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HURRICANE IKE STRUCK 5 YEARS AGO.

ARE WE READY FOR THE NEXT BIG STORM?



THE ANSWER IS NO.

Houston's Centennial Gate is part of the Solution



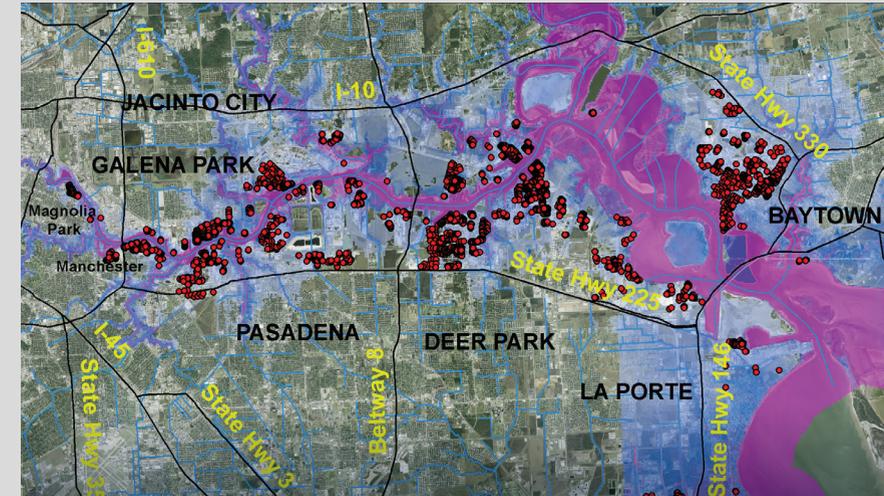
SEVERE STORM PREDICTION, EDUCATION AND EVACUATION FROM DISASTERS CENTER

Are We Ready?

Hurricane Ike struck the Texas Gulf Coast in 2008. More than two dozen people perished and the cost of infrastructure damage was in excess of \$24 billion.

If Hurricane Ike, a category 2 storm, had higher wind speeds and made landfall just 30 miles west of where it actually came ashore, it would have generated a 25 foot surge of water into the Houston Ship Channel, causing catastrophic economic and environmental damage and possible loss of life.

The probability of a direct hit from a category 4 "Super Ike" is increasingly difficult to predict. Highly unusual weather events in recent years - including Hurricane Sandy in the northeast in 2012 - have climatologists and scientists questioning long-held assumptions and weather modeling tools. For these reasons, devastating storms that previously were considered likely once-in-a-hundred-years may now happen more frequently.



Legend

- Aboveground Storage Tanks
- Inundation Depth (ft)**
- High : 25
- Low : 1

25-ft Storm Surge in the Houston Ship Channel



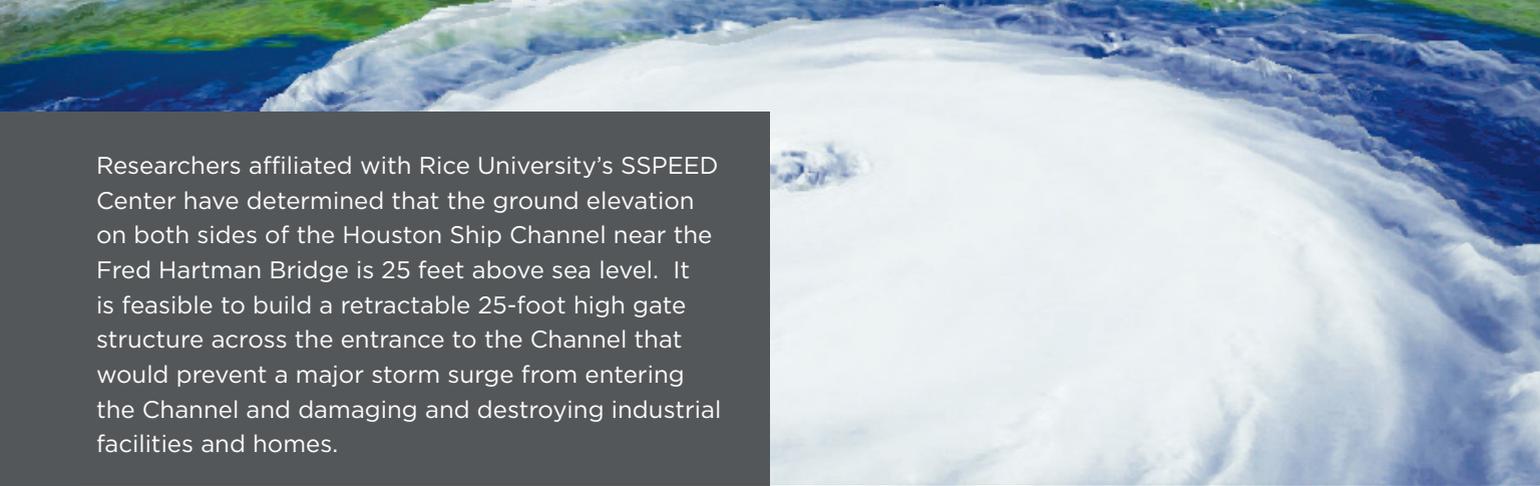
What's at Stake?

One of the most vulnerable areas in our region is the Houston Ship Channel, which will celebrate its 100th year of service in 2014. Extending approximately 20 miles from Loop 610 East to the Fred Hartman Bridge, the Channel's industry supports more than 150,000 jobs for Houstonians and more than 1 million jobs in Texas. It generates annual payrolls in excess of \$13 billion and more than \$178 billion in economic impact, with customers at the Port of Houston contributing nearly \$5 billion annually in tax revenues.

