

Green Infrastructure In the Lower Galveston Bay watershed



Site Scale



Address runoff from a single site. Is appropriate for both new developments and retrofits. Bioswales, pervious pavement, bioretention.

Mid Scale



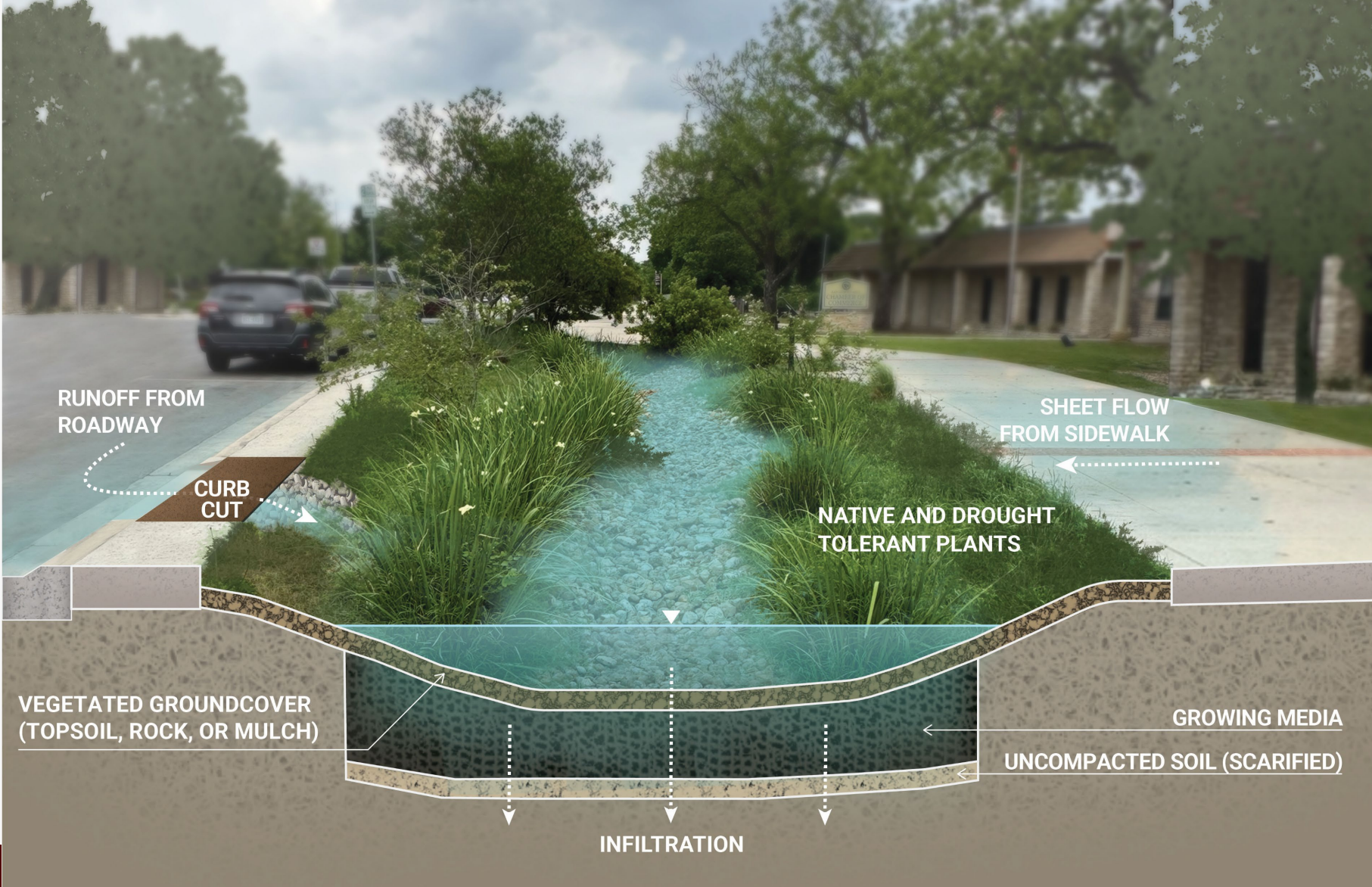
Neighborhood sized projects that reduce stormwater quantity and improve water quality. Construct wetlands, conservation subdivisions.

Large Scale



Conservation, restoration, and preservation of large tracts of land that provide ecological services.

