GALVESTON BAY PARK

A VISION FOR HOUSTON AND GALVESTON BAY

SSPEED CENTER

The Severe Storm Prediction, Education and Evacuation from Disaster (SSPEED) Center is a multi-university research center based out of Rice University and serves as a resource for research and education related to severe flooding from storms and hurricane-related surge. The SSPEED Center's goal is to educate the Gulf Coast region by increasing governmental and public awareness of the risks associated with severe storms and hurricanes. It is also to address both structural and non-structural mitigation strategies at all scales for the region.

ROGERSPARTNERS

ROGERS PARTNERS Architects+Urban Designers unites multiple disciplines and designs environments where architecture, landscapes and urban spaces converge. We are a studio of 40 architects, urban designers and landscape architects with a breadth of experience in projects of varying types and sizes including projects for a range of civic and public clients. We approach these projects with a focus on making places and spaces that encourage social connections and activity in many forms, with a commitment to the continued viability of the communities in which we work.

WALTER P. MOORE

Walter P Moore is an international company of engineers, architects, innovators, and creative people who solve some of the world's most complex structural and infrastructure challenges. Providing structural, diagnostics, civil, traffic, parking, transportation, enclosure, and construction engineering services, we design solutions that are cost- and resource-efficient, forward-thinking, and help support and shape communities worldwide. Founded in 1931 and headquartered in Houston, Texas, our 600+ professionals work across 18 U.S. offices and five international locations.

GALVESTON BAY PARK

A VISION FOR HOUSTON AND GALVESTON BAY

GALVESTON BAY PARK

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01

A VISION

LET'S DO SOMETHING AMAZING, AGAIN

On November 10, 1914, the Houston Ship Channel opened to great fanfare. Rightly so, as the occasion was to be a pivotal one for the future of the region, shifting the Gulf's commercial power to Houston and creating a port that would transform a small town into a global energy leader. This catalytic moment was about a decade in the making and resulted from strong civic leadership. Funding was assembled from a mix of federal and local dollars via private sector leadership from the likes of Jesse Jones to clear the path to implementation.

Today, in the face of a highly probable direct hit by a deadly hurricane to this critical economic infrastructure and the bayfront communities that surround it, the region once again has the opportunity and cause to initiate and demonstrate what transformational public and private investment can do. Without action, the Houston and Galveston Bay region remains on the precipice of imminent devastation. With the support of public and private local leadership, we can protect and bolster the vitality, economy, and health of this vibrant and important community by implementing a regional surge protection system that also provides recreational opportunities for all to enjoy. **It's time to act, again.**

Price Two Cents

THE HOUSTON CHRONICLE

HOME EDITION

VOL. 14. NO 28 HOUSTON, TEXAS, TUESDAY, NOVEMBER 10 1914 EIGHTEEN PAGES

WILSON TOUCHES A BUTTON AND THE SHIP CHANNEL IS OPENED

WITH BOOM OF CANNON PORT OF HOUSTON OPENS TO WORLD'S COMMERCE

Many Notables Present to Witness Formal Opening of Houston's Waterway—Score or More Gaily Decorated Vessels in Fleet—Perfect Weather Prevails and Thousands Line Banks of the Channel as the Port Is Christened.

Interrupts Cabinet Meeting

Newspaper Clipping from November 10th 1914 celebrating the opening of the Houston Ship Channel

PROVIDING SURGE PROTECTION & GIVING THE BAY BACK TO EVERYONE

DREDGE
DREDGE DEPOSIT
COASTAL SPINE

02

A 100 YEAR PLAN

A VISION FOR THE FUTURE

In order to serve the region in the most effective way, the new surge protection system will begin with achievable goals, while at the same time be proactive and forward looking to care for the needs of future generations. Understanding that the ship channel will continue to be dredged, the plan anticipates and provides locations for the deposition of dredge material towards a productive use. For the next 100 years, the port will know where the dredge product goes, and the community will see it used to create and sustain bay habitat and recreational facilities. Silt build-up in the channel is a natural process that is exacerbated by runoff from the region's high rainfall flood events. Galveston Bay Park envisions a symbiotic relationship between the economic drivers of the region and its' natural environment.

As part of a comprehensive coastal plan, the mid-bay barrier is an essential early action line of defense in a generational plan for Galveston Bay resiliency.

Dredger depositing sediments

Beach Camping

MULTIPLE LINES OF DEFENSE

Existing (E) Galveston Seawall

BUILDING GATES AND LEVEES

Proposed (G1) Mid Bay Gate (approx. 1,000 ft wide)

Proposed (G2) Bolivar Roads Gates (approx. 9,000 ft wide)

