

LOWER BRAZOS RIVER BASIN FLOODPLAIN PROTECTION STUDY FINAL PUBLIC MEETING

Waller County, Texas
July 26, 2018

Reasons for the Study

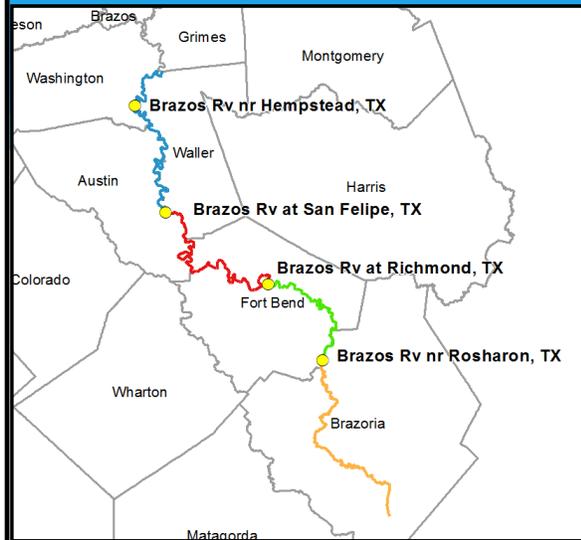
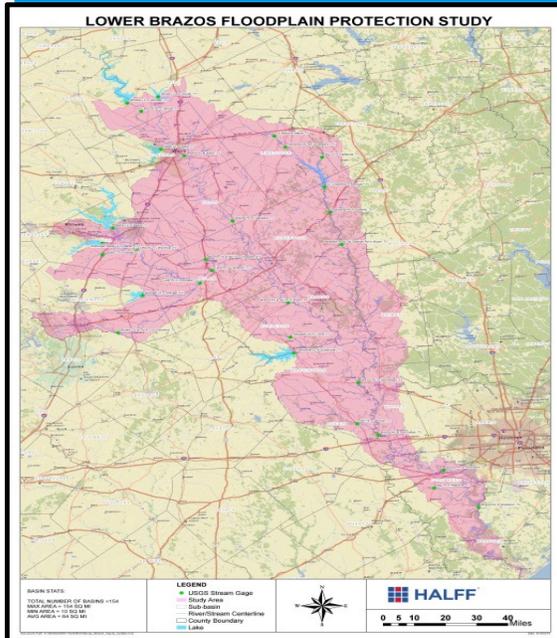
- * One of the fastest growing areas in the country
- * Hydrologic and hydraulic models/data are dated outside of Fort Bend County
- * Need for consistent modeling methodology across county boundaries
- * Need to assess lower Brazos watershed from a comprehensive basinwide perspective (existing conditions and alternatives)
- * 10,000 square miles of uncontrolled drainage area



Goals of the Study

- * Quantify existing flooding issues and flood damage reduction alternatives
- * Update hydrologic and hydraulic data for the lower Brazos River (above Hempstead gauge to mouth across 5 counties)
- * Calibrate new models to historical events and provide flood volumes, flood depths, and flood durations
- * Facilitate land use planning, emergency response, and sound floodplain management

Lower Brazos River Floodplain Protection Planning Study



Lower Brazos River Floodplain Protection Planning Study



Where are We Today?

- * Contract was extended to include additional modelling for the impacts of Hurricane Harvey
- * Basin wide hydrology is 100% complete
- * Hydraulics models are 100% complete from the Washington/Waller County Line to the Gulf of Mexico
- * Floodplain mapping is 100% complete
- * Alternative Analysis is nearly complete
- * Flood Damage Analysis Modeling is nearly complete
- * Environmental Constraints Analysis is nearly complete
- * Draft Report is underway



Hempstead Comparison

Flows (cfs)

Elevation NAVD88 (feet)

Return Period	2009 Waller Co. FIS	Gage Freq. Storm Analysis	HEC-RAS Design Storm Analysis
10-Year	110,000	97,000	98,000
50-Year	182,473	140,000	142,000
100-Year	206,962	157,000	161,000
500-Year	260,000	195,000	227,000

Return Period	2009 Waller Co. FIS	HEC-RAS Unsteady Model
10-Year	163	158.62
50-Year	167.8	162.05
100-Year	169.2	162.92
500-Year	171.7	165.66



San Felipe Comparison

Flow (cfs)

Return Period	HEC-RAS Design Storm Analysis
10-Year	94,000
50-Year	136,000
100-Year	157,000
500-Year	225,000

Elevation NAVD88 (feet)

Return Period	2010 Austin Co. FIS	HEC-RAS Unsteady Model
10-Year	120.2	123.59
50-Year	123.4	127.96
100-Year	127.2	129.84
500-Year	129.5	132.71



Richmond Comparison

Flows (cfs)

Return Period	2014 Ft. Bend Co. FIS	Gage Freq. Storm Analysis	HEC-RAS Design Storm Analysis
10-Year	103,000	88,000	87,000
50-Year	147,000	117,000	123,000
100-Year	164,000	127,000	139,600
500-Year	202,000	148,000	187,000

Elevation NAVD88 (feet),
27.02 feet above USGS Gauge

Return Period	2014 Ft. Bend Co. FIS	HEC-RAS Unsteady Model
10-Year	76.7	77.18
50-Year	81.3	82.82
100-Year	82.8	84.45
500-Year	85.2	87.69



Rosharon Comparison

Flows (cfs)

Return Period	2014 Ft. Bend Co. FIS	HEC-RAS Design Storm Analysis
10-Year	103,000	86,000
50-Year	145,000	125,000
100-Year	162,000	145,000
500-Year	200,000	204,000

Elevation NAVD88 (feet)