Rain Gardens



Rain garden

Hitchcock, TX



Rain garden

Houston City College
Katy, TX





Rain garden, League City, TX

Vegetated Buffers

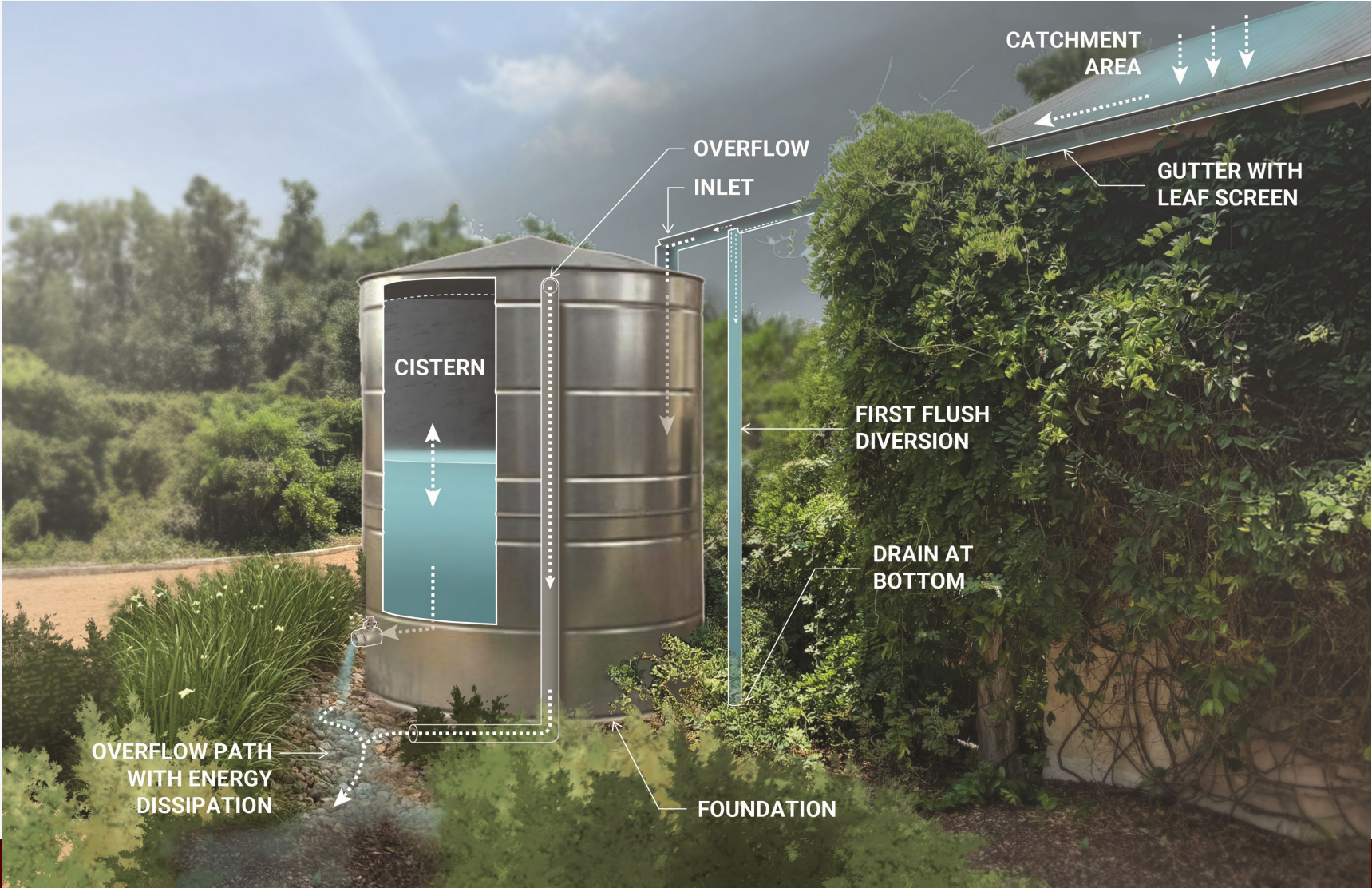


Vegetated Buffer

Hitchcock, TX



Rainwater Collection



Rainwater collection

Houston City College,
Katy, TX





Sarita Elementary, Sarita, Tx (Kleberg County)



Keach Family Library, Robstown, Tx (Nueces County)

**Green infrastructure is
not complicated.**

**Green infrastructure is
not easy.**



TEXAS STATE

Soil & Water

CONSERVATION BOARD

WHY HEALTHY SOIL MATTERS

MAKING THE CASE FOR IMPROVING SOIL HEALTH IN GREEN
INFRASTRUCTURE AND URBAN LANDSCAPES

BRIAN KOCH

TEXAS STATE SOIL & WATER CONSERVATION BOARD

SOIL HEALTH AND WATER QUALITY

A FEW REASONS WHY IMPROVING SOIL HEALTH CAN BE BENEFICIAL TO WATER QUALITY

- INCREASED WATER HOLDING CAPACITY IN THE SOIL REDUCES RUNOFF
- INCREASED PLANT VIGOR, BIOLOGICAL ACTIVITY, AND DEEPER ROOTS CAN INCREASE WATER INFILTRATION
- DECREASED EROSION (WIND AND WATER) AND DECREASED LOSSES OF NITRATE UP TO 88% AND PHOSPHOROUS UP TO 92% IN DIFFERENT STUDIES
- ADDITIONAL BENEFITS ARE POSSIBLE

WHY HEALTHY SOIL MATTERS

- REGULATING WATER - SOIL HELPS CONTROL WHERE RAIN AND IRRIGATION WATER GOES. WATER AND DISSOLVED SOLIDS FLOW OVER THE LAND OR INTO AND THROUGH THE SOIL.
- SUSTAINING PLANT AND ANIMAL LIFE - THE DIVERSITY AND PRODUCTIVITY OF LIVING THINGS DEPENDS ON SOIL.
- FILTERING AND BUFFERING POTENTIAL POLLUTANTS - THE MINERALS AND MICROBES IN SOIL ARE RESPONSIBLE FOR FILTERING, BUFFERING, DEGRADING, IMMOBILIZING, AND DETOXIFYING ORGANIC AND INORGANIC MATERIALS, INCLUDING INDUSTRIAL AND MUNICIPAL BY-PRODUCTS AND ATMOSPHERIC DEPOSITS.
- **CYCLING NUTRIENTS - CARBON, NITROGEN, PHOSPHORUS, AND MANY OTHER NUTRIENTS ARE STORED, TRANSFORMED, AND CYCLED IN THE SOIL.**

The logo for the Texas State Soil & Water Conservation Board is located in the top left corner. It consists of a white rectangular box with three horizontal sections. The top section contains the text "TEXAS STATE" in a dark, sans-serif font. The middle section contains "Soil & Water" in a larger, blue, serif font. The bottom section contains "CONSERVATION BOARD" in a smaller, green, sans-serif font. The background of the slide is light blue with several water droplets of various sizes scattered around the logo.

TEXAS STATE

Soil & Water

CONSERVATION BOARD

WHY HEALTHY SOIL MATTERS

FOR EVERY 1% INCREASE IN SOIL ORGANIC
MATTER THAT RESULTS IN UP TO 25,000
GALLONS OF WATER PER ACRE INFILTRATED

TEXAS STATE

Soil & Water

CONSERVATION BOARD

HOW WE MAKE OUR SOILS HEALTHIER

- UNDERSTAND YOUR CONTEXT
- COVER THE SOIL
- REDUCE SOIL DISTURBANCE (BIOLOGICAL, MECHANICAL AND CHEMICAL)
- KEEP PLANTS GROWING THROUGHOUT THE YEAR TO FEED THE SOIL
- DIVERSIFY AS MUCH AS POSSIBLE USING CROP ROTATION AND COVER CROPS
- INCORPORATE LIVESTOCK

Improving Water Quality in Galveston Bay with Healthy Soil and Green Infrastructure

Kelli Ondracek

Natural Resources Manager

City of Houston Parks and Recreation Department



HPARD
HOUSTON PARKS
AND RECREATION DEPARTMENT
A CAPRA Accredited Agency

Nature-Based Green Infrastructure Initiatives



Land Preservation

Nature Preserve Ordinance
Land acquisition



Riparian Restoration Initiative

Restoration of all parks along waterways-
70 Parks
Herman Brown Park example



Prairie Restoration

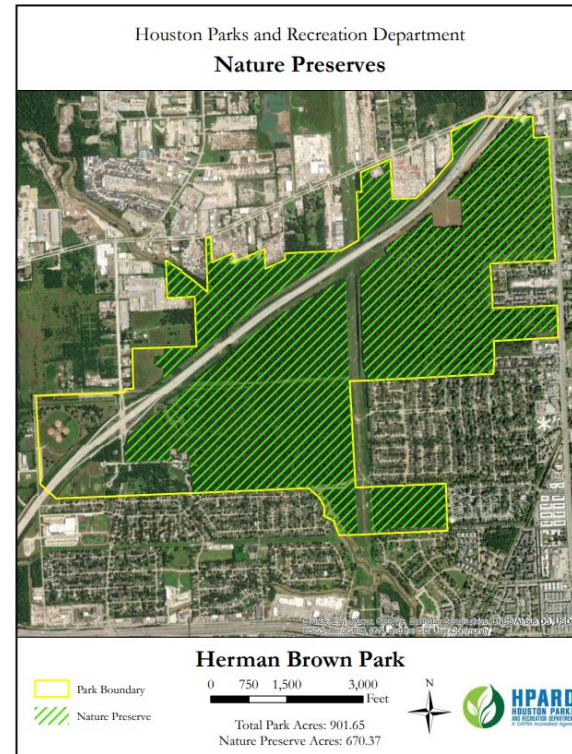
Six prairie restoration sites
ER & Ann Taylor Park example

City of Houston Nature Preserve Ordinance

- Chapter 32, Article V.-Nature Preserves, Sec. 32-116.