Updating (1) Texas City Levee

RAISING ROADWAYS

Proposed (2) Raised Highway 87

Proposed (3) Raised FM 3005

CONSTRUCTING BERMS

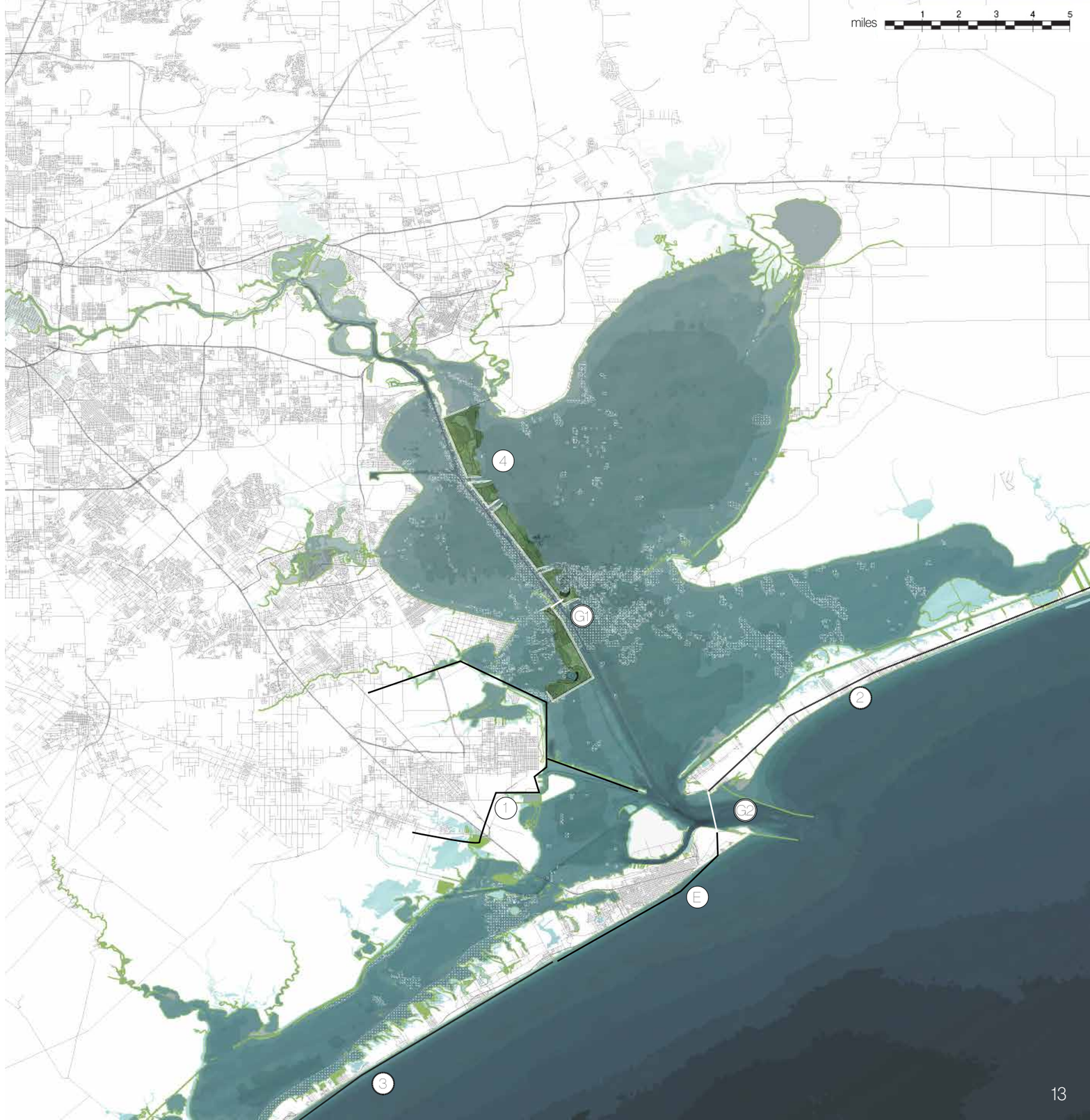
Proposed (4) In-Bay Berms

Proposed (2) Small Dunes

Proposed (3) Small Dunes

RESTORING OYSTER REEFS

Updating Oyster Reefs



03

RISK

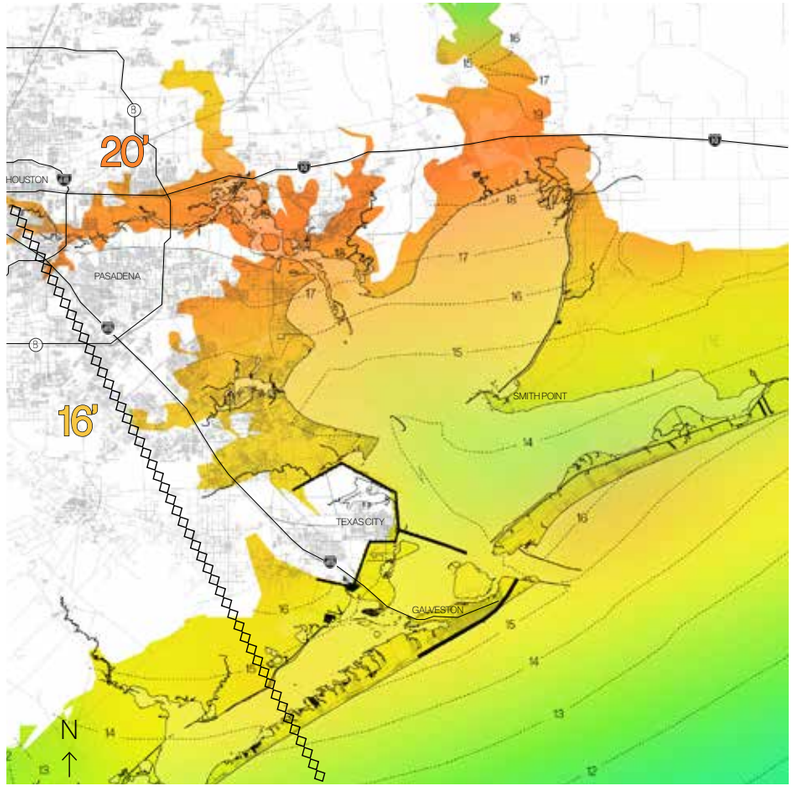
WE ARE WITHOUT PROTECTION

According to NOAA, the Houston-Galveston area is statistically due to be hit by a hurricane roughly every seven years. While 2017's Hurricane Harvey changed the landscape of the area - due to its torrential rains rather than its surge - the last hurricane force winds and storm surge to deeply impact the region came with 2008's Hurricane Ike, a Category 2 that tracked up the Houston Ship Channel. Ike produced storm surges up to 13 feet in the west and northwest portions of the bay, flooding thousands of acres of residential and commercial properties.

Fortunately, the industrial complex in those areas are generally protected for a surge level of up to 15 feet. However, had Ike struck further west following a track known as "p7", the region's "sweet spot" for creating the worst case storm surge for the Houston area, the impact of Ike would have been far worse. Scientific models show that the convergence of high category storms, sea level rise, and coastal development patterns will lead to significant risks for the region. We are now overdue for a major hurricane, and yet ten years on from the cataclysmic effects of Hurricane Ike, bay-front communities, the city of Galveston, and the Houston Ship Channel remain virtually unprotected.

Hurricane Ike 2008

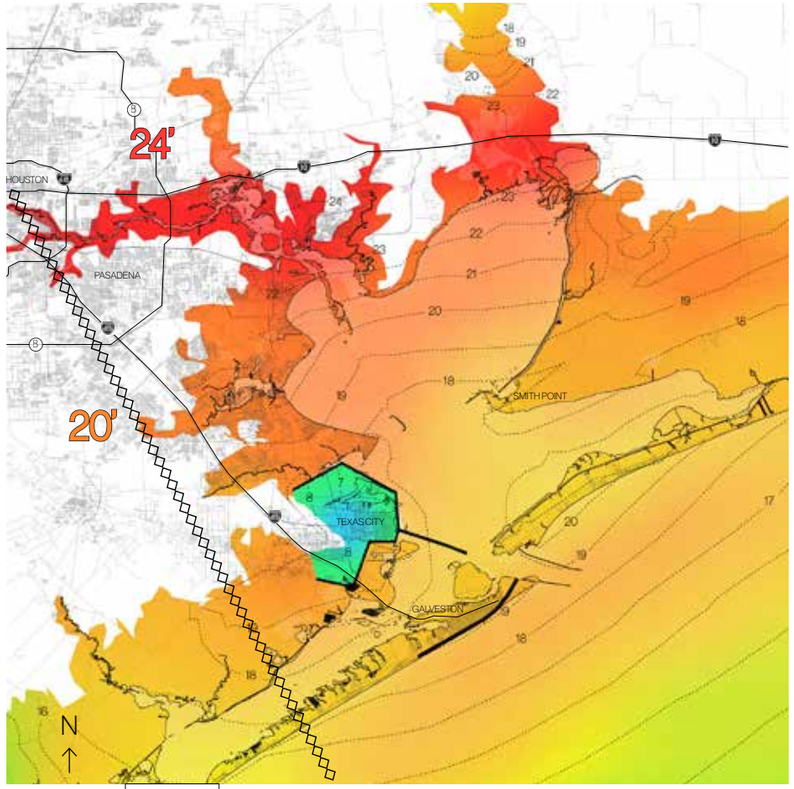
30'
28'
26'
24'
22'
20'
18'
16'
14'
12'
10'
8'
6'
4'
2'
0'



Large Category 2 (Ike at p7) with Existing Protection

EXISTING PROTECTION
◇◇◇◇ TRACK p7

SSPEED Center simulation of maximum surge levels (in feet) during Hurricane Ike with westward track shift to p7.