Government regulations require protection of many Channel facilities to about 14 feet elevations, well short of a projected 25 foot surge from a "Super Ike" storm. A hurricane of this magnitude would result in a significant area of the channel complex going under

water. An estimated 2,800 above-ground storage tanks would be surrounded by varying depths of water and many could float off their foundations or otherwise breach their contents. Also, an undetermined number of pumps, generators and ancillary equipment would be damaged, as occurred to Invista chemical company in Orange, Texas during Hurricane Ike. It could take many weeks or months to make repairs, assuming that flooded facilities were rebuilt.

Such a flood event would have catastrophic effects on Ship Channel facilities, their residential neighbors and Galveston Bay. For example, hundreds of homes adjacent to Murphy Oil Corp.'s Meraux refinery were destroyed when Hurricane Katrina flood waters lifted a crude oil tank and released 1.05 million gallons.



Researchers affiliated with Rice University's SSPEED Center have determined that the ground elevation on both sides of the Houston Ship Channel near the Fred Hartman Bridge is 25 feet above sea level. It is feasible to build a retractable 25-foot high gate structure across the entrance to the Channel that would prevent a major storm surge from entering the Channel and damaging and destroying industrial facilities and homes.

The Need for SSPEED

The Severe Storm Prediction, Education and Evacuation from Disasters (SSPEED) Center was established in 2007 at Rice University as a research and education organization. Its mission is to prepare the Houston region by increasing public awareness of the risks associated with severe storms and proposing small and large scale mitigation strategies.

The Solution: Houston's Centennial Gate

Two designs have been developed thus far as a storm surge barrier. In both cases, levees would be constructed to the edges of the dredged Channel. One design is a two-hinged gate structure with curved walls that would connect in the middle in an open "V" shape. A version of this design, known as The Maeslantkering, was completed in 1997 and has been used to protect the Rotterdam Harbor in the Netherlands. The second design involves a linear gate structure that would slide across the Channel, much like a sliding deadbolt lock on a door entryway.

This solution for dramatically reducing current risks facing the Ship Channel is compatible with larger, regional levee concepts that will take far longer to implement and that must rely heavily on federal funding to build.

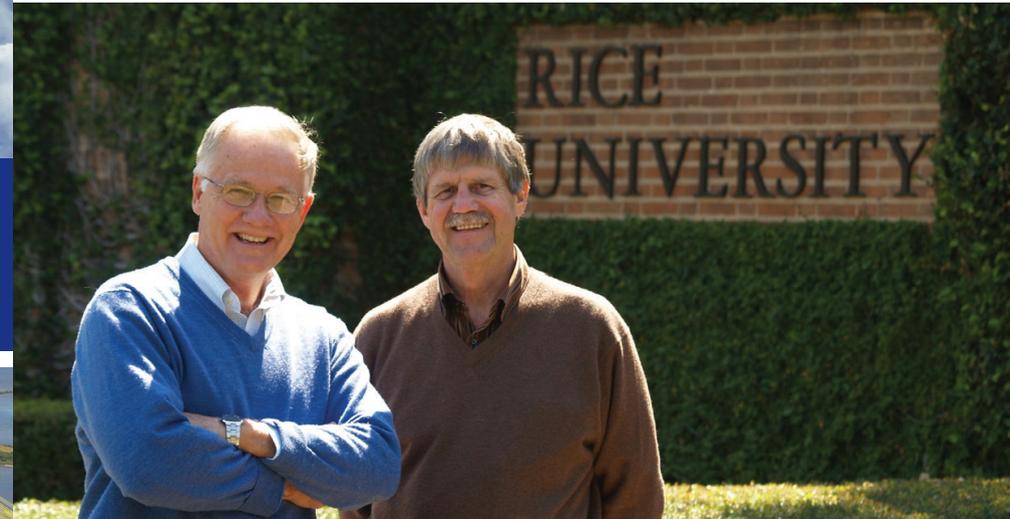
Houston's Centennial Gate Project is a local solution which can be funded with local funds, perhaps through a future bond election. Precise cost estimates are not yet possible, but the cost of designing and building the Centennial Gate is likely to be in the range of \$1 billion. A cost-versus-benefit calculation makes the Gate a clear winner, since the overall economic costs from a "Super Ike" in the Channel could be in the range of \$60 to \$100 billion, with environmental damage also severe.



Two-hinged gate structure with curved walls



Linear gate structure



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Centennial Gate will provide economic security for Houston's future and ecological security for Galveston Bay.

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Scientists and engineers also are participating from the University of Texas, the University of Houston, Texas A&M University, Texas A&M Galveston, Texas Southern University and Louisiana State University. Several local engineering and architectural companies are actively involved as well.

Following Hurricane Ike, the SSPEED Center received a \$1.2 million grant from the Houston Endowment to identify lessons learned from Ike and to evaluate Houston's preparedness. A second, three-year grant of \$3.2 million was awarded in 2011. The conclusions from Phase I of the Center's research are available in *Lessons from Hurricane Ike*, published by A&M Press in 2012.



The Houston Centennial Gate Project described above is one of the most important strategies resulting from the SSPEED Center's research. The Centennial Gate name recognizes the century of beneficial commerce the Houston Ship Channel has provided the Houston region. More importantly, the Centennial Gate will help ensure the Channel's continued vitality for us and future generations of Houstonians.