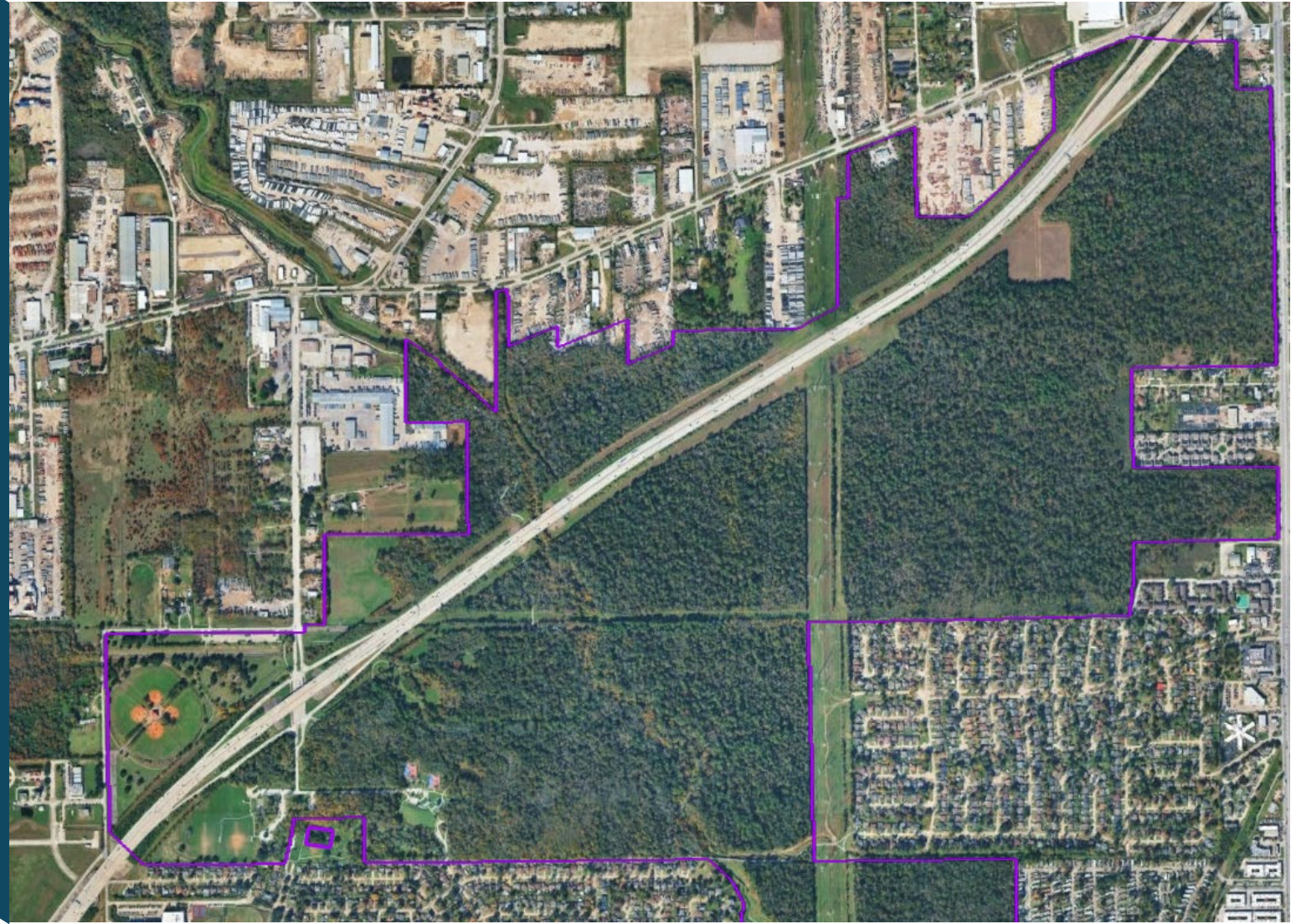
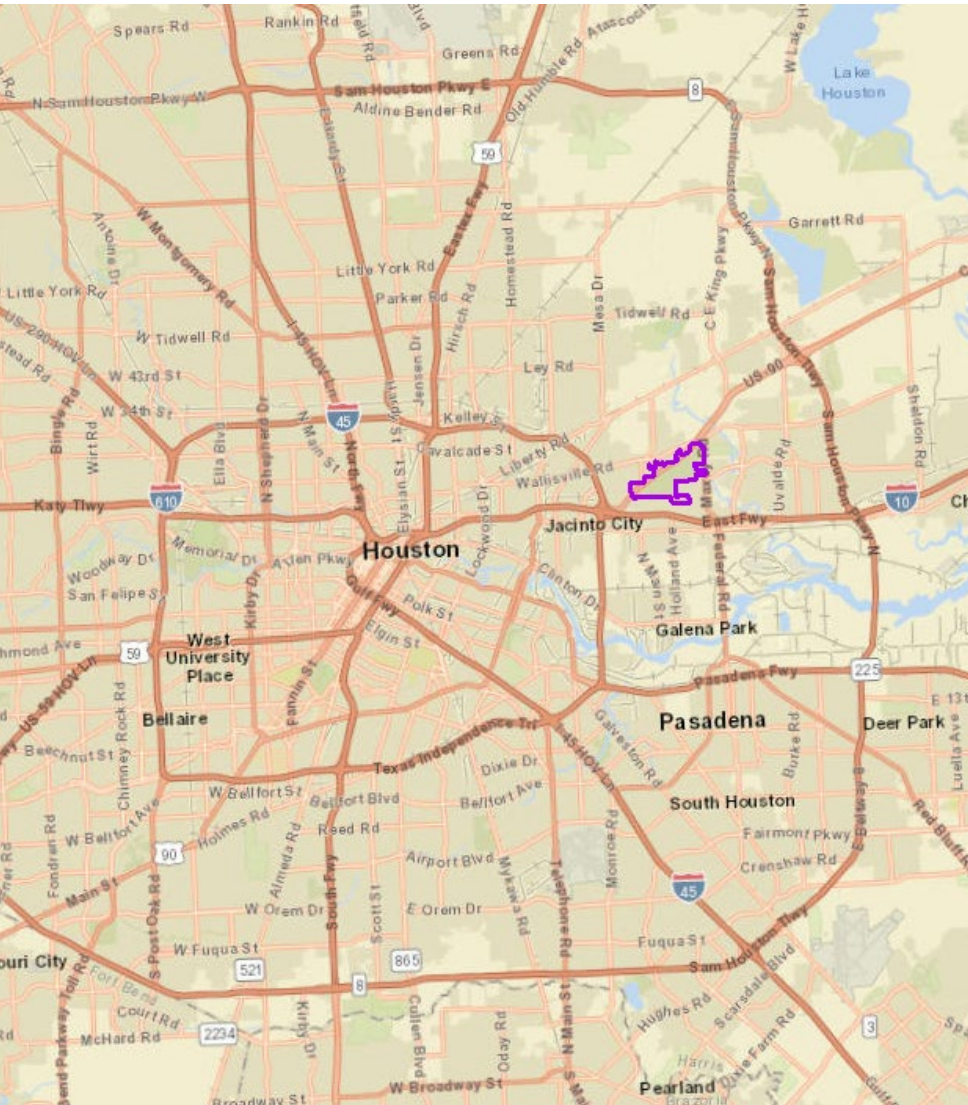
https://library.municode.com/tx/houston/codes/code_of_ordinances?nodeId=COOR_CH32PARTE_ARTVNAPR

- 7,423 acres of land in 26 parks
 - Development limitations
 - Rules for use
 - Penalties



A photograph of a dense forest with many green trees. A large, dark tree trunk is prominent in the center. The text "Herman Brown Park" is overlaid in white in the middle of the image.