Category 3 (Ike +15% at p7) with Existing Protection

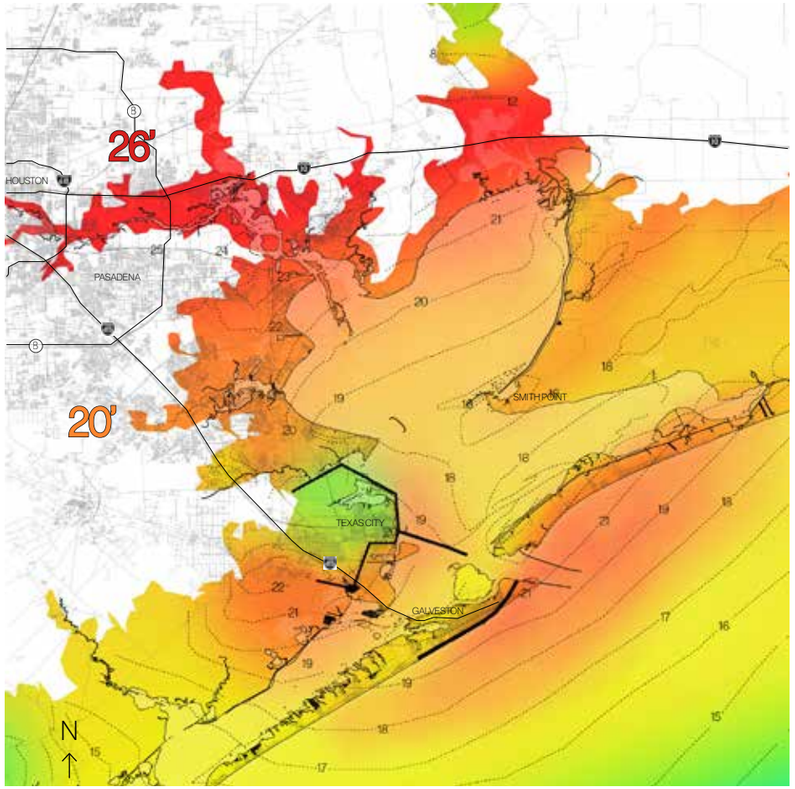
EXISTING PROTECTION
◇◇◇◇ TRACK p7

SSPEED Center simulation of maximum surge levels (in feet) during Hurricane Ike with westward track shift to p7 and wind speeds increased by 15% to simulate a hypothetical, but possible, surge scenario for the region.

WE ARE WITHOUT PROTECTION

Models by the SSPEED Center and others demonstrate what inaction means in the face of the next major hurricane (i.e. a small Category 4) with a trajectory westward of Galveston Bay which would cause the worst case surge scenario. Rapid and severe coastal flooding is anticipated with water levels as high as 26 feet causing major impacts on the heavily populated communities that surround the bay. With rising sea levels, the resulting storm surges will get even higher. On top of that, the nation's fourth largest port and the extensive energy infrastructure that line the Houston Ship Channel would face significant damage. If the chemical storage tanks and facilities here are compromised, the result could be a new record-setting environmental disaster. Given the importance of Houston's petrochemical facilities, the entire nation could be crippled by such a direct hit to the ship channel. **This is a matter of national security.**

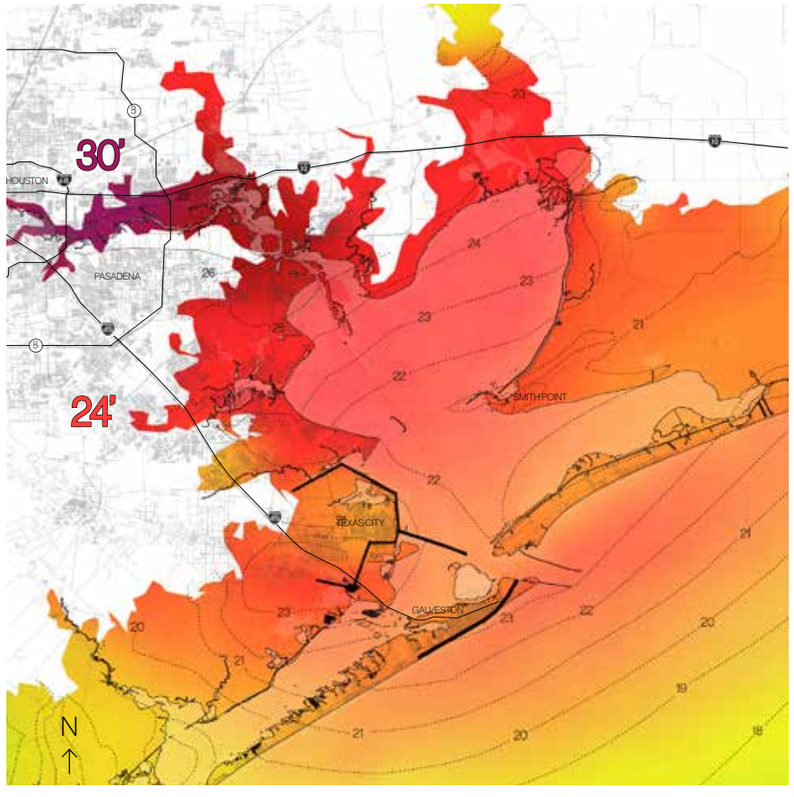
Hurricane Ike 2008



Small Category 4 (FEMA36) with Existing Protection

EXISTING PROTECTION

SSPEED Center simulation of maximum surge levels (in feet) during a hypothetical, small Category 4 storm named "FEMA 36".



Small Category 4 (FEMA 36) + Sea Level Rise with Existing Protection

EXISTING PROTECTION

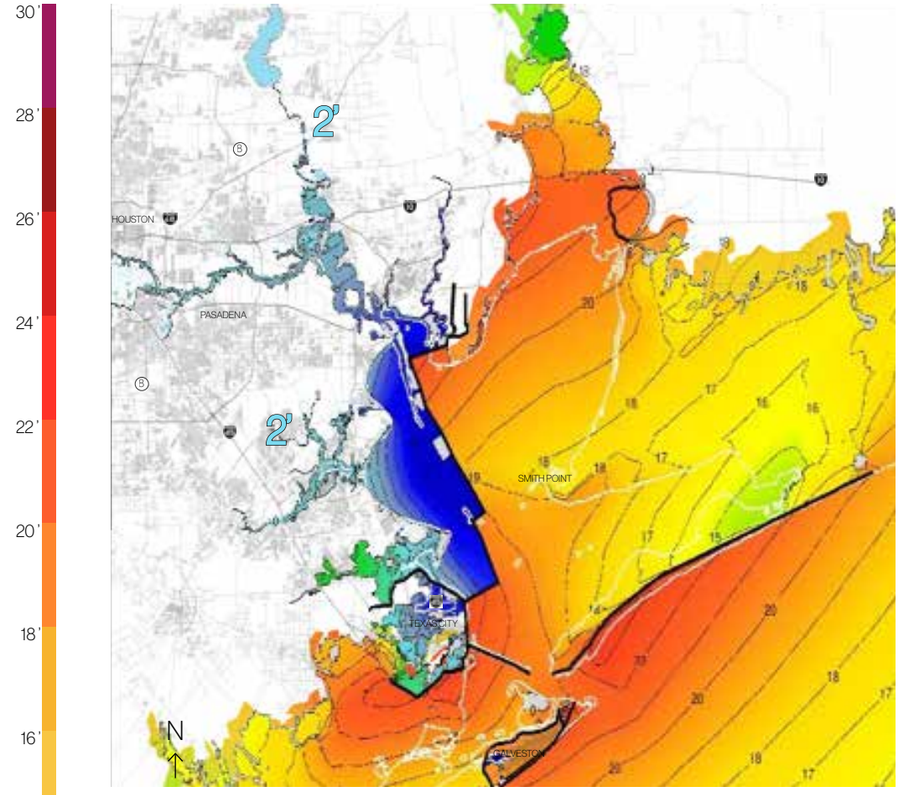
SSPEED Center simulation of maximum surge levels (in feet) during FEMA 36 with a sea level rise scenario of ~2.4 ft for the year 2085.