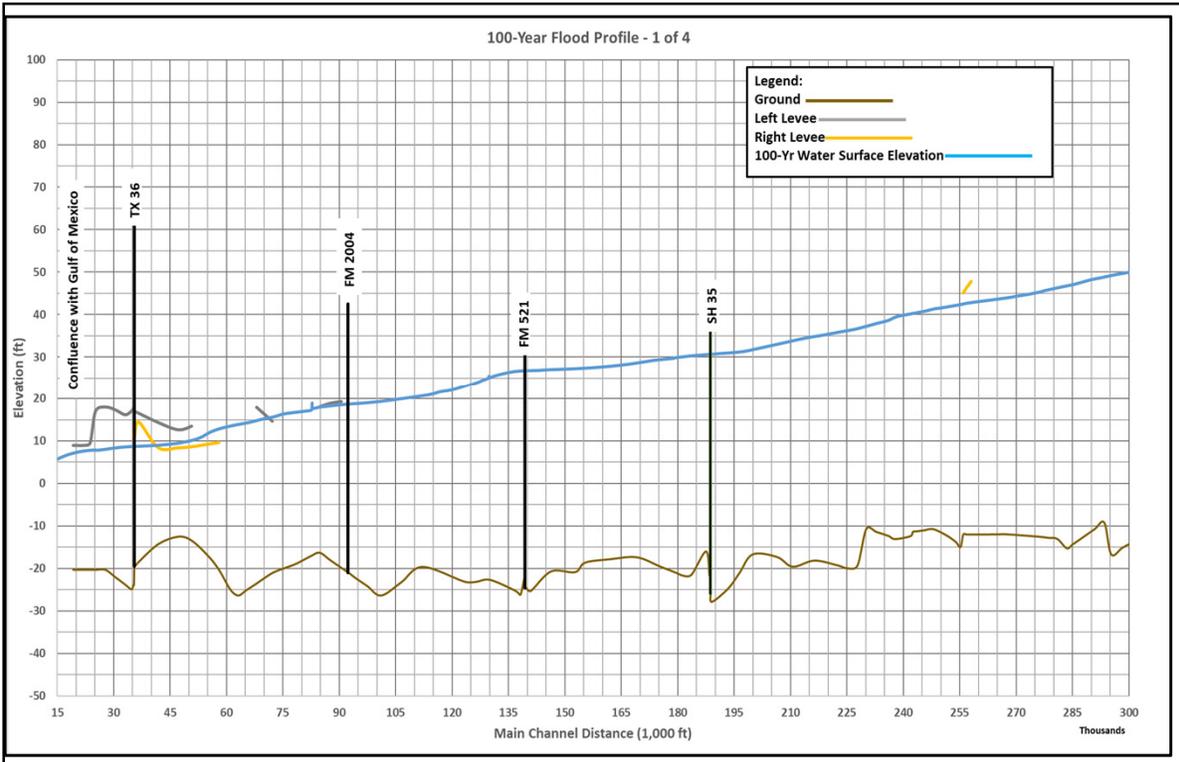
Return Period	2014 Ft. Bend Co. FIS	HEC-RAS Unsteady Model
10-Year	51	50.98
50-Year	51.5	51.32
100-Year	51.5	51.42
500-Year	51.8	51.72

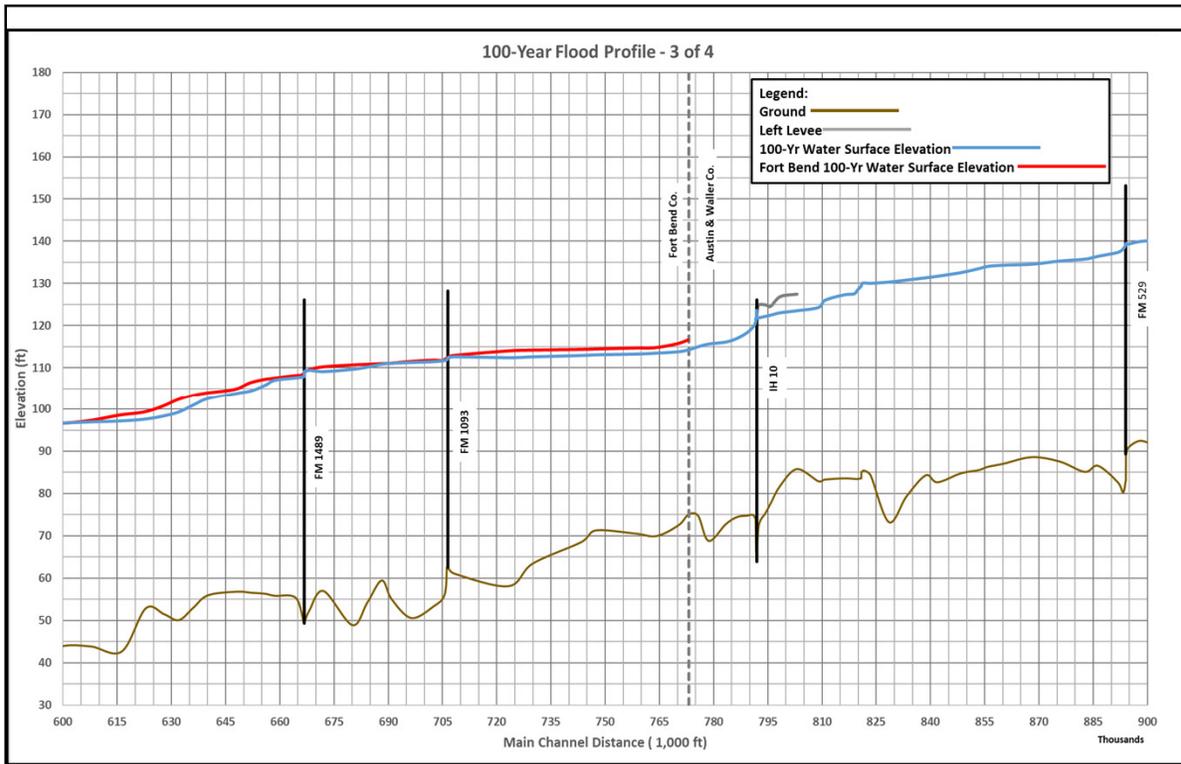
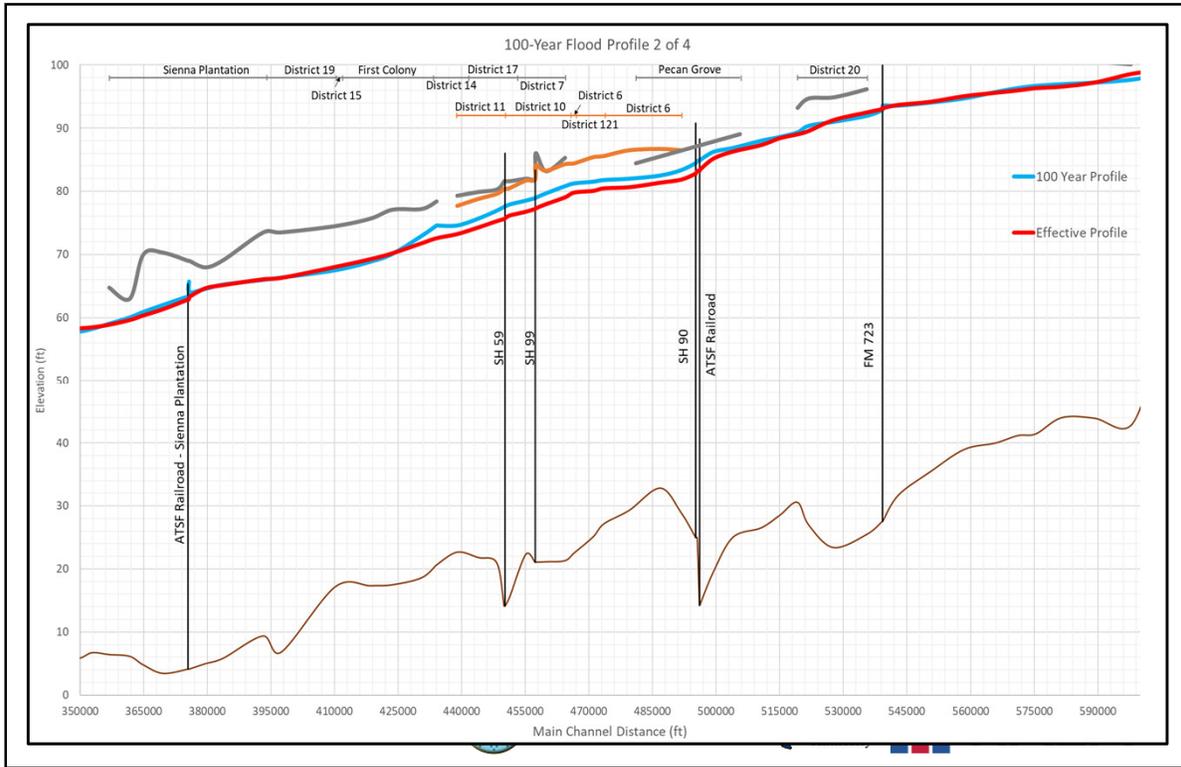
Lower Brazos River Floodplain Protection Planning Study