Herman Brown Park



HERMAN BROWN PARK

HABITAT MANAGEMENT PLAN

Proposal prepared by Resilient Future Studio for the
City of Houston Parks and Recreation Department
August 26, 2025



Table 3. Most Commonly Observed Vegetation Species

Common Name	Scientific Name	Number of Plots Observed At	Percent of Plots
Dwarf Palmetto	<i>Sabal minor</i>	138	89.0%
Willow Oak	<i>Quercus phellos</i>	136	87.7%
Chinese Tallowtree	<i>Triadica sebifera</i>	132	85.2%
Yaupon	<i>Ilex vomitoria</i>	124	80.0%
Water Oak	<i>Quercus nigra</i>	107	69.0%
American Elm	<i>Ulmus americana</i>	101	65.2%
Hackberry	<i>Celtis laevigata</i>	96	61.9%
Deciduous Holly	<i>Ilex decidua</i>	89	57.4%
Glossy Privet	<i>Ligustrum lucidum</i>	89	57.4%
Slender Wood-Oats	<i>Chasmanthium laxum</i>	88	56.8%
Chinese Privet	<i>Ligustrum sinense</i>	84	54.2%
Loblolly Pine	<i>Pinus taeda</i>	84	54.2%
American Beauty-Berry	<i>Callicarpa americana</i>	79	51.0%

Overstory Dominant Species Communities Composition	Number of Sample Plots	Percent of Plots
Hardwood	65	41.9%
Hardwood-Invasive	39	25.2%
Hardwood-Pine	9	5.8%
Invasive-Early Successional	8	5.2%
Invasive Dominated	7	4.5%
Hardwood-Successional	7	4.5%
Early Successional	6	3.9%
Hardwood-Invasive-Successional	4	2.6%
Pine	3	1.9%
Hardwood-Pine-Invasive	2	1.3%
Pine-Invasive	2	1.3%
Pine-Successional	1	0.6%
Pine-Successional-Invasive	1	0.6%
Hardwood-Pine-Invasive-Successional	1	0.6%



Invasive Species Removal:

Chainsaw, hydro-ax, herbicide treatments



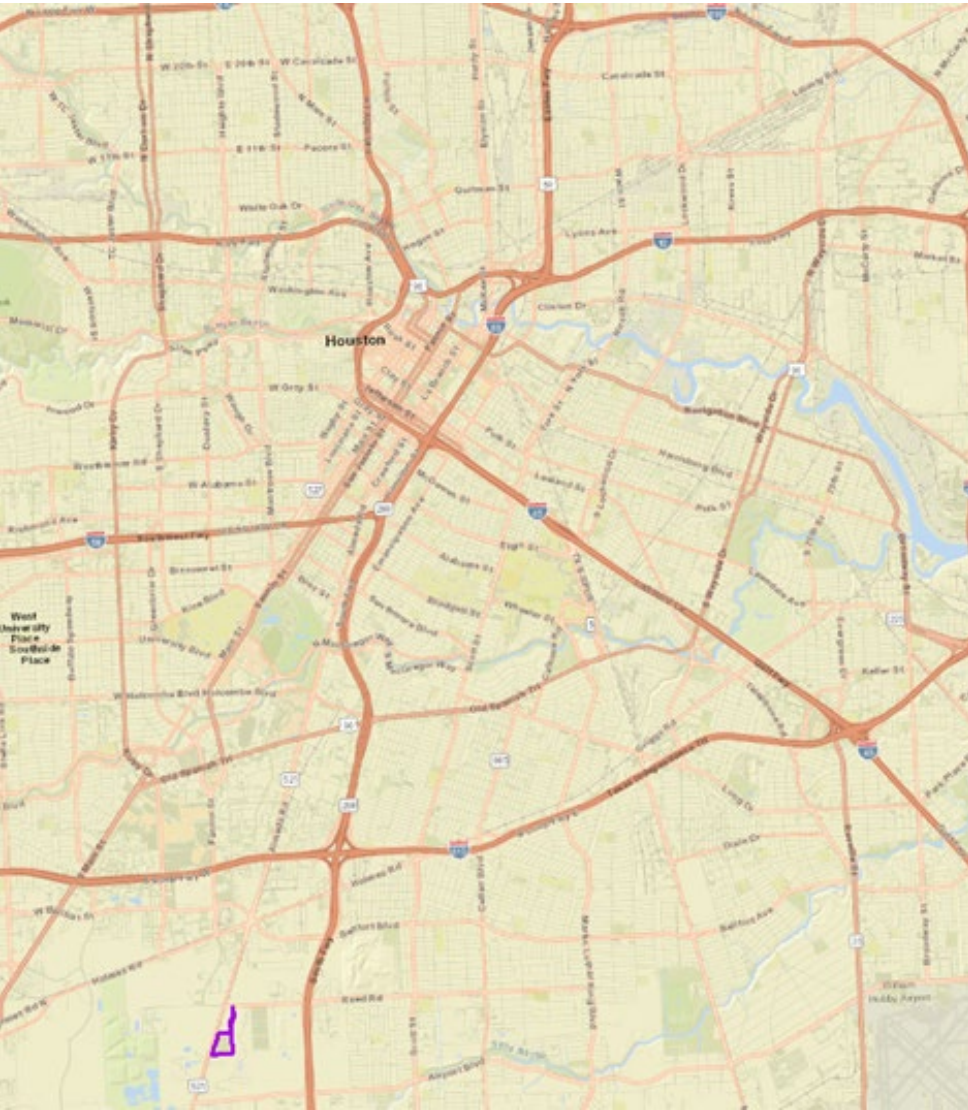


Native Tree Planting:

Reforestation within areas cleared by heavy invasive removal. Plantings include mix of locally native species that have been recorded as currently present on site.

E.R. & Ann Taylor Park



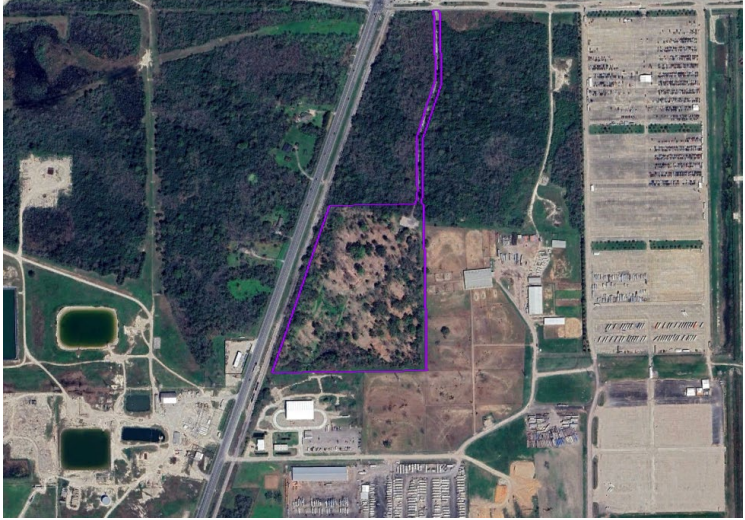




1944



2024



2025





Selective tree clearing and mulch removal

Spreading hay from remnant Deer Park prairie to increase species diversity



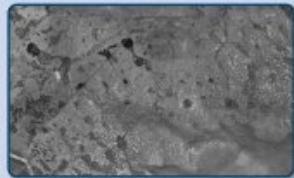


Community planting events with plants propagated by hand-collected seed from remnant and restored prairies around Houston



A Prairie Mystery

For much of its history, Ann Taylor Park functioned as a homestead and was never plowed or heavily disturbed. Because the soil remained largely intact, the park still preserves rare geological features known as *mima* or *pimple* mounds.