GALVESTON BAY PARK MITIGATION

A coastal barrier (i.e. the Ike Dike) has been proposed to provide the region with surge protection by forming a barrier connecting Galveston Island and Bolivar Peninsula. At a height of about 17 feet, this barrier would provide flood protection from storm surge caused by small hurricanes. However, for larger hurricanes, there will still be residual flooding behind the barrier keeping the risk of devastating damages high for the west and northwest areas of the bay.

Models show that the potential loss of the homes and infrastructure present in these coastal cities could be catastrophic even with a coastal barrier. Without adequate measures of protection from storm surge, history is destined to repeat itself with the next large hurricane. This is why the SSPEED Center has proposed a comprehensive storm surge protection plan through the initiative known as the Houston-Galveston Area Protection System (H-GAPS). This plan includes protection features on Galveston Island and Bolivar Peninsula, but adds a vital component: an in-bay barrier system known as Galveston Bay Park (formerly known as the Mid-Bay). This feature promises enhanced storm surge protection for the industrial complexes and densely populated areas in the west and northwest areas of the bay.

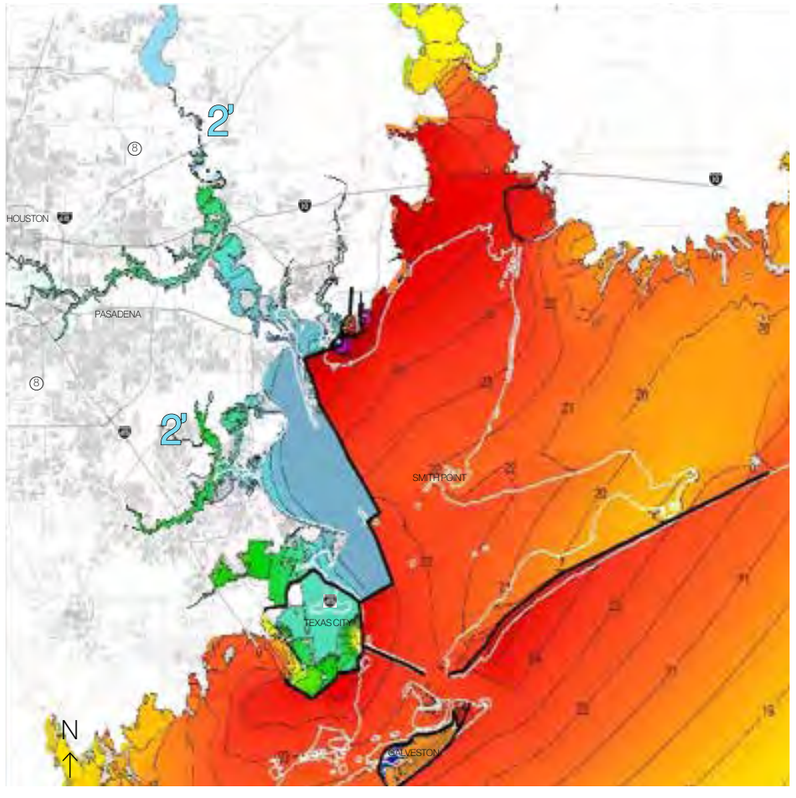
Delta Works series of storm surge barriers in the Netherlands protecting against a heavy storm



Small Category 4 (FEMA 36) with the Galveston Bay Park

EXISTING PROTECTION WITH GALVESTON BAY PARK/H-GAPS IN PLACE

SSPEED Center simulation of maximum surge levels (in feet) during FEMA 36 with the Galveston Bay Park including elevated coastal roadways and a backside levee on Galveston Island.



Small Category 4 (FEMA 36) + Sea Level Rise with the Galveston Bay Park

EXISTING PROTECTION WITH GALVESTON BAY PARK/H-GAPS IN PLACE

SSPEED Center simulation of maximum surge levels (in feet) during FEMA 36 + sea level rise with the Galveston Bay Park including elevated coastal roadways and a backside levee on Galveston Island.

BAYFRONT COMMUNITY & WORKFORCE HOUSING

EXAMPLE ASSESSMENT OF TANK FLOTATION FAILURE PROBABILITY:

- 0.00 - 0.01
- 0.02 - 0.05
- 0.06 - 0.10
- 0.11 - 0.20
- 0.21 - 0.25
- 0.26 - 0.50
- 0.51 - 1.00
- urban areas

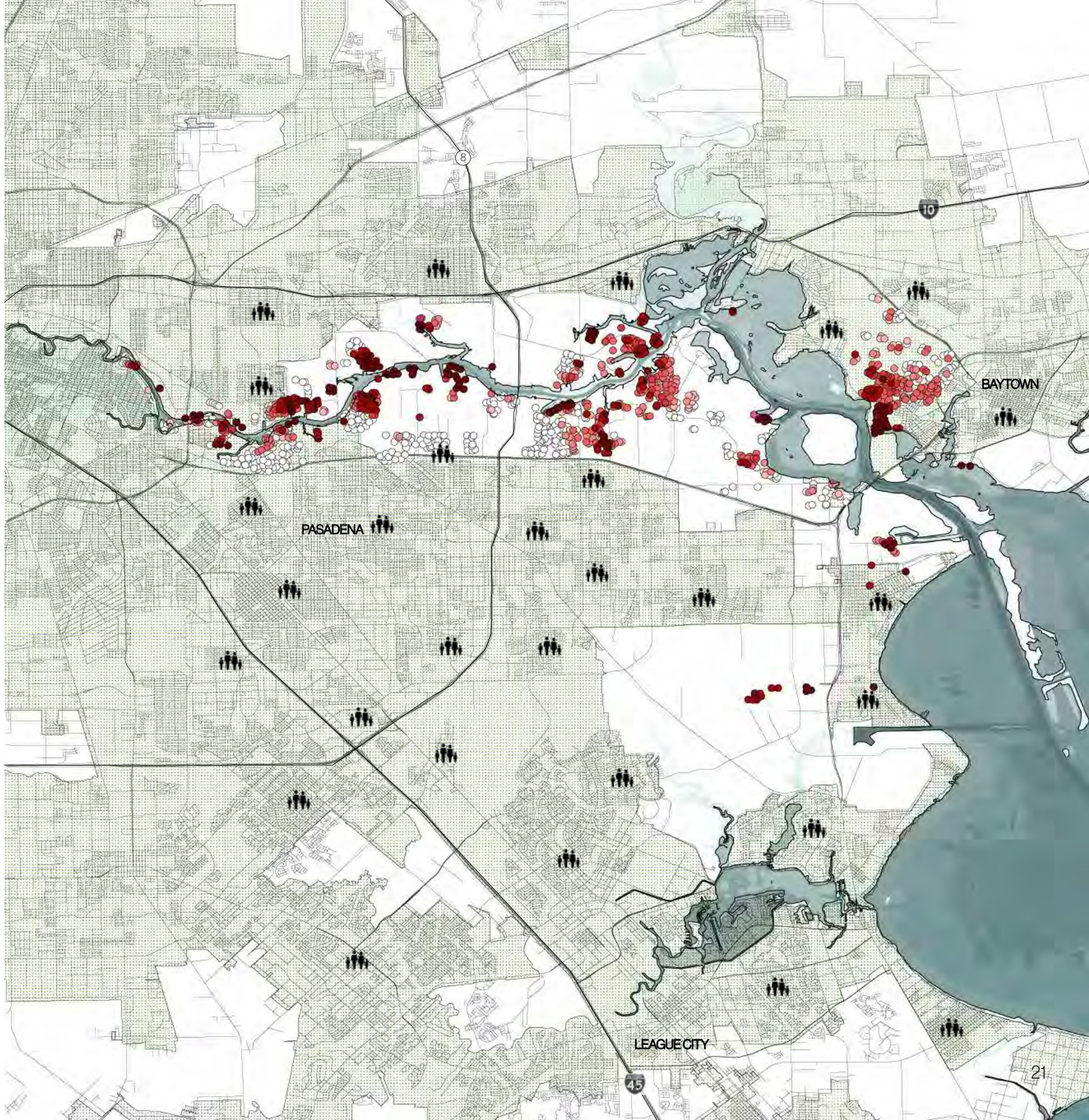
WHO AND WHAT IS AT RISK?

