GALVESTON BAY PARK PLAN: EXECUTIVE SUMMARY

Storm Surge Protection · Navigation Improvement · Park Creation · Environmental Mitigation



PROJECT TEAM

Dr. Philip Bedient – SSPEED Center – Director Jim Blackburn – SSPEED Center – Co-Director Larry Dunbar – SSPEED Center – PM Clint Dawson – U.T. Austin Rogers Partners Architects Walter P. Moore Eng. Blake Eskew Mustafa Tameez David Robinson Kristina Cibor



SPONSORS

- Harris County
- City of Houston
- Port of Houston
- Joe Swinbank

Introduction

The Houston-Galveston region faces a growing threat from hurricane storm surge, with potentially catastrophic consequences for its people, economy, and environment. The SSPEED Center at Rice University, along with its consultants, developed the Galveston Bay Park Plan (GBPP), a mid-bay barrier/park system, to address this threat for the highly vulnerable west side of the bay, especially its industrial complexes, while being compatible with the larger USACE Coastal Barrier plan that serves to help protect all around the bay. Together, the GBPP and the USACE Coastal Barrier plan provide solutions for shared objectives to (1) enhance storm surge protection for the people, property, and critical infrastructure located around the bay, (2) advance navigation along the Houston Ship Channel in the bay by coordination and implementation of the proposed Project 12 of the Port of Houston Authority, and (3) create a vibrant and dynamic destination for our region that includes significant environmental enhancement.

By working together and engaging key stakeholders – City of Houston, City of Galveston, Port of Houston, Harris and adjacent counties, State of Texas (i.e. GLO and GCPD), USACE, community leaders, and residents – we believe that the collaboration of these two plans will accomplish our shared objectives. The engineers and architects of the GBPP estimate total construction costs of \$7 billion with completion targeted for 10 years following the start of construction. Over the long-term, the GBPP is expected to offer compatibility with future developments and improvements by the USACE and Port of Houston, such as the Port of Houston's proposed Project 12 deepening of the Houston Ship Channel (HSC).

This executive summary provides an overview of the GBPP, its key features and benefits. This project was funded by four key parties, each of whom contributed \$250,000 for this project that spans almost two years. These key funders were Harris County, the City of Houston, the Port of Houston Authority and Joe Swinbank, an individual entrepreneur.

The Urgent Need for Enhanced Protection

The Houston-Galveston region is home to 5+ million residents, 4,000+ commercial / industrial complexes (including oil & gas operations, which account for 14% of U.S. crude oil refining), and the second largest port in the United States – the Port of Houston. This region is highly susceptible to the damaging effects of hurricane storm surge, even with existing protection systems, including the Galveston Seawall and the Texas City levee system, that do not offer sufficient defense against the increasing severity and frequency of major storms. Based on research conducted by the SSPEED Center, the risk of more severe storms (Category 3, 4, and 5) is expected to continue to increase in the future. For reference, when Hurricane Ike landed on the Texas Coast in 2008 as a large Category 2 storm, the Houston-Galveston region suffered about \$30 billion in damages. More recently, we have seen how storms crossing the Gulf dramatically increase in size and strength. The more severe the storms, the greater the damages will be to residents, industries, and the broader U.S. economy. Yet since Ike hit us in 2008, nothing has been constructed to help reduce this ever-growing risk.

Key Features of the GBPP

Given the expected increase in storm severity, the additional storm surge protection offered by the GBPP, coupled with the USACE Coastal Barrier plan, can better protect the Houston-Galveston region, limiting damage and recovery costs. **Figure 1** outlines the elements of the GBPP (1 and 2), coupled with elements of the USACE Coastal Barrier plan (3, 4, and 5).



Figure 1: Elements of the Galveston Bay Park Plan coupled with the Coastal Barrier

Elements 1 and 2 are the main differentiating features of the GBPP. **Element 1** is a mid-bay levee protection structure running along the Houston Ship Channel (HSC) up to 25 feet above sea level, which is proposed to replace the two gate structures and pump systems proposed on Dickinson Bayou and Clear Lake in the USACE plan. The mid-bay structure offers more comprehensive protection and limits storm surge impacts to the west side of the bay, including communities and industries such as those in League City, Kemah, Seabrook, Morgan's Point, Houston, Baytown and all those along the Houston Ship Channel. **Element 2** increases storm surge protection up to 25 feet for the Texas City levee, which is above the 16-25 feet of protection offered by the current levee structure at Texas City. Beyond Elements 1 and 2, the design and implementation of the coastal protection aspects of the USACE plan (Elements 3-5) remain unchanged.

The GBPP consists of various components to its mid-bay protection system, such as 25-foot high levees along the HSC, a number of small navigation gates at openings between the levees to allow for water circulation and small craft to pass through the levee system, a large main navigation gate crossing the HSC, and other features to enhance the usefulness of the system in non-surge

conditions (e.g. a park). Figure 2 shows the general gate locations and layout of the GBPP, with the levee system aligned along the black line.