Mima or "pimple" mounds can clearly be seen in aerial photos of the Texas coastal prairie.

Did You Know?

Mima mounds were named after the Mima Prairie in Washington State where they were first identified by scientists in the 19th century.

What Are They?

Mima mounds are low, earthen mounds that formed thousands of years ago. They're scattered across prairie landscapes worldwide, and have puzzled scientists for many years because no one knows exactly how they're formed.

Could they be caused by sediment that's been slowly redistributed by wind and rain over time? Or perhaps they're caused by prairie soils shrinking and swelling as they wet and dry? Some say they could even be caused by burrowing mammals such as pocket gophers! What do you think?



Mima mounds on prairies in the Pacific Northwest look more like gentle waves on the prairie rather than the smaller "pimple" mounds that occur here in Texas.

Islands of Life

Mima mounds are slightly elevated with better drainage and more sandy soils than the surrounding landscape. Over thousands of years, these slight differences have created important microhabitats that support greater plant diversity and a richer prairie ecosystem. Many kinds of plants and animals are found utilizing mima mounds--here are just a few:



Gulf Muhly Grass



Texas Prairie Dawn



Pocket Gopher



Eastern Hognose Snake



Gulf Coast Toad



Houston Parks and Recreation Department



This program has been funded in part by the United States Environmental Protection Agency under cooperative agreement #8333-001-0001-0001-0001. This content reflects the views of the author and not necessarily those of the U.S. Environmental Protection Agency. For more information, please contact the Harris County Environmental Protection Agency at (281) 416-2000.

Thank you to our funders!

Texas Commission on Environmental Quality's
Galveston Bay Estuary Program

Restore America's Estuaries

Contact :

naturalresources@houstontx.gov





BAYOU PRESERVATION
ASSOCIATION

celebrate. protect. restore.

Stream Corridor Restoration Principles

Guiding Restoration Initiatives for Sustainable Communities

The Importance of Stream Corridors

- Stream corridors and watersheds are essential regional resources, providing numerous benefits:
 - Recreational opportunities
 - Mitigation of flood risk
 - Protection of water quality
- Human activities have significantly altered these natural areas, affecting their stability and functionality.
- The Bayou Preservation Association and our partners advocate for and employ nature-based solutions to restore stream corridor ecosystems and improve resiliency



Guiding Principles

- The Bayou Preservation Association adopted our Stream Corridor Restoration Principles
 - Incorporating Outreach
 - Comprehensive Approach
 - Using Best Practices
 - Planning for Sustainability

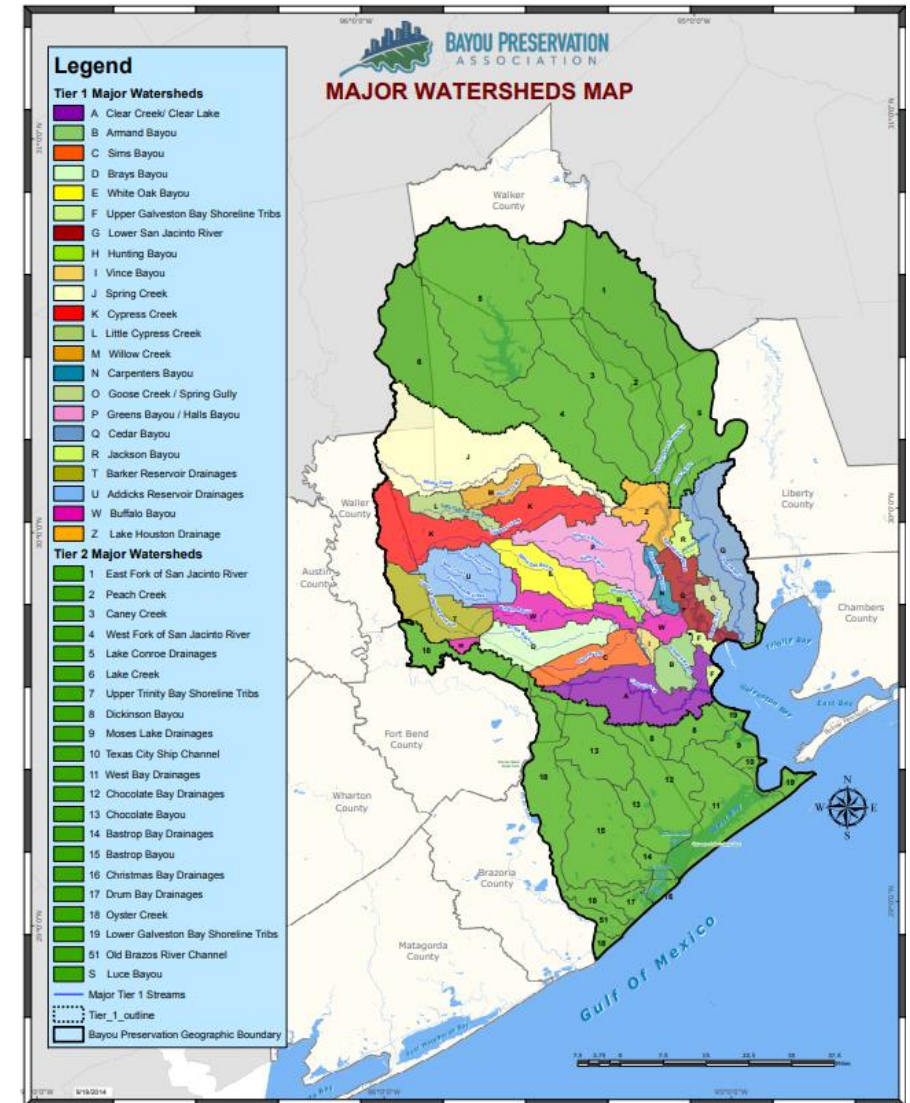
Principle 1: Incorporating Outreach

- Community-Centric Approach
- Continuous Community Engagement
- Cultivating Ownership and Appreciation



Principle 2: Comprehensive Approach

- Comprehensive Management
 - Stream corridors should be managed by watershed and floodplain
 - Consider the entire stream
- Optimize Natural Functions
 - Preserve what is already beneficial in the stream
- Preventing Negative Outcomes
 - Avoid or reduce negative impacts on stream health
- Multi-Disciplinary Approach