The mapping of infrastructure destruction and tank floatation failure only hints at the extent of potential economic and environmental damage to the region. In addition to this major impact to the chemical and refining industry, the residential community on the west side of Galveston Bay would be devastated by the hypothetical Category 4 storm. It is certainly feasible that over 25,000 homes could be destroyed by such a surge and tens of thousands flooded.

Furthermore, many of the smaller communities in southeast Harris County are at significant risk, including southeastern Houston and the communities of northern Galveston County. Collectively, over 300,000 people live in these areas, not counting the population in the Clear Lake City area. The area behind the Texas City levee would also be flooded by this storm event. If people in these areas do not heed evacuation warnings, several thousand people could be killed by this surge event.

Bayfront Industry

Bayfront Residents



PHASE 01 Barriers and Gates will be built on existing spoils

PHASE 02 Dredge Spoil will be added from the HSC

PHASE 03 Programmatic Components will be added

PHASE 03A Native plants will be added

04

PHASING

FAST & EFFECTIVE EARLY PHASES

While federal funding is being pursued for a coastal barrier, the in-bay component needs to be pushed forward. Presently, inland construction in the bay is active. Dredging activity in the port is already permitted by the Army Corps of Engineers, and existing dredge banks or islands in the bay could rapidly be converted into a portion of the efficient and high-performing surge protection system. With the environmental review being completed for the coastal barrier portion of the protection system, the permitting process is now relatively straightforward and can begin immediately for the in-bay component of the H-GAPS plan.

Dredge depositing sediment

EXISTING CONDITIONS

The bay exists as a large open waterway which is subject to a hazard of tall surge in the event of another hurricane. Without high performing surge protection, the bay's wetlands keep getting whittled away, leaving the bay with less and less protection as time moves forward, exposing the population to devastating floods with each impending hurricane.

PHASE 01
BARRIERS & GATES

The existing dredge islands will be extended along the eastern boundary of the ship channel with another line of islands closing the southern boundary of the system with a connection to Dollar Point. Preceding this, or simultaneously, a series of new and expanded oyster beds will be created in optimized locations in anticipation of the disturbance of select existing oyster beds in the bay. A series of smaller storm gates will close the gaps between the islands while allowing free navigation of the bay and free flow of bay water and wildlife. A larger gate at the ship channel itself will be included in this phase. The islands will be linked by an access road that allows for the maintenance and operation of the system. **Once construction begins, the system has the potential to be operational within three years and will provide significant protection to the western shore of the bay and the ship channel.**

PHASE 02
BARRIER ISLANDS

Ongoing dredging activity in the port will produce material that will be deposited on the outward edges of the protection system, building up the islands and creating a new soft edge to the bay. These growing islands will then be planted with native coastal wetland species. Additional oyster beds will be constructed too, extending from the soft edges of the islands where bay-floor substrates allow. This ecological restoration will reshape the coast of the bay creating new sources of freshwater runoff, restored habitat, and a soft buffer to further deaden storm wave action.

PHASE 03
ADDITIONAL PROGRAMS

With the protection system in place along with the expanded islands, facilities for recreation and enjoyment of the bay will be put in place. These trails, camps, event spaces, and temporary or mobile facilities will enable extensive access to the bay by the public. The storm protection system will be an icon for the region and destination in itself, with opportunities for ecotourism, boating, and various bay-front activities.

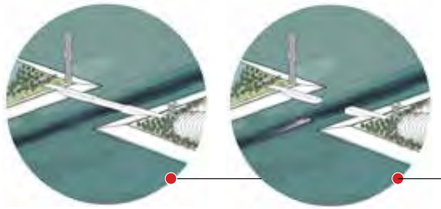
MAIN GATE
MECHANICAL GATE

05

TECHNOLOGY

LEVERAGE EXISTING TECHNOLOGIES

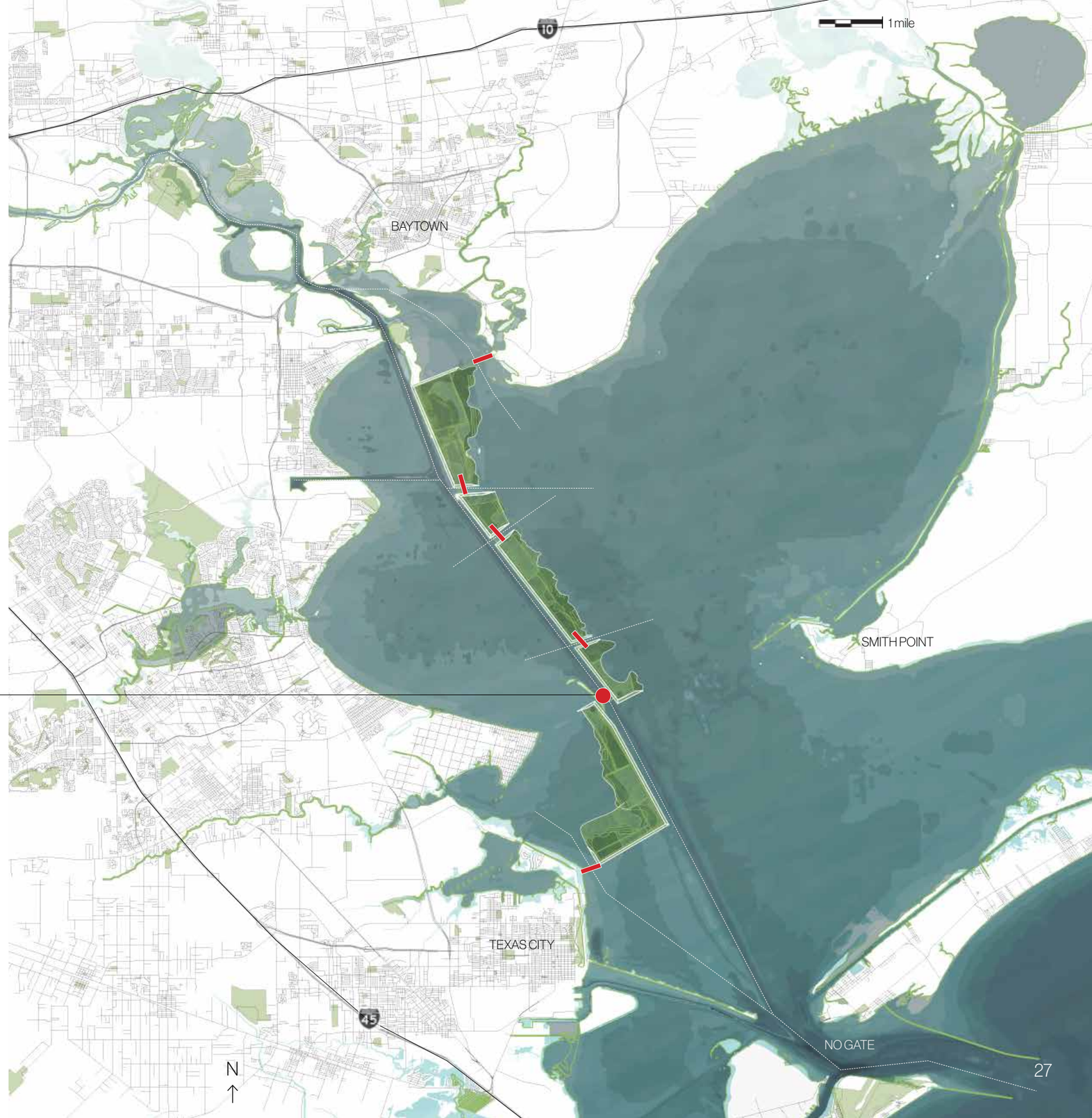
The Maeslant, Ijssel and Hartel Barriers are storm surge gates that protect key navigational points within the Dutch Delta Works system. These are proven technologies that have been in place for decades, providing reliable storm surge protection to the Dutch western coast. In the interest of efficiency and reliability, the storm surge protection system in Galveston Bay has been designed around these **known and implementable technologies**. Openings in the barrier system are minimized to preclude closure distances that exceed current technologies. The mid-barrier navigational openings and gates allow for easy passage of recreational and commercial vessels across the line of protection. At the intersection of the ship channel navigational lanes, the opening is larger--indeed large enough for future expansion of the ship channel capacity should that happen--but still within the distances where proven technologies can be deployed.



