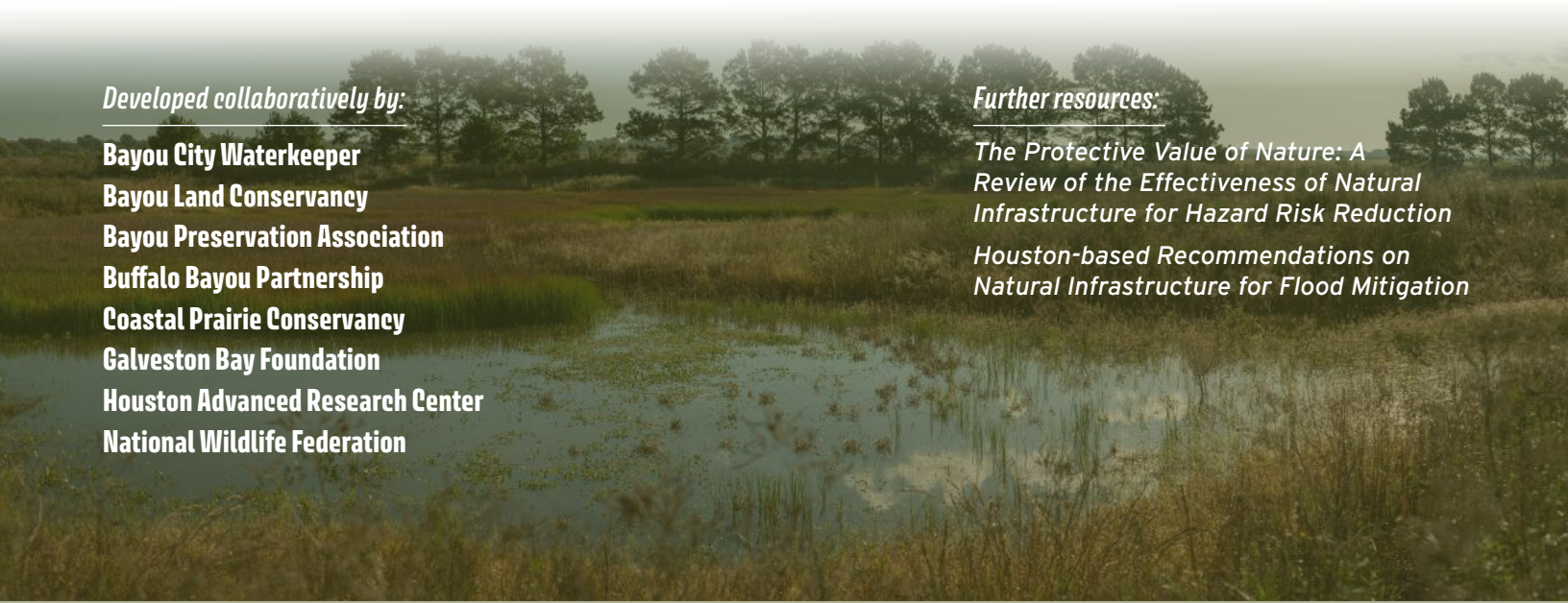
Funding Opportunities

Multiple funding opportunities at the state and federal level are available and should be utilized to the greatest extent possible to ensure equitable flood mitigation. A few of these funding opportunities include:

Flood Infrastructure Fund (FIF)
Once the first State Flood Plan is adopted in 2024, the state's FIF will provide grants and loans to projects included in the State Flood Plan. Uses include planning and design activities, obtaining regulatory approval to provide nonstructural and structural flood mitigation and drainage, and construction of flood mitigation and drainage infrastructure. Nonstructural including nature-based projects are encouraged uses of FIF financing.

Building Resilient Infrastructure and Communities (BRIC)
FEMA's new BRIC program, largely funded by a 6% set aside of estimated disaster expenses for each major disaster included under the Stafford Act, will continue to represent a significant source of investment in years to come. BRIC provides 100% grants. BRIC provides priority points for nature-based projects and has provided many resources to help communities access BRIC funds for nature based projects, including this helpful guide. In addition to developing strong nature-based projects, the State of Texas and sub-applicants must make applications more competitive by adopting enforceable up-to-date building and residential codes.

Clean Water State Revolving Fund (CWSRF)
In addition to traditional infrastructure projects (ex. construction of publicly owned treatment works and decentralized wastewater treatment systems), financial assistance from the CWSRF can be used for nonpoint source, national estuary program, watershed pilot, and water conservation, efficiency, and reuse projects. While repayment of loans are often difficult, Conservation of watersheds via easements is an eligible project and is an important nature based tool, and many entities are coming up with creative ways to repay CWSRF loans for these projects.



Developed collaboratively by:

Bayou City Waterkeeper
Bayou Land Conservancy
Bayou Preservation Association
Buffalo Bayou Partnership
Coastal Prairie Conservancy
Galveston Bay Foundation
Houston Advanced Research Center
National Wildlife Federation

Further resources:

The Protective Value of Nature: A Review of the Effectiveness of Natural Infrastructure for Hazard Risk Reduction

Houston-based Recommendations on Natural Infrastructure for Flood Mitigation