Principle 3: Using Best Practices

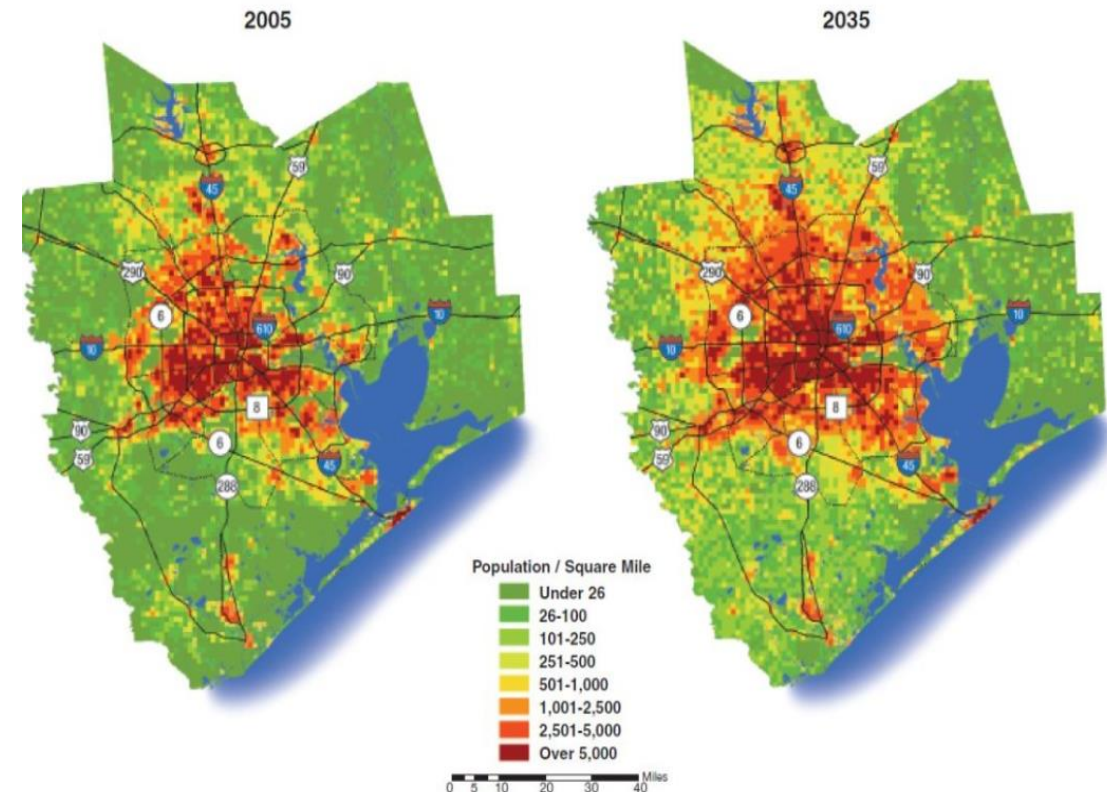
- Clear Restoration Goals
- Comprehensive Design Consideration
 - Incorporate stream channel form considerations such as:
 - Cross-sectional dimensions (bank to bank)
 - Meander pattern
 - Upstream to downstream elevation changes
- Best Practices for Stream Corridor Restoration
 - Thorough evaluation of the stream in its landscape context
 - Identify suitable segments as references
 - Prioritize natural, stable channel design principles and use diverse native vegetation



Principle 4: Planning for Sustainability

Population Growth Forecast 2005-2035

- Comprehensive Sustainability Approach
 - Integrate best design practices
 - Align with the three components of sustainable development
 - Ecologic, economic, and social considerations
- Balancing Short- and Long-Term Goals
- Adaptive Management for the Future
 - Must be able to adjust to changing circumstances



Applying the Principles

- Stream Corridor Restoration Principles and Checklist
- Designed to be used as a dynamic set of guidelines
 - Revisited and integrated into each stage of the project process.
 - Serve as a continuous reference
- This checklist can be found on our website bayoupreservation.org



STREAM
CORRIDOR
RESTORATION
PRINCIPLES AND
CHECKLIST

2022



At Bayou Preservation Association, we work to protect and restore Houston's bayous through applied science, targeted restoration, and collaboration. By translating data into action and connecting resources to areas of greatest need, we strengthen bayou function, reduce environmental risk, and support resilient communities across the Houston region.

Connect With Us!

www.bayoupreservation.org

Info@bayoupreservation.org

Texas-based Ecosystem Service Valuation for Benefit- Cost Analysis of Nature-based Solutions



Funded by the Texas
General Land Office

Michael Niebuhr

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Texas A&M AgriLife Disaster Assessment and Recovery

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Purpose

Develop Texas-specific ecosystem service benefit values to support the evaluation of nature-based solutions in Benefit-Cost Analysis (BCA).