CLOSED MIDBAY GATE

OPEN MIDBAY GATE

Storm surge barrier in Delft, Netherlands



HARD EDGE
SOFT EDGE

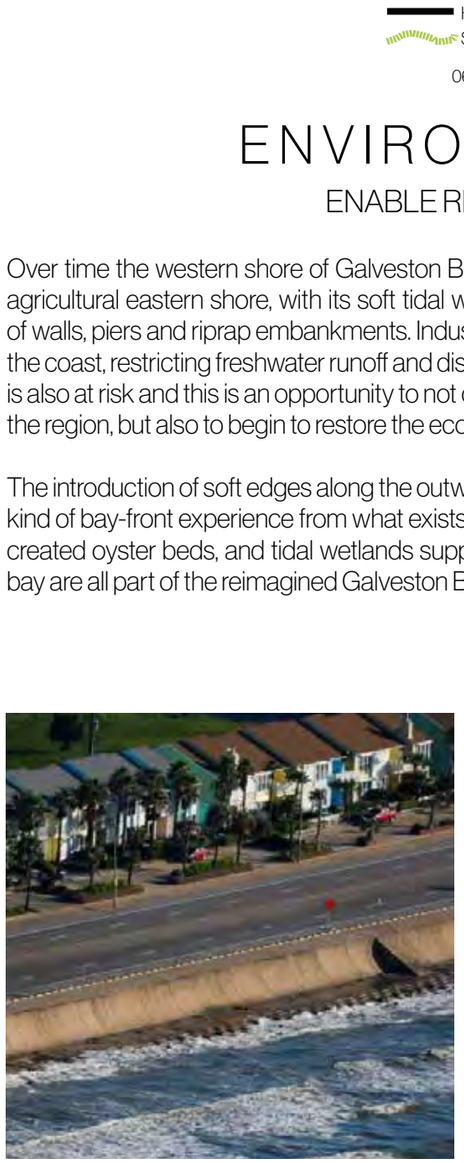
06

ENVIRONMENT

ENABLE RECOVERY

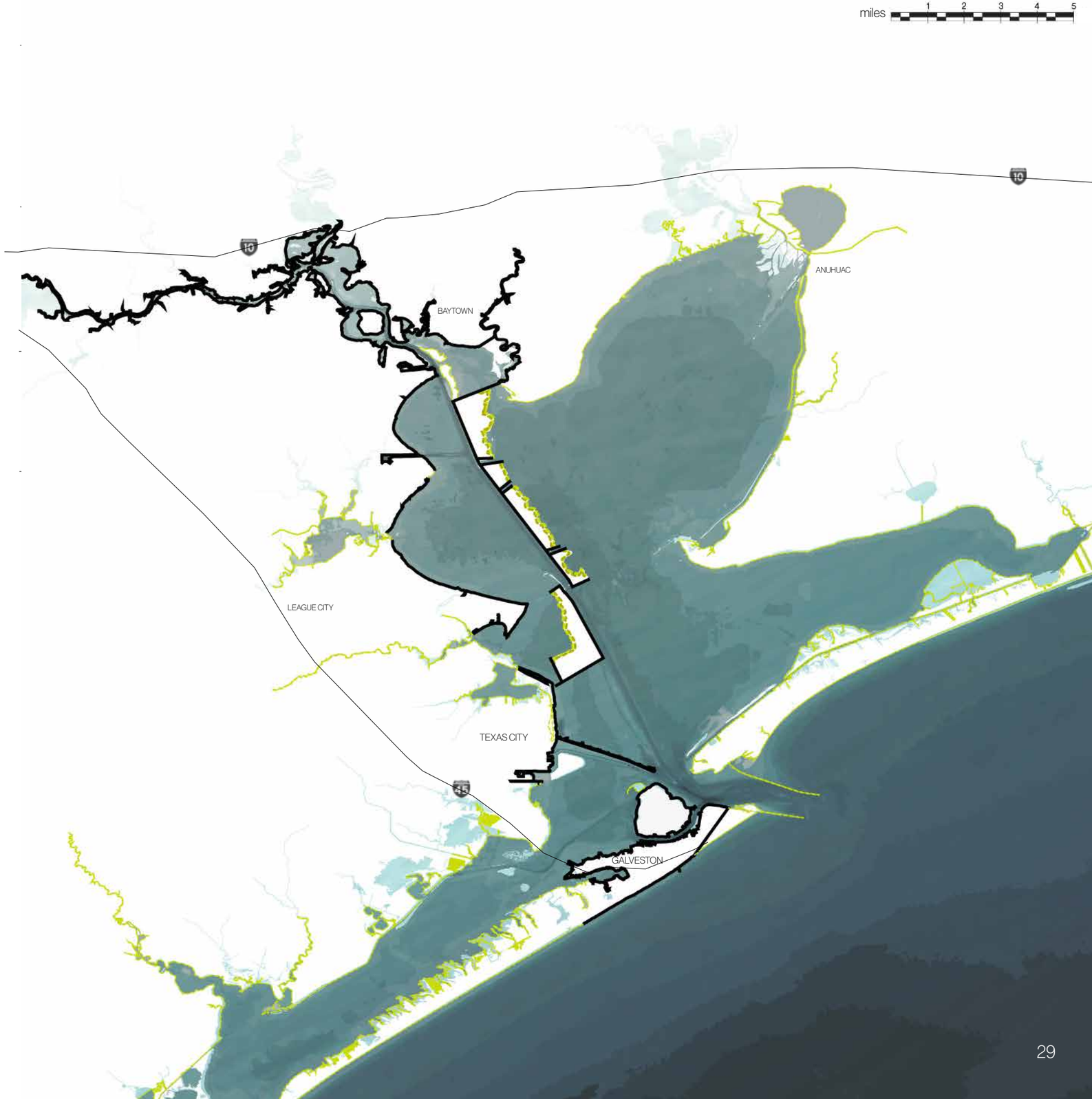
Over time the western shore of Galveston Bay has been built as a hard edge. Unlike the agricultural eastern shore, with its soft tidal wetland edge, the western shore is made up of walls, piers and riprap embankments. Industry and development infrastructure reach to the coast, restricting freshwater runoff and displacing habitat. The balance of life in the bay is also at risk and this is an opportunity to not only protect the communities and industry of the region, but also to begin to restore the ecological vibrancy of Galveston Bay.