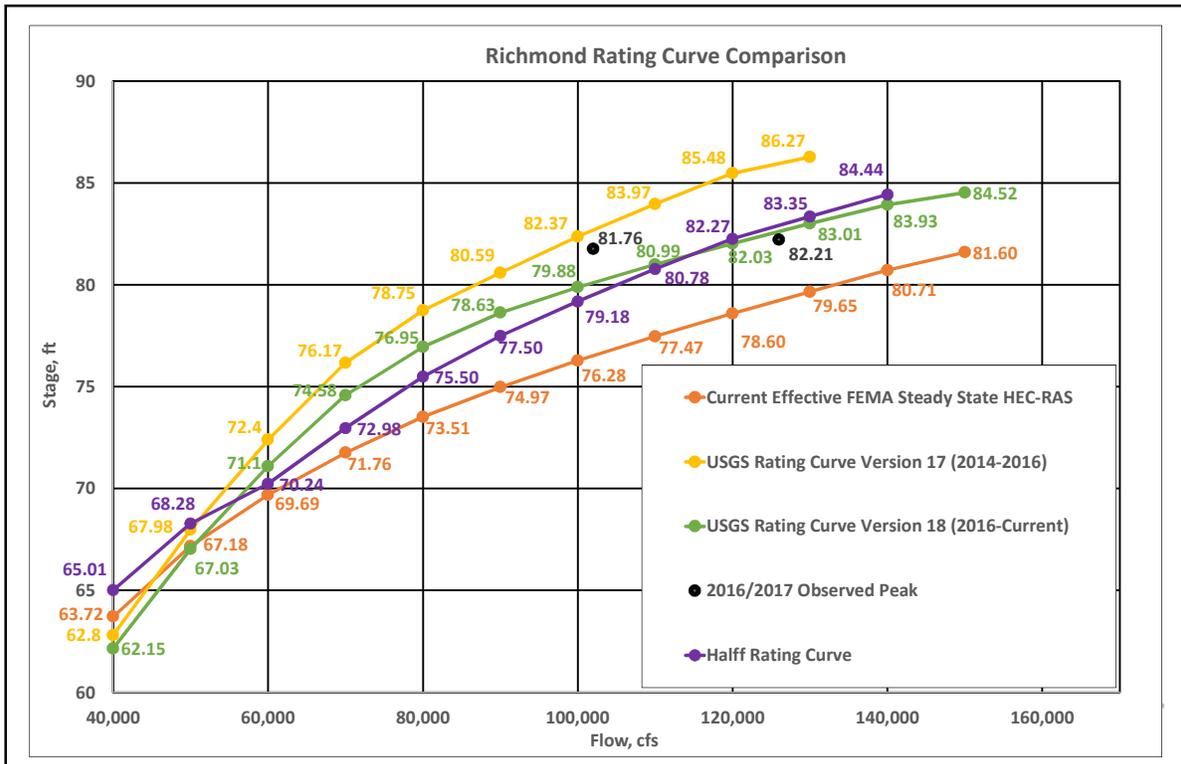
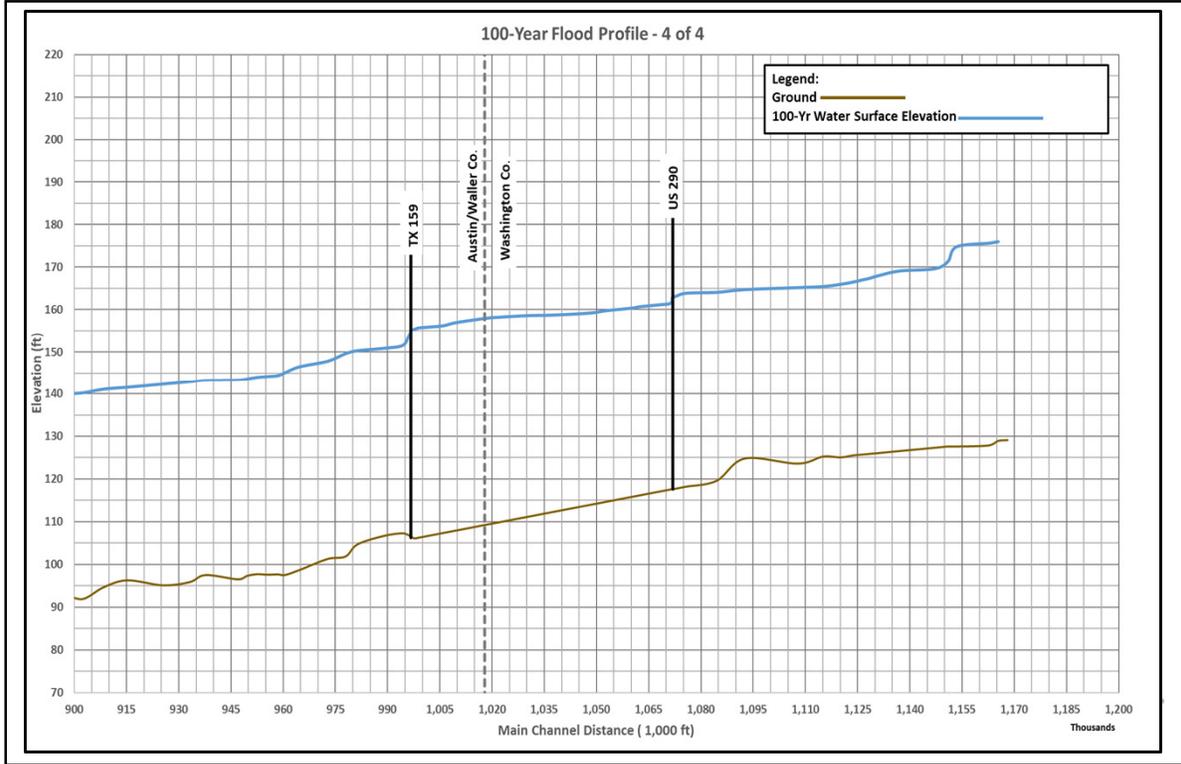