Figure 2: Gate locations and layout of the GBPP mid-bay structures

A few unique features of the GBPP mid-bay structure are detailed below.

- **Navigation and circulation gates:** Strategically placed gates at openings in the levee system will ensure safe navigation and water circulation while also acting as part of the barrier against storm surge. These gates will be designed to accommodate small crafts, minimizing disruption to local maritime traffic.
- **Innovative gate design:** The engineers of the GBPP have developed an innovative arcshaped gate design for the main gate across the Houston Ship Channel. This design, inspired by movable stadium roofs, offers significant advantages over traditional sector gates, including reduced material costs and improved stability.

• The Park: A 10,000+ acre park will be created adjacent to the levee system (shown in Figure 2 as light green areas) using dredged material, offering a variety of recreational opportunities and contributing to the restoration of the Galveston Bay ecosystem. The park will feature trails, campgrounds, and other amenities, providing public access to the bay and enhancing the region's quality of life.

It is important to note that the earthen-levee portion of the GBPP is proposed to be constructed from the material dredged to deepen and/or widen the Houston Ship Channel as part of the Port's proposed Project 12. Virgin clay material from this dredging will be compacted and used to form the 25-foot-high mid-bay levee barrier that ultimately will connect Houston Point in Chambers County with the Texas City levee system in Galveston County. As such, both navigation and flood protection features will be integrated into a single project.

Storm Surge Protection Offered by the GBPP

To validate the additional protection offered by the GBPP mid-bay structure, storm surge projections were run by the SSPEED Center for a variety of hurricane sizes, using the ADvanced CIRCulation (ADCIRC) computer model. The ADCIRC model is the state-of-the art technology for simulating hurricanes and their resulting storm surges as they move across the oceans and make landfall. The University of Texas at Austin developed an updated ADCIRC model for the Galveston Bay area which was used by the SSPEED team to perform its storm surge analyses for this study effort. The outputs of the model allowed the team to compare surge protection offered by the USACE Coastal Barrier plan with and without the GBPP.

In **Figures 3a, 3b and 3c**, the results of one of those storms (a small Category 4 hurricane – FEMA Storm 36) are presented for three levels of protection (**Existing**, the **Coastal Barrier** without the GBPP, and the Coastal Barrier with the **GBPP**). The track of the storm is indicated by the black dotted line on these figures.

The **Existing** storm surge protection system (Galveston Seawall and Texas City levee) provides virtually no protection to surge flooding in the Galveston Bay area from major hurricanes, as shown in Figure 3a, with about 20 feet of flooding throughout the bay area, and as much as 23 feet of surge flooding predicted in east Harris County along the HSC.

The **Coastal Barrier** plan reduces such surge flooding by about 5 feet for most of the bay area, but these major hurricanes will overtop the coastal barrier dune system and still produce devastating flood damage, as shown in Figure 3b.

The **GBPP** provides additional surge flood protection to the vulnerable west side of the bay area, further reducing surge flooding by more than 5 feet beyond that provided by the Coastal Barrier plan, as shown in Figure 3c.



Figure 3a. Cat 4 Storm Surge Inundation under Existing Protection Systems



Figure 3b. Cat 4 Storm Surge Inundation under USACE Coastal Barrier Plan without GBPP



Figure 3c. Cat 4 Storm Surge Inundation under USACE Coastal Barrier Plan with GBPP

It is also important to note that this research has identified an important remaining risk to the La Marque-Texas City area, even with the Coastal Barrier and GBPP in place. As can be seen in Figures 3b and 3c, significant flooding still occurs from the "backside" of Texas City. This surge flooding comes from the overtopping of the West End of Galveston Island and across West Bay, bringing significant flooding to Texas City and to the Dickinson Bayou and Clear Lake areas from the south and west rather than from the bay. This is a new finding that should lead to consideration of the expansion of the Texas City levee system to the west to attempt to intercept this overland surge water.

In **Figure 4**, the table at the top of the figure compares storm surge projections (depicted by water surface elevation – WSEL – in feet) at three critical locations labeled on the map: (A) the upper Houston Ship Channel, (B) Clear Lake, and (C) Texas City. The table columns compare storm surge projections at each of the three locations at the three levels of protection. As shown in Figure 4, the level of storm surge protection at each of these three locations provides a percentage of flood reduction that is almost doubled by the GBPP, versus the protection offered by the USACE Coastal Barrier plan without the GBPP. Additional surge flood reduction would occur behind the GBPP barrier if the surge waters entering from the overflows across West Bay were to be blocked from entering into the Dickinson and Clear Lake areas.

