SUPPRESION OF HURRICANE SURGE FORERUNNER AND PEAK SURGE IN GALVESTON AND WEST BAYS ACHIEVED WITH A WESTERN SEGMENT OF THE COASTAL SPINE.

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Abstract

The original Ike Dike concept was a coastal barrier, or "spine", comprised of a continuous line of dike/wall sections that followed the coastline from Freeport, TX to Sabine Pass, TX, with storm surge gate systems at the two tidal passes, San Luis Pass and Bolivar Roads. The Ike Dike concept has evolved slightly to a shorter alignment, which turns inland at High Island and follows Texas State Highway 124 north to Winnie, TX. This latest alignment, referred to herein as Alignment 1a and comprised of western, middle and eastern dike sections, is shown in Figure 1.

Figure 1

The Gulf Coast Community Protection and Recovery District (GCCPRD) conducted a Storm Surge Suppression Study; and, in their 2016 Phase 3 Report they recommended a different alignment for a coastal spine. The approximate alignment they recommended is shown in Figure 2, referred to here as Alignment 2. Their recommended alignment had only a middle section, without any eastern or western sections, and it had a storm surge gate system only at Bolivar Roads. The tidal inlet at San Luis Pass is left open in their recommended plan. The alignment shown in Figure 2 is approximate, in the sense that it is situated at the coastline; whereas, the actual alignment recommended by the GCCPRD is situated along the highways on both Galveston Island and Bolivar Peninsula.

Figure 2

Most recently, as part of Alternative A developed by the U.S Army Corps of Engineers (USACE) in the Coastal Texas Study, a coastal spine was proposed that has similarities to the alignments of both the current Ike Dike coastal spine concept and the coastal barrier recommend by the GCCPRD. The USACE Alternative A, was recently presented as their Tentatively Selected Plan for this region of the Texas coast. The approximate alignment of the coastal barrier recommended by the USACE is shown in Figure 3, and is referred to here as Alignment 3. The alignment recommended by the USACE has middle and eastern sections; however, the tidal pass at San Luis Pass is left open in their plan as well. The alignment shown in Figure 3 is approximate, in the sense that it is situated at the coastline; whereas, the actual alignment recommended by the USACE is situated along the highways on Galveston Island and Bolivar Peninsula, as was the case for the alignment recommended by the GCCPRD. Also, the eastern section of the coastal barrier shown in Figure 3 extends further to the north along State Highway 124 than the alignment in the USACE plan. Figure 4 shows the coastal barrier as proposed by the USACE as part of Alternative A.