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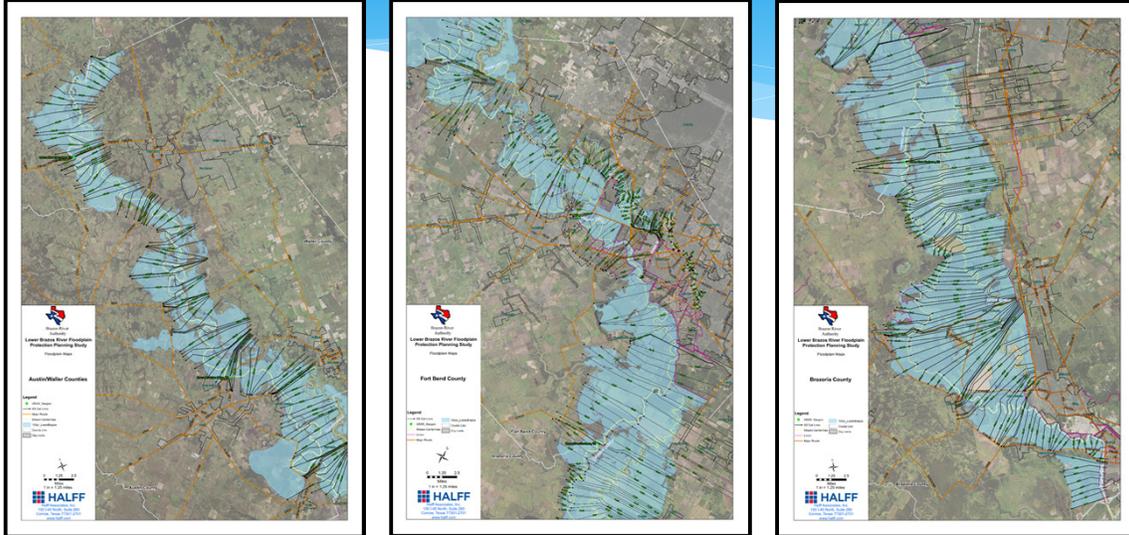






100-Year Inundation Maps



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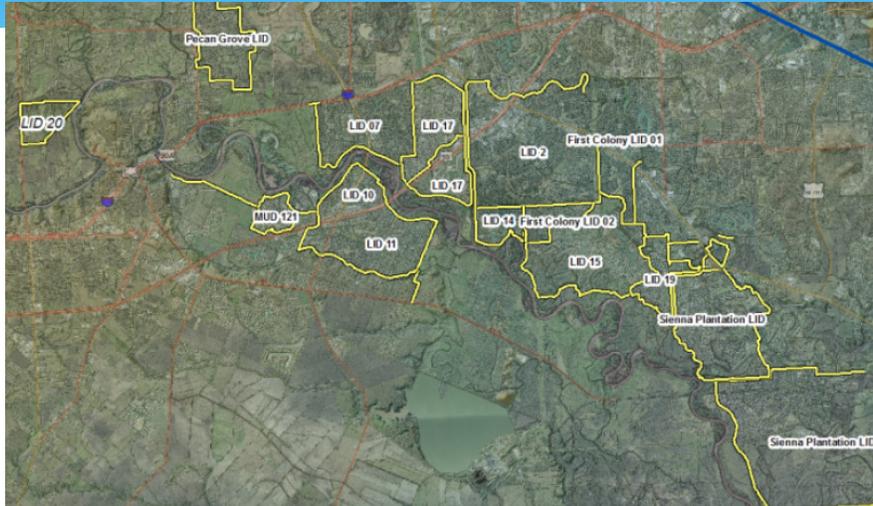
Brazos River Study Results