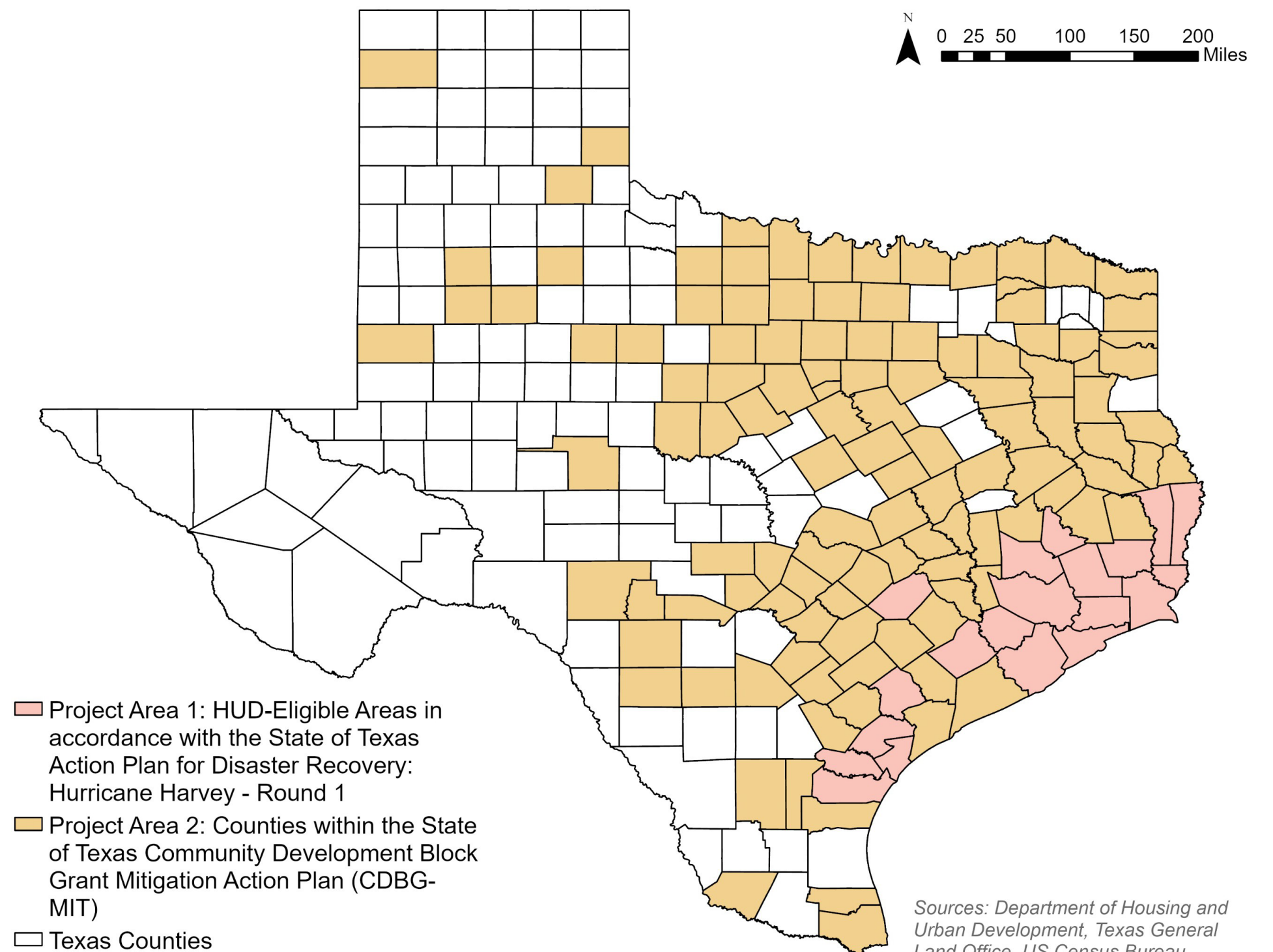


Galveston Bay Foundation Kemah TX Living Shoreline

Study Areas

Project Area 1 is comprised of HUD Eligible Areas in accordance with the **State of Texas Action Plan for Disaster Recovery: Hurricane Harvey, Round 1**.

Project Area 2 are counties within the state of Texas **Community Development Block Grant Mitigation Action Plan (CDBG-MIT)**.



Benefit Cost Analysis

A systematic process for identifying, quantifying, and comparing expected benefits and costs of an investment, action, or policy.

Two primary economic indicators help assess the financial viability of a project:

Net Present Value (NPV)

The difference between the present value of all benefits and the present value of all costs associated with a project over a defined lifespan. Addresses the time value of money.

Benefit Cost Ratio (BCR)

A ratio comparing the present value of benefits to the present value of costs. A BCR greater than 1.0 means that benefits exceed costs, indicating that the project is cost effective.

Frequently Used BCA Tools

Two frequently used BCA Tools are publicly available:

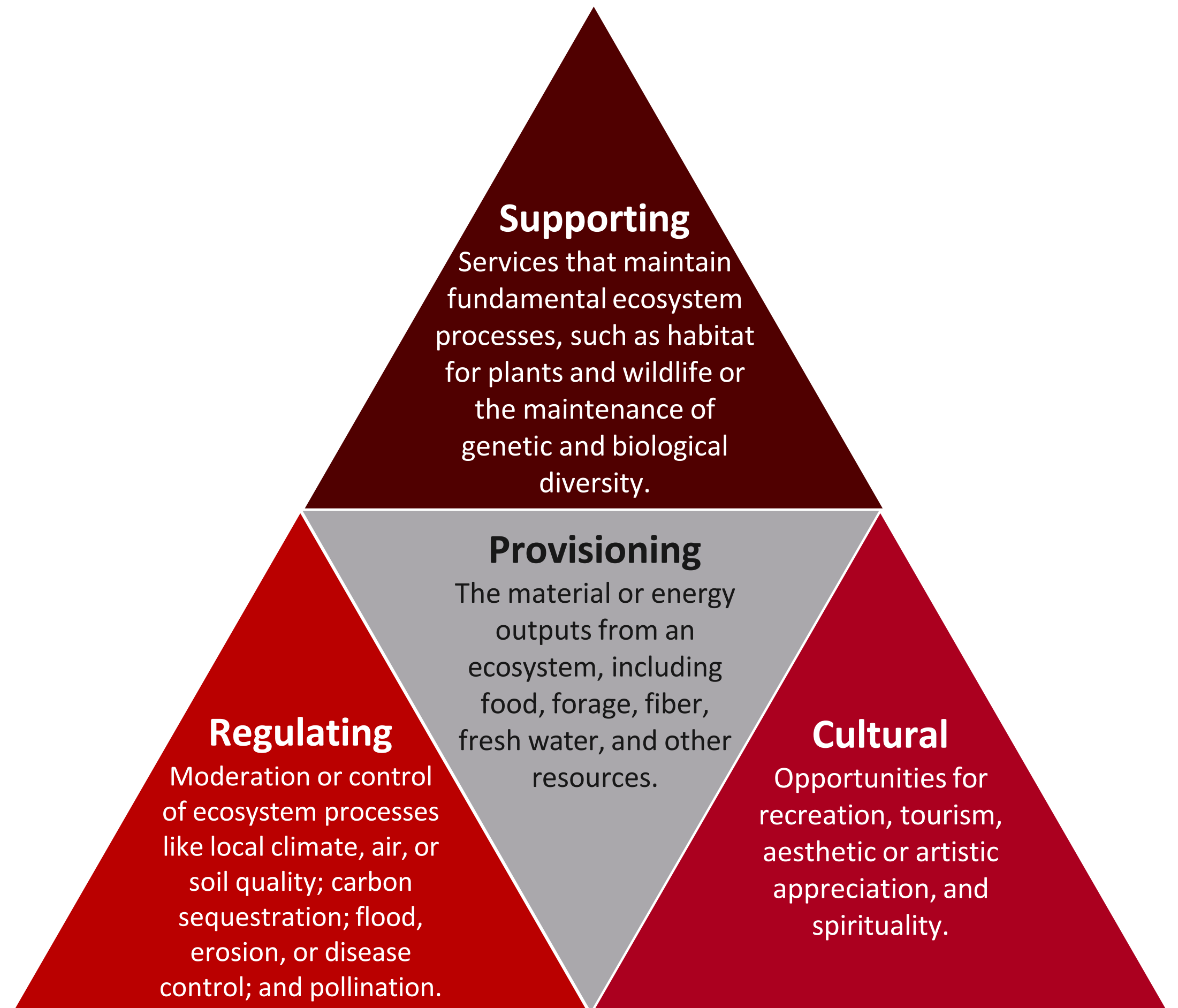
- [FEMA BCA Toolkit](#)
- [Texas Water Development Board \(TWDB\) BCA Input Tool](#)

Does the project include any green infrastructure or ecosystem elements?		Yes
Type of habitat	Acres	FEMA (\$2025)
Urban green open space		\$ 17,834.48
Rural green open space		\$ 12,201.03
Riparian		\$ 42,688.67
Forest		\$ 14,446.83
Coastal wetland		\$ 10,276.54
Inland wetland		\$ 9,376.84
Coral reefs		\$ 8,170.74
Shellfish reefs		\$ 3,163.87
Beaches and dunes		\$ 345,017.51

×

Classifying Ecosystem Services

Originally developed through the 2001 *Millenium Ecosystem Assessment* (MEA), ecosystem services can be classified into **four broad categories**