Figure 3

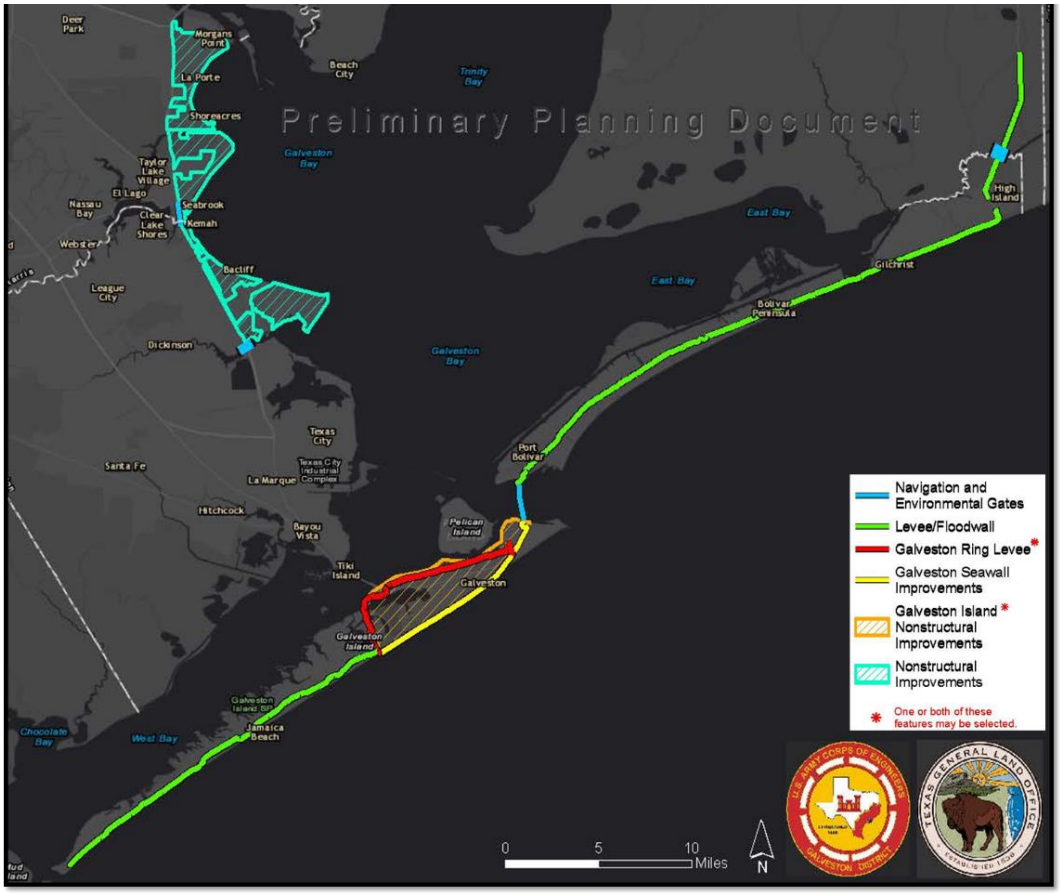

Figure 4

The Ike Dike coastal spine concept (Figure 1) achieves its effectiveness by greatly reducing the amount of water which enters both Galveston and West Bays during a hurricane surge event. During the surge forerunner development stage of major hurricanes, which can begin several days before landfall, water enters the bays through both Bolivar Roads and San Luis Passes. Later, when the low-lying barrier islands become inundated by the storm surge forced by the hurricane's core winds as it approaches landfall, water flows over Galveston Island and Bolivar Peninsula and into the bays. Water continues to flow even more strongly through both tidal passes as the hurricane eye nears landfall.

Once inside the shallow bays, accumulated water can be easily pushed about by hurricane force winds. Strong winds create high surge levels on the down-wind side of the bays, flooding areas adjacent to West Bay, potentially flooding the City of Galveston and the heavily populated and industrialized western shoreline of Galveston Bay, and then driven up the Houston Ship Channel, flooding industrialized areas adjacent to the ship channel. To maximize the effectiveness of the coastal spine, it is desirable to minimize the amount of water that resides insides the bays at the time of landfall through early closure of storm surge gates at both tidal passes.

Without a western section of the coastal spine, as is the case for coastal barrier alignments proposed by both the GCCPRD and USACE, there is a "back door" for the hurricane surge to propagate through San Luis Pass, leading to higher peak surges within West Bay and Galveston Bay. Figure 5 illustrates the effects of leaving the "back door" open. Figure 5 shows the difference in peak storm surge that is realized within West Bay when the back door is open (Alignment 3 above) compared to peak surge that is realized when it is closed (Alignment 1a above). Results in the figure are for a 100-yr proxy storm that produces an open-coast peak surge at San Luis Pass of 14 ft, NAVD88, at the present sea level.

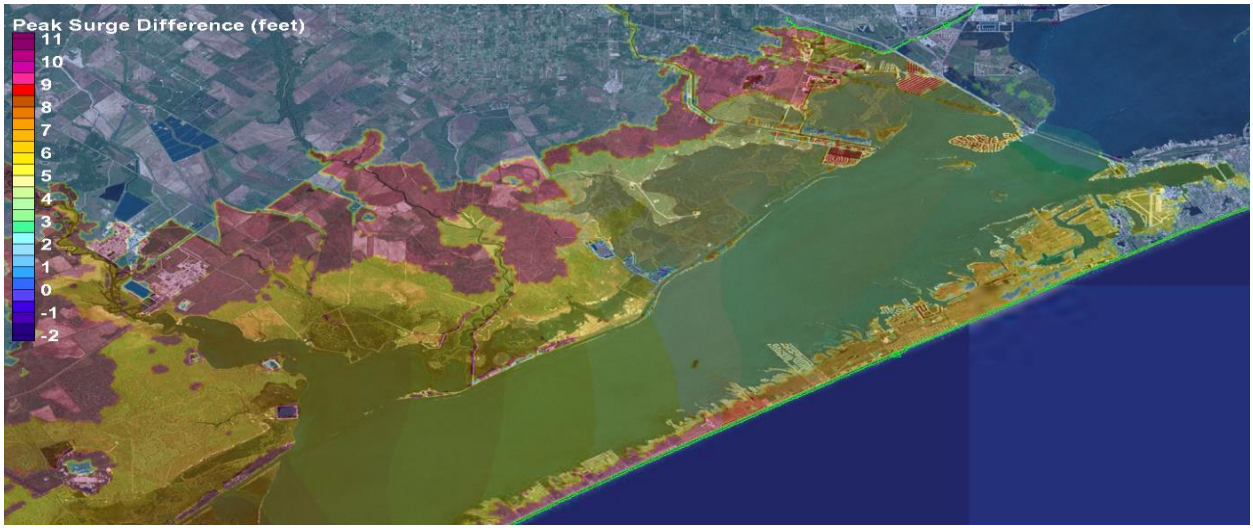

Figure 5

Results show the widespread increases in peak surge that occur within West Bay without a western dike section and surge gate at San Luis Pass. Peak surge differences generally range from 4 to 7 ft, with greater amounts in some places. The darker orange and red shaded

colors, in particular, show additional areas that are inundated by leaving the back-door open, compared to the dike alignment that has a western section which closes the back-door. The open back-door leads to inundation of nearly all of Galveston Island west of the City of Galveston, as well as inundation at the Galveston Airport and a few other areas within the City itself. The open back-door also leads to inundation of numerous communities and several industrial facilities along the north shore of West Bay, which do not experience inundation with the western dike section in place. Other severe hurricanes, for both present and future sea levels, show the same general results. Omission of a western dike section from the USACE Tentatively Selected Plan should be examined more closely.

The back-door also appears to enable propagation of the hurricane surge forerunner into Galveston Bay, through West Bay. The presentation examines the dynamics behind development of the surge forerunner, its propagation into Galveston and West Bays, and the implications of peak surge and surge forerunner propagation on flood risk within Galveston Bay.