- * Freeboard Check
- * Bank Station Changes
- * Key Elevations

Lower Brazos River Floodplain Protection Planning Study



Levee Freeboard Check



Lower Brazos River Floodplain Protection Planning Study



Levee Freeboard Check

- * LiDAR was used to compare the 100-year WSEL to check FEMA's freeboard requirements
- * FEMA Freeboard Requirements:
 - * 3-feet above the 1% ACE water surface elevation
 - * Additional 1-foot within 100-feet of structures
 - * Additional 0.5 feet at the upstream end of a levee
- * Analyses showed that further investigation maybe required at LID#6, LID #7, LID #10, LID#14, LID#17, and LID #20
- * Freeboard Range
 - * LID#2 – 4.39 to 5.37 feet
 - * LID# 6 – 2.64 to 4.04 feet
 - * LID#7 – 3.82 to 4.89 feet
 - * LID#10 – 2.88 to 3.6 feet
 - * LID#11 – 2.4 to 4.5 feet
 - * LID#14 – 2.89 feet to 4.11 feet
 - * LID#15 – 3.05 to 5.32 feet
 - * LID#17 – 3.08 to 3.2 feet
 - * LID#19 – 4.85 to 5.3 feet
 - * LID#20 – 2.01 to 4.22 feet
 - * MUD 121 – 3.52 to 3.8 feet
 - * First Colony – 3.49 to 4.73 feet
 - * Sienna Plantation – 8.04 to 8.25 feet
 - * Pecan Grove – 2.25-4.03 feet

Lower Brazos River Floodplain Protection Planning Study



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Lower Brazos River Floodplain Protection Planning Study

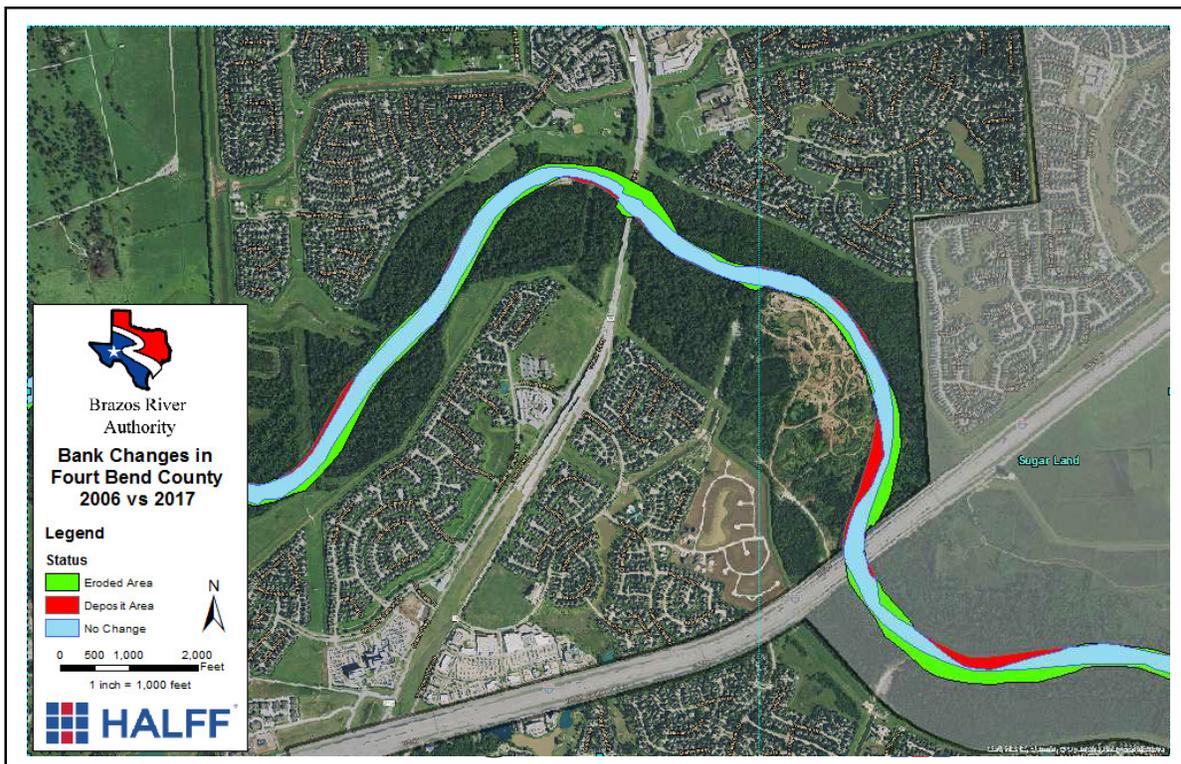
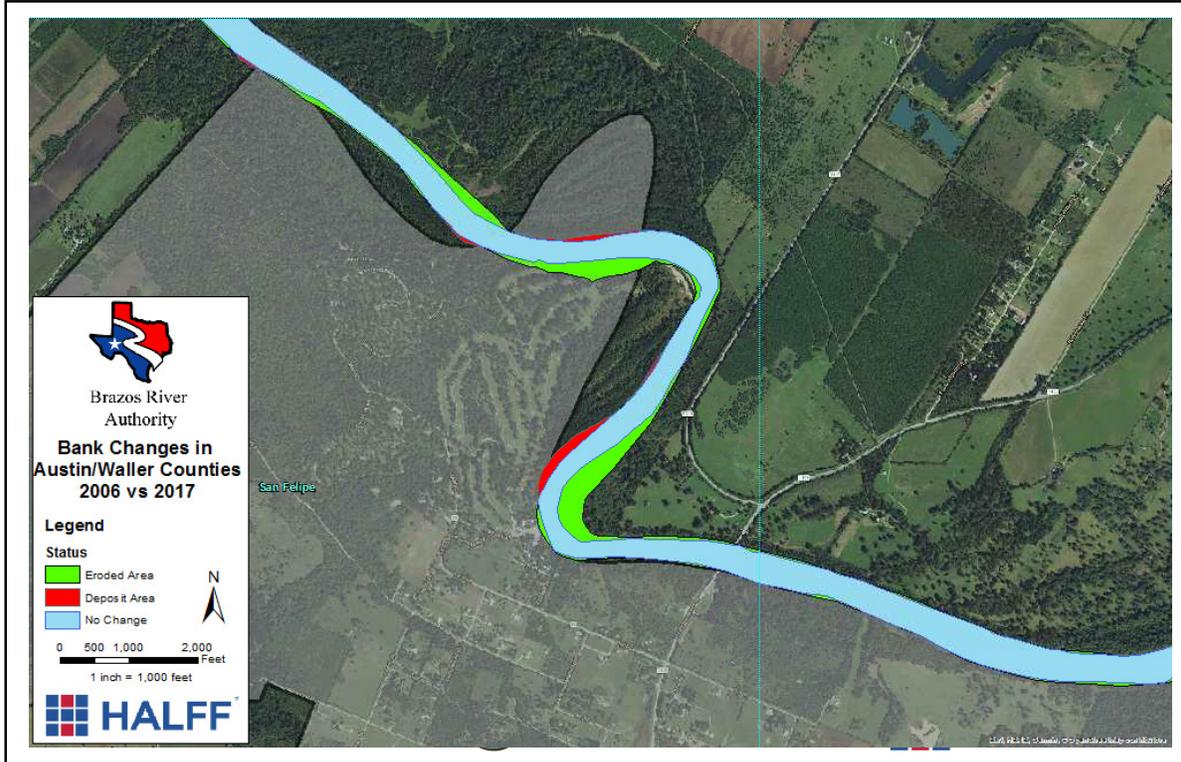


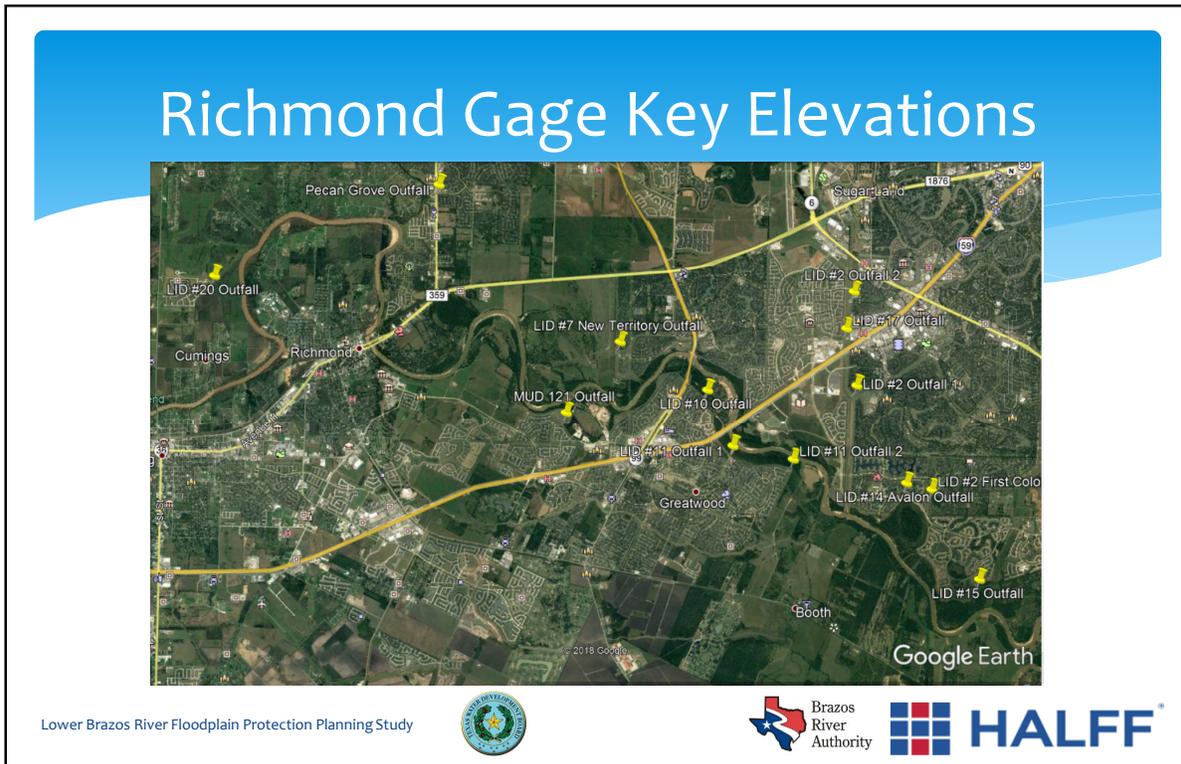
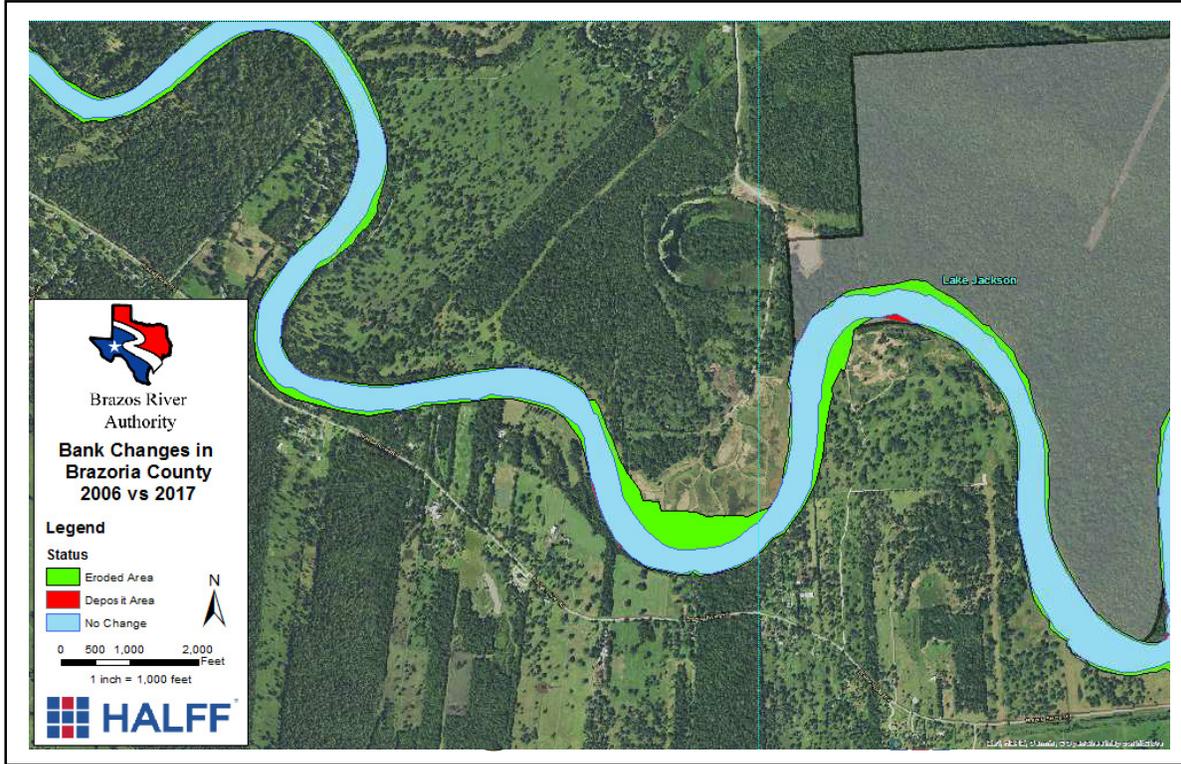
Bank Station Changes