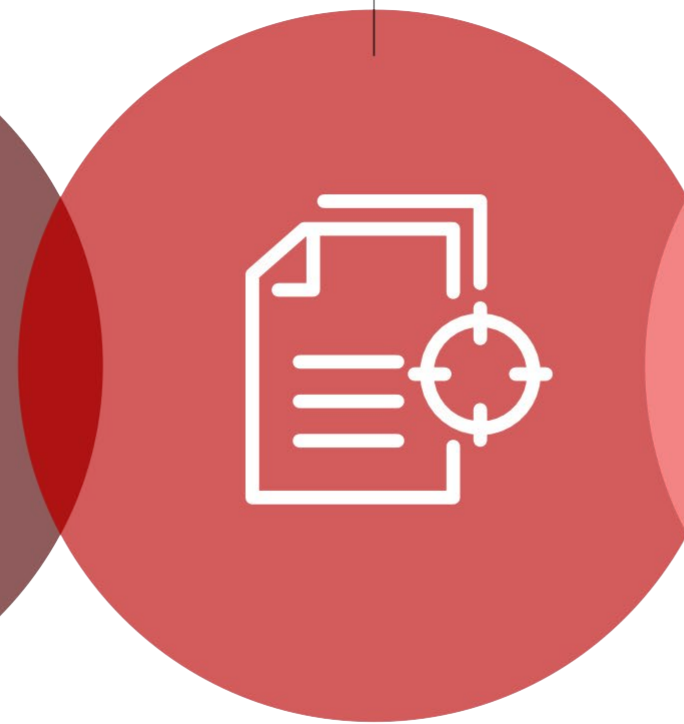


Study Approach

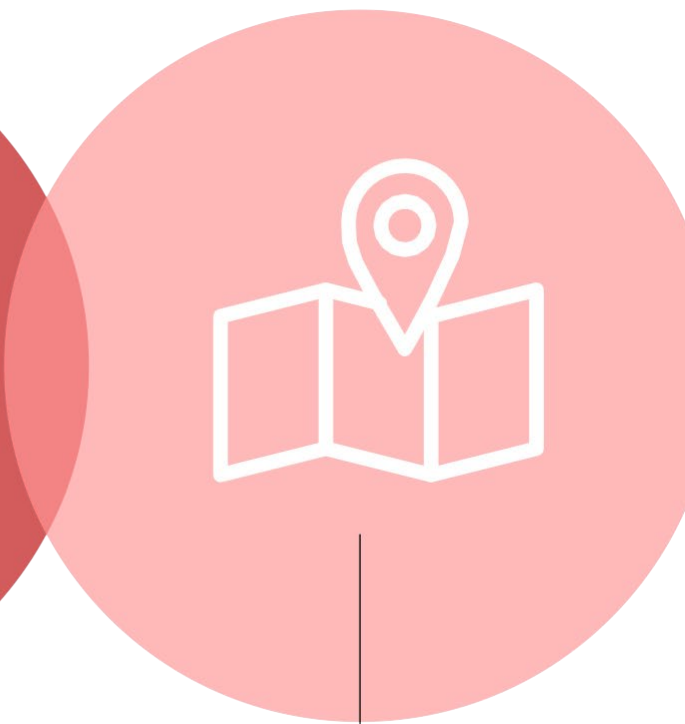
Conduct thorough **literature review** of priority ecosystems with an emphasis on Texas-specific or regionally relevant studies.



Identify a set of **priority ecosystems in Texas** for detailed consideration.



Combine the findings of available research to **derive ecosystem service values for Texas** (Benefit Transfer method).

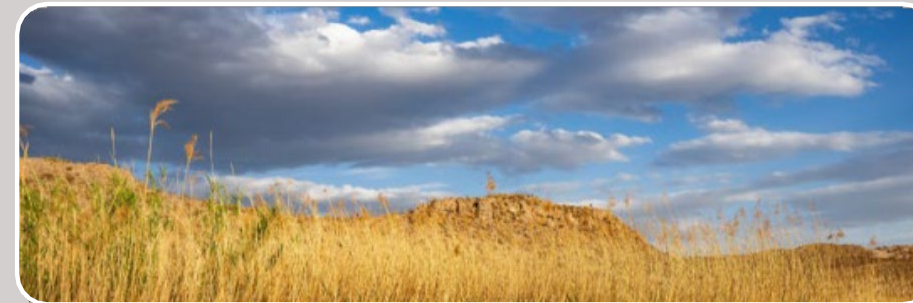


Priority ecosystems

This study employed a combination of preliminary desktop research and collaborative discussions with GIFT to identify priority ecosystems for ecosystem service valuation:



Wetlands



Grasslands/
Prairies



Urban Green
Open Space

Summary of Texas Ecosystem Service Values (2021 USD/acre/year)

Ecosystem service	Wetlands	Grasslands/Prairies	Urban Green Open Space
Aesthetic Value	921	-	9,820
Air Quality	-	-	-
Biological Control	-	-	-
Climate Regulation	289	236	2,891
Erosion Control	-	-	-
Existence Value	-	-	-
Flood and Storm Hazard Risk Reduction	4,349	363	104
Food Provisioning	1,988	129	-
Habitat	3,792	286	5,872
Pollination	-	-	-
Recreation/Tourism	1,271	95	1,305
Research and Education	-	-	-
Water Filtration	-	-	-
Water Supply	5,937	190	-
Water Quality*	401	330	-
Soil Quality*	-	312	-
Total estimated benefits	19,000	2,000	20,000

* Ecosystem services as termed in the literature. Does not directly align with FEMA.

All values displayed in 2021 USD/acre/year.

Total estimated benefits have been rounded to the nearest \$1,000.

Average values for each ecosystem service have been rounded to the nearest whole dollar.

FEMA's published values distinguish between Coastal Wetlands (\$8,995) and Inland Wetlands (\$8,171), a level of detail not possible using the Texas-specific literature available to date.

Case Study

Coastal Heritage Preserve



Priority Ecosystems: Wetlands and Grasslands/Prairie

Project Location: West Galveston Island, TX

Key Features:

- Acquire 500 additional acres of coastal habitat (expanding on the 898 acres already under protection).
 - 198 acres of interior wetlands and coastal prairie.
- Supports 33 migratory bird species and 12 threatened or endangered species.

Coastal Heritage Preserve

Prioritized Habitat Type	FEMA			Texas-specific	
	Acres	\$/acre/year	Annual Benefit Value	\$/acre/year	Annual Benefit Value
Wetlands	70	\$9,000	\$627,000	\$19,000	\$1,326,000
Grasslands and Prairies	128	N/A	-	\$2,000	\$248,000
Urban Green Open Space	-		-		-
Project Capital Cost			\$12,437,000		\$12,437,000
Estimated Annual Operations & Maintenance			\$124,000		\$124,000
(A) Present Value of Ecosystem Services			\$8,653,000		\$21,722,000
(B) Present Value of Project Cost			\$14,148,000		\$14,148,000
Benefit Cost Ratio (BCR = A / B)			0.61		1.54

Notes: Present Value calculations assume a 7% discount rate and a 50-year useful life. Project Cost assumes all costs incurred in 2025. Benefits shown account only for ecosystem services and do not account for other categories of benefits commonly included in a full Benefit-Cost Analysis (BCA), such as avoided physical damages. All values rounded to nearest \$1,000.