CAT4 WSEL (ft)			Flood Reduction		
Exist.	СВ	GBPP	Exist.	СВ	GBPP
22.5	16	9.5	0%	-29%	-58%
18.5	13	9	0%	-30%	-51%
19	13.5	9	0%	-29%	-53%

Houston Ship Channel, A Clear Lake, B Texas City, C

Exist.: Existing Conditions

CB: Coastal Barrier

GBBP: Galv.Bay Park Plan



Figure 4: Modeled storm surge impact of a Category 4 Storm at specific locations with three levels of protection (Existing and Coastal Barrier without and with the GBPP)

Given the increased protection offered by the GBPP mid-bay structure relative to the protection offered by the USACE proposed gate structures and pump systems at Dickinson Bayou and Clear Lake, the engineers who designed the GBPP mid-bay protection structure suggest applying the estimated cost of these proposed gate structures and pump systems to offset some of the \$7 billion construction cost of the GBPP that replaces those structures.

Benefits of the GBPP – Industries, Communities, and Environmental Considerations

Beyond its surge protection and economic benefits, the GBPP offers positive opportunities for industries, communities, and the environment in the Houston-Galveston region. The Park feature of the GBPP provides access to 10,000+ acres of public lands for recreation, creating a new comprehensive relationship with and understanding of the Bay. Of particular importance is that with the exception of the construction of the 25-foot barrier along the ship channel itself, significant discretion exists in the placement of the dredge material for park development and environmental enhancement. In the way that some great infrastructure projects like the Golden Gate Bridge and Chicago's Navy Pier have contributed to the cultural quality of a region and have become celebrated icons of their cities, we believe the Galveston Bay Park Plan provides storm surge protection while embracing the opportunity to do more for the region and its communities.

- Industrial protection: The Houston-Galveston region is at the center of the oil & gas industry in the U.S. Approximately 14% of US crude oil is refined and stored in this region. Without the protection offered by the USACE Coastal Barrier and GBPP, the vulnerability of the above-ground storage tanks (ASTs) is very high, with a total regional spill risk exceeding 541 million liters. With the GBPP and USACE Coastal Barrier plan in place, this spill risk reduces to 18 million liters. Similarly, the expected regional spill cleanup cost drops from \$6.5 billion without these plans in place to \$220 million with the GBPP and USACE Coastal Barrier plan.
- Economic Development: As proposed, the GBPP will be a key element in the implementation of Project 12, providing synergy between navigation enhancement and flood protection. By integrating dredge material placement within the GBPP, the implementation of Project 12 should be enhanced.
- **Community resilience:** The Houston-Galveston region is home to 5+ million residents and many of the coastal communities (such as in Galveston, Texas City, and League City) have low-income and underserved populations, which are particularly vulnerable to and often disproportionately affected by hurricane impacts. During a severe storm, these populations may have limited access to resources to adequately prepare for and recover from such events. They may reside in less resilient housing, have limited access to transportation for evacuation, and face greater challenges in rebuilding their lives after a storm. With the additional protection offered by the mid-bay structure and the 25-foot levee in Texas City, the GBPP has the potential to better safeguard such communities and others for decades to come.
- Environmental stewardship: GBPP is committed to minimizing its environmental impact and maximizing its positive contributions to the Galveston Bay ecosystem.

Potential impacts on oysters, bay circulation, and floodwater evacuation have been carefully considered, and mitigation efforts are incorporated into the plan.

- Oyster Reef Protection: The placement of dredged material will be carefully planned to avoid damage to oyster reefs, which are vital to the bay's health.
 Mitigation efforts will focus on restoring oyster reefs in areas where salinity is expected to increase in the future due to reduced local freshwater inflow.
- *Bay Circulation*: The design of the levee system with its multiple openings will ensure adequate water circulation and salinity levels in the bay. Navigation and circulation cuts will be strategically placed to maintain the bay's existing flow patterns.
- *Floodwater Evacuation*: The GBPP mid-bay structures will not impede the ability for floodwaters to evacuate from inland areas. Computer modeling indicates that there will be sufficient time to open all gates and allow stormwater runoff/floodwaters to drain into the bay during hurricane events.

Implementation

At this point in time, the design team for the GBPP are in discussion with the U.S. Army Corps of Engineers about next steps in the potential implementation of the Galveston Bay Park Plan. In coordination with the Corps, the GBPP will be evaluated as an alternative to the two gates currently proposed within Galveston Bay at Dickinson Bayou and Clear Lake as part of the Corps' Coastal Barrier project. In the future, evaluation will be undertaken of both the feasibility of incorporating the GBPP into the Corps plan as well as implementing this project through permitting if necessary.

Conclusion

The Galveston Bay Park Plan (GBPP) not only offers a comprehensive solution that complements the USACE Coastal Barrier plan, it makes beneficial use of available dredging/excavated material from the Port of Houston's Project 12, and is set up to be compatible with any future improvements planned for the region by the USACE and Port of Houston. The threat of more severe hurricane storm surge in the Houston-Galveston region is increasing. By integrating robust protection measures with environmental restoration and recreational opportunities, the GBPP offers a sustainable and resilient approach to safeguarding the community and the region's future.