The introduction of soft edges along the outward edges of the barrier will create a different kind of bay-front experience from what exists today. New nesting sites for migratory birds, created oyster beds, and tidal wetlands supporting the diverse and unique wildlife of the bay are all part of the reimagined Galveston Bay.



Hard edge

Soft edge



CURRENT OYSTER REEFS
HISTORIC OYSTER REEFS
PRIORITY PROTECTION HABITATS

07

ECOLOGY

OYSTERS ARE THE LIFE OF THE BAY

A single oyster can filter tens of gallons of bay water every day. Although devastated by over-harvesting and the direct and indirect destruction of their habitat, Galveston Bay's oysters are critical to the ongoing survival of the bay's ecosystem. Without the oysters, the unfiltered waters of the bay will struggle to support life.

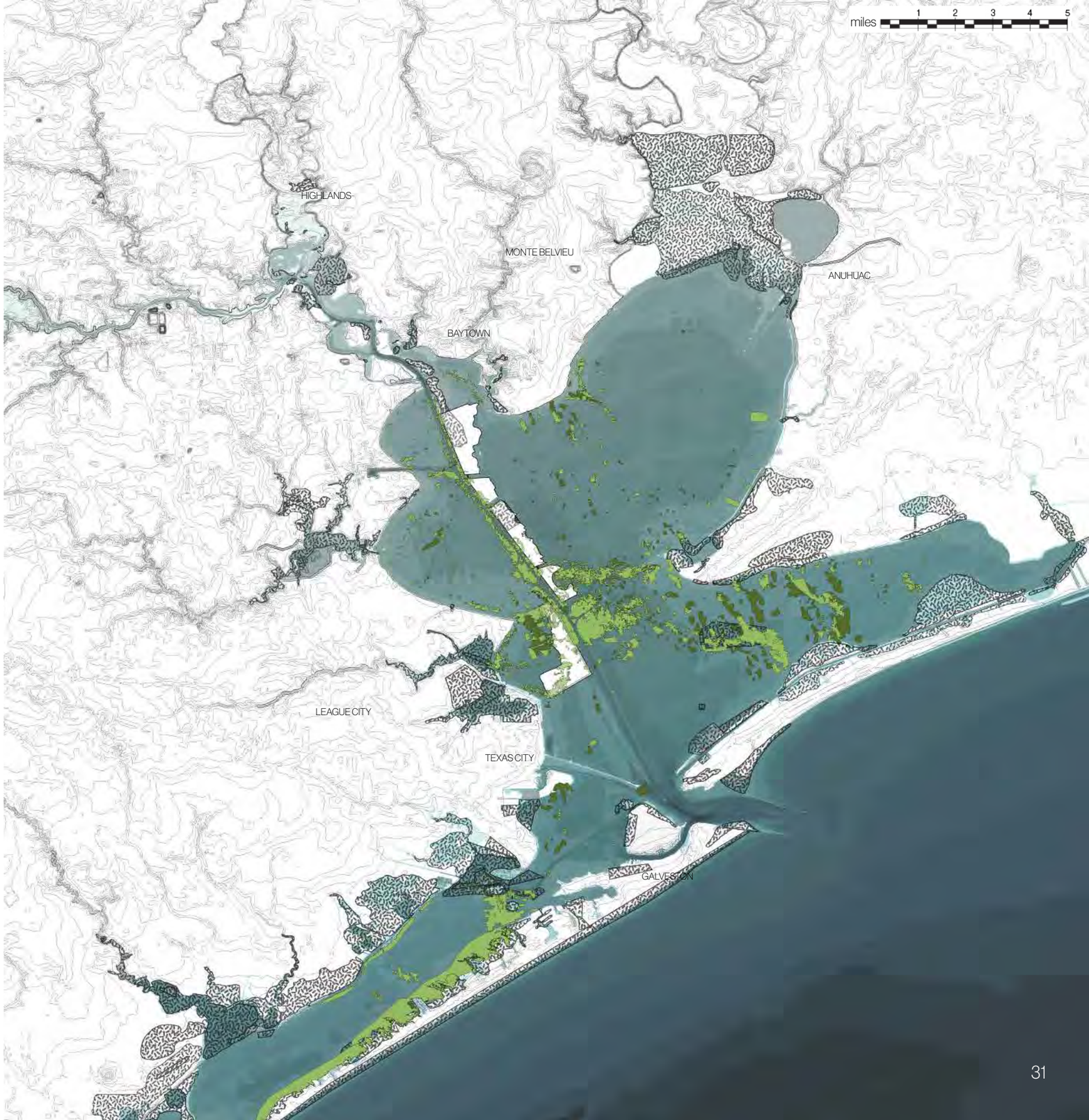
The creation of new oyster beds is integral to the planning of Galveston Bay Park and the mid-bay storm surge protection system. These new oyster habitats will be established in the locations where they are the most ecologically viable and they will be built as part of the project's first phase. Starting with the oysters, a range of flora and fauna will be supported through new habitats within the bay promoting healthy and vibrant ecosystems.

(1)
oxygen and suspended particles are absorbed into the oyster with water.

(2)
these particles are absorbed through the gills.

(3)
the water passes through the mantle and the particles are processed into the protective shell.

(4)
The filtered water returns as clean water. Oysters can filter up to 50 gallons of water every day.



PRIVATE COAST
ROAD / BIKE ACCESS
BOAT ACCESS
PUBLIC BOAT DOCKS
FULL PUBLIC ACCESS

08

ACCESS

THE BAY BELONGS TO EVERYONE

Today, the shores of the bay are mostly privately owned and controlled. Anyone not owning bay-front property only has access to the bay through a few select points. The bay-fronting public lands total about 500 acres which is miniscule considering the bay's shores extend for over 200 miles. As the development of the region continues, lands reserved for public recreation and immersive experiences in the natural environment have become scarce. Galveston Bay Park is an opportunity to simultaneously provide a new shoreline with **miles of continuous access and nearly 10,000 acres of public lands** for recreation and appreciation of the bay's ecosystem.

Existing private properties along the Houston Galveston Bay

ROAD TOWER TRIATHLON RIDING TRAILS EVENT SPACES CAMPING BIRD WATCHING

GALVESTON BAY PARK BELONGS TO THE PEOPLE

For the operation and maintenance of the gates, an access road will be built. From this base infrastructure, a whole network of activities can be planned. From horse trails, to fish camps, to bicycle trails, the protection system's islands will become destinations for outdoor enthusiasts. In the middle of the bay, at the ship channel gate, an event center will include amphitheater seating and a floating stage where musical performances can take place against the backdrop of the expansive bay waters and high Texas skies. Marinas for recreational vessels will create a whole new set of places to go while out for a day on the bay. Boaters who miss the recently lost Redfish Island will find various new locations to drop anchor and explore.