- * Channel erosion and deposits change the alignment and hydraulic properties of the Brazos
- * Goal was to show how much the Brazos has changed since 2006
- * Aerial imagery from 2006, 2008, 2015 and 2017 were used to compare banks along the Brazos

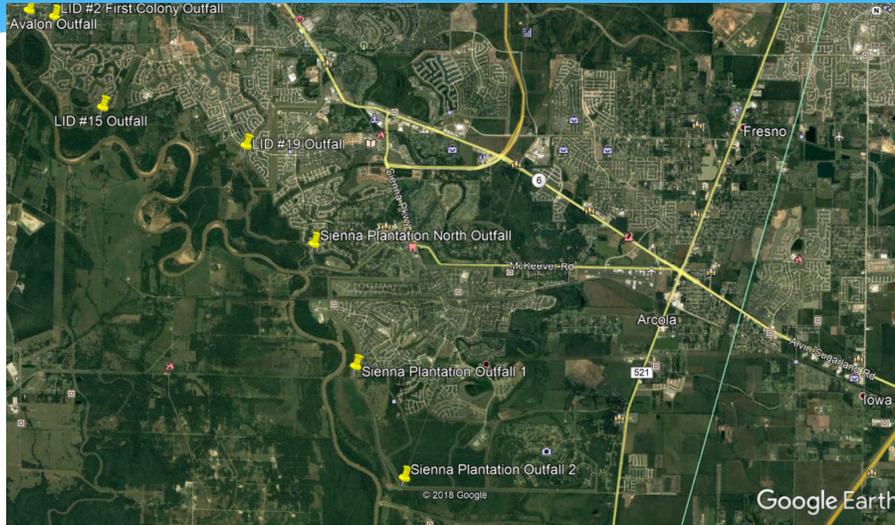
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Richmond Gage Key Elevations



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Richmond Gage Key Elevations

Key Elevation Points

Location	Water Surface Elevation based on Richmond Elevations	
	84.45' (NAVD 88) /57.43' (Gauge)	
LID #20 Outfall	91.89	
Pecan Grove Outfall	86.51	
MUD 121 Outfall	81.51	
LID #7 New Territory Outfall	81.06	
LID #10 Outfall	78.58	
LID #11 Outfall 1	76.99	
LID #11 Outfall 2	75.64	
LID #2 Outfall 2	74.79	
LID #17 Outfall	74.75	
LID #2 Outfall 1	74.66	
LID #14 Avalon Outfall	74.59	
LID #2 First Colony Outfall	74.59	
LID #15 Outfall	69.72	
LID #19 Outfall	66.91	
Sienna Plantation North Outfall	64.60	
Sienna Plantation Outfall 1	61.28	
Sienna Plantation Outfall 2	58.93	

Rosharon Gauge Key Elevations

- * Analyzed locations within Brazoria County to determine depths to be expected at selected locations given elevations at the Rosharon gage.

Lower Brazos River Floodplain Protection Planning Study



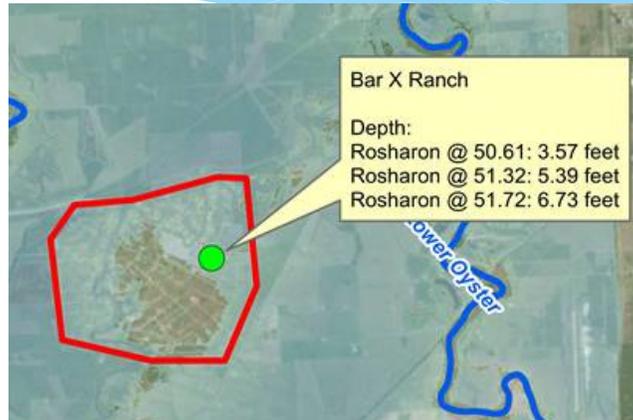
Rosharon Gage Key Elevations

Key Elevation Points

Location	Maximum Ponding Depth based on Rosharon Elevations (feet NAVD88)						
	34.88	41.3	50.61	50.98	51.32	51.42	51.72
Lochrige	0.00	0.00	2.71	4.05	6.06	6.70	8.29
CR25 & Brazos River Rd	0.00	0.00	1.26	1.49	1.73	1.82	2.09
TDCJ Prisons	0.00	0.00	0.81	1.95	3.81	4.44	6.02
Holiday Lakes, TX	0.00	0.00	5.16	6.17	7.81	8.35	9.69
Columbia Lakes	0.00	2.15	4.66	4.86	5.33	5.53	6.64
West Columbia, TX	0.00	0.00	1.60	1.89	2.48	2.69	3.75
Bar X Ranch	0.00	0.00	3.57	4.46	5.39	5.39	6.73
Lake Jackson Farms	0.00	1.71	6.21	7.20	8.71	9.17	10.21
Brazoria, TX	0.00	0.00	0.00	0.26	1.80	2.29	3.56
Jones Creek, TX	0.00	0.00	2.71	4.75	7.10	7.48	8.32

Rosharon Gage Key Elevations

- * Bar X Ranch can expect to see 3.57 feet of depth when Rosharon peaks at 50.61 feet (NAVD88)



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Flood Reduction Alternatives

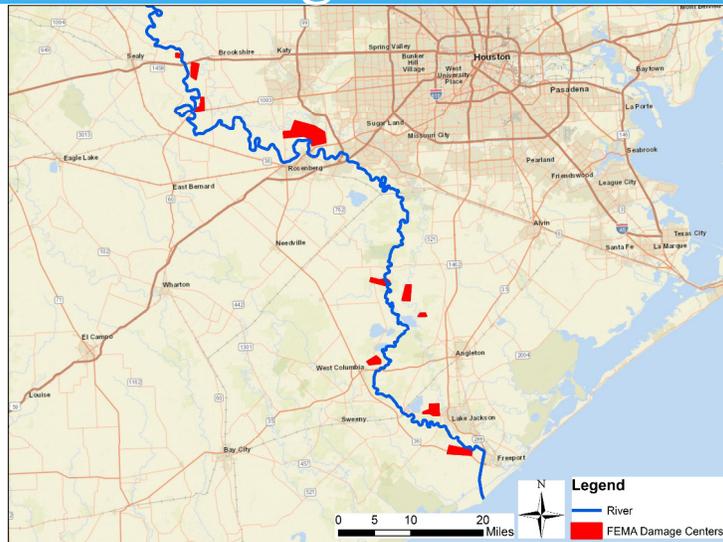
Flood Reduction Alternatives

- * Large Scale Mitigation Alternatives
 - * Large Scale Detention
 - * Channelization
 - * Bypass Channel

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Damage Centers



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Large Scale Detention

- * Determined the volume required to minimize flooding impacts along developed areas for the 1% ACE.
 - * Design of the detention areas was not considered.
- * Detention was considered in 2 locations along the Brazos River
 - * Waller County
 - * Brazoria County

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Large Scale Detention

Benefits

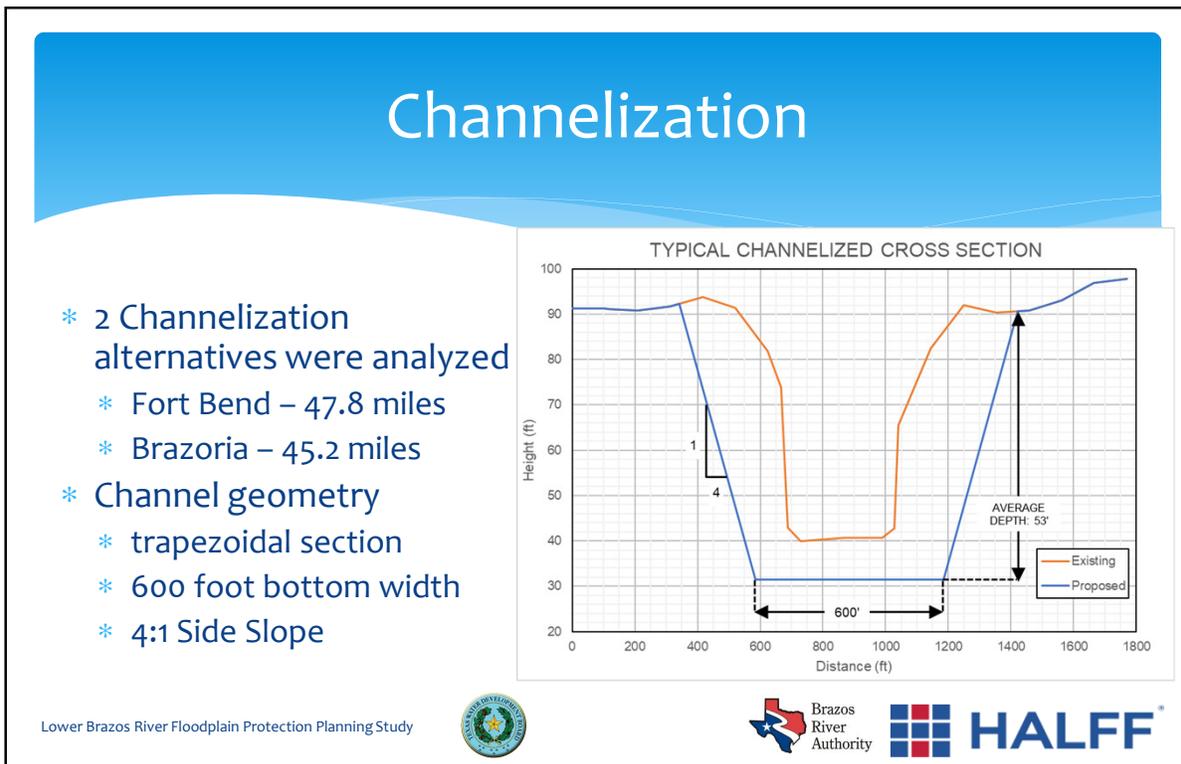