Visualization of the type of park space that will exist on Galveston Bay Park

BIRD ROOKERIES
CONCENTRATION BIRDS

FISH
CRUSTACEANS

09

PARTICIPATION

LIFE IN THE BAY IS A CONSTANT ATTRACTION

More species of migrating birds fly through Texas than any other state in the country. Positioned on the Upper Texas Coast Wildlife Trail, the Galveston Bay region is already an international draw for birders. The construction of Galveston Bay Park will increase habitat and ecotourism sites. The bay already supports a great diversity of flora and fauna and the park is poised to benefit the health of the bay ecosystem. **The islands are planned to support varied habitat types, from tidal wetlands to coastal prairies.**

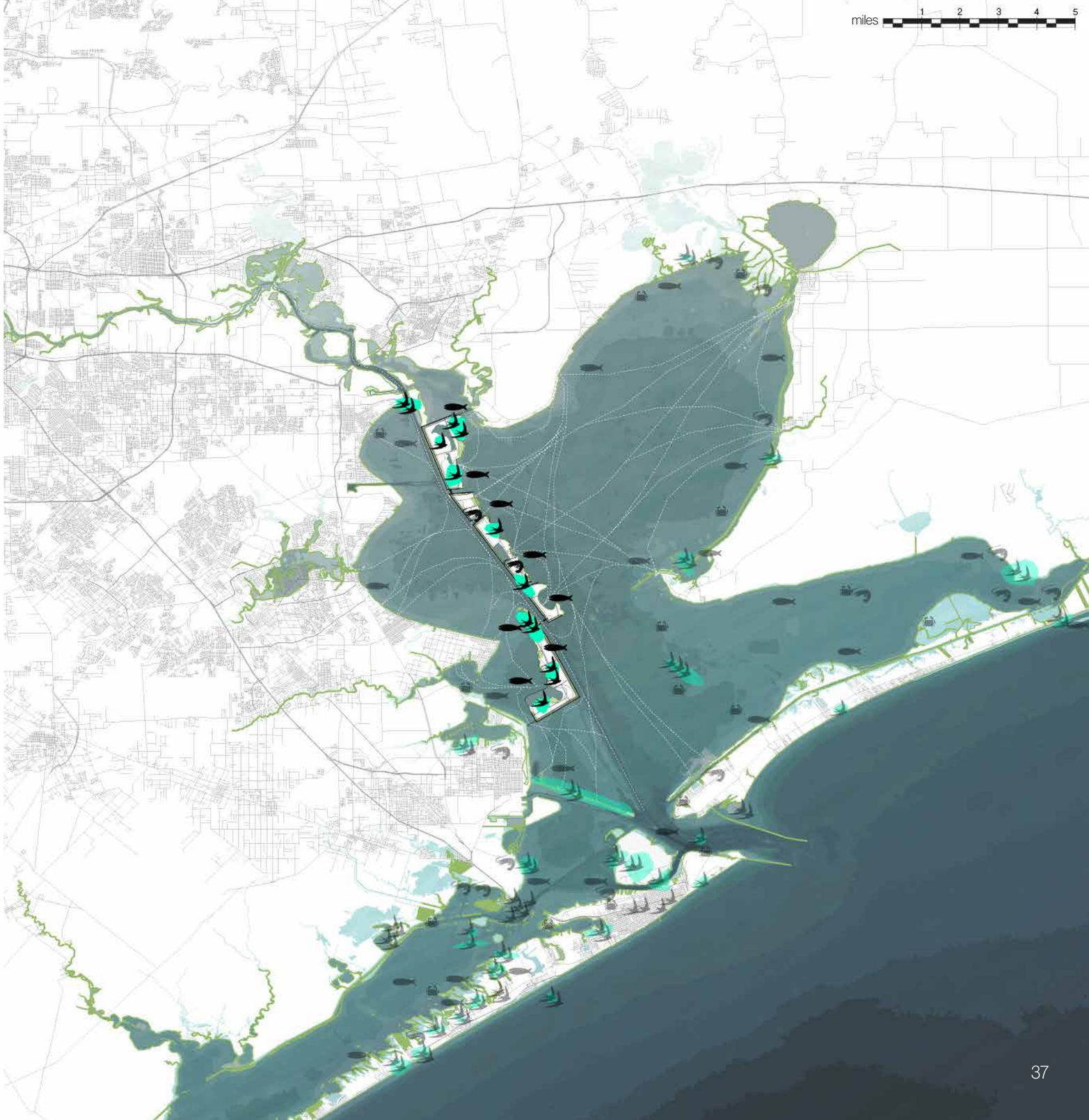
Understanding that a vibrant ecosystem requires multiple ingredients to survive, the islands of the protection system will be maintained to thrive ecologically while simultaneously protecting the communities and economic infrastructure of the bay.

BROWN PELICAN

GREEN SEA TURTLE

KING MACKEREL

PIPING PLOVER



10

FUNDING

FAST, AFFORDABLE, DOABLE

A storm surge protection system for the region can't wait any longer. With the start of each annual hurricane season, disaster is on the doorstep. The Galveston Bay Park project is designed to be built quickly and efficiently. Strategically located along the line of dredge banks currently permitted by the Army Corps of Engineers, the project is ready to start today. The project's cost is estimated at less than a third of the cost of other proposals for the region. Rather than rely on a single source for backing, the project funding strategy is envisioned to enable a range of participants to contribute. Public funding will be a mix of federal, state, and local dollars while private philanthropy will also play a role. Just as the ship channel was built with a mix of federal and local funding, this project will be a joint effort and an honest Texan public-private partnership. Scaled and calibrated to create the most benefit, on the quickest schedule, for the least cost, this project is ready to go.

H-GAPS PLAN SCENARIO :	COST ESTIMATE :	.....WITH 20% CONTINGENCY :
MID-BAY GATE	$ 0.5 B	$ 0.6 B
IN-BAY BERMS	$ 1.4 B	$ 1.7 B
GALVESTON FM-3005	$ 0.075 B	$ 0.09 B
BOLIVAR SH-87	$ 0.06 B	$ 0.07 B
SMALL SAND DUNES	-	-
GALVESON LEVEE	$ 0.25 B	$ 0.3 B
PHASE 1 SUBTOTAL	$ 2.3 B*	$ 2.8 B**

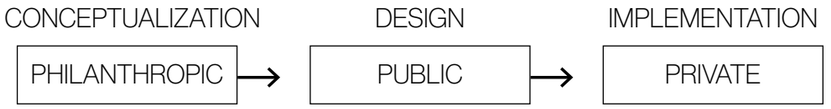
* This cost estimate does not include the cost of raising Texas Levee and the construction of small sand dunes at F' and G'

** One Tenth of the cost of IKE at 28 B

BREAKDOWN

Financial support and leadership often evolve over the project lifecycle enabling different partners to facilitate project realization.

PROJECT PHASE



FUNDING AND SUPPORT MECHANISMS

GRANTS
TECHNICAL ASSISTANT
PROJECT CHAMPION

FEDERAL GRANTS
TAX CREDITS
STREAMLINED APPROVALS

PRIVATE EQUITY
BONDS
LOANS

BENEFITS

Galveston Bay Park will enable a range of benefits to public. private, and civic stakeholders:

JOB CREATION & RETENTION

LOCAL, STATE & GOVERNMENT SAVINGS

ACCESS TO OPEN SPACE AND AMENITIES

REDUCED RESIDENTIAL FLOODING

KEY INDUSTRIAL PROTECTION

DECREASED INSURANCE COSTS

SSPEED CENTER

HOUSTON

6100 Main St, MS-317
Houston, TX 77005
+1 713.348.4951

ROGERS PARTNERS

NEW YORK

100 Reade Street
New York, NY 10013
+1 212.309.7570

HOUSTON

718 Richmond Avenue
Houston, TX 77006
+1 646.442.8778

WALTER P. MOORE

HOUSTON

1301 McKinney Suite 1100
Houston, TX 77010
+1 713.630.7300

LET'S GET STARTED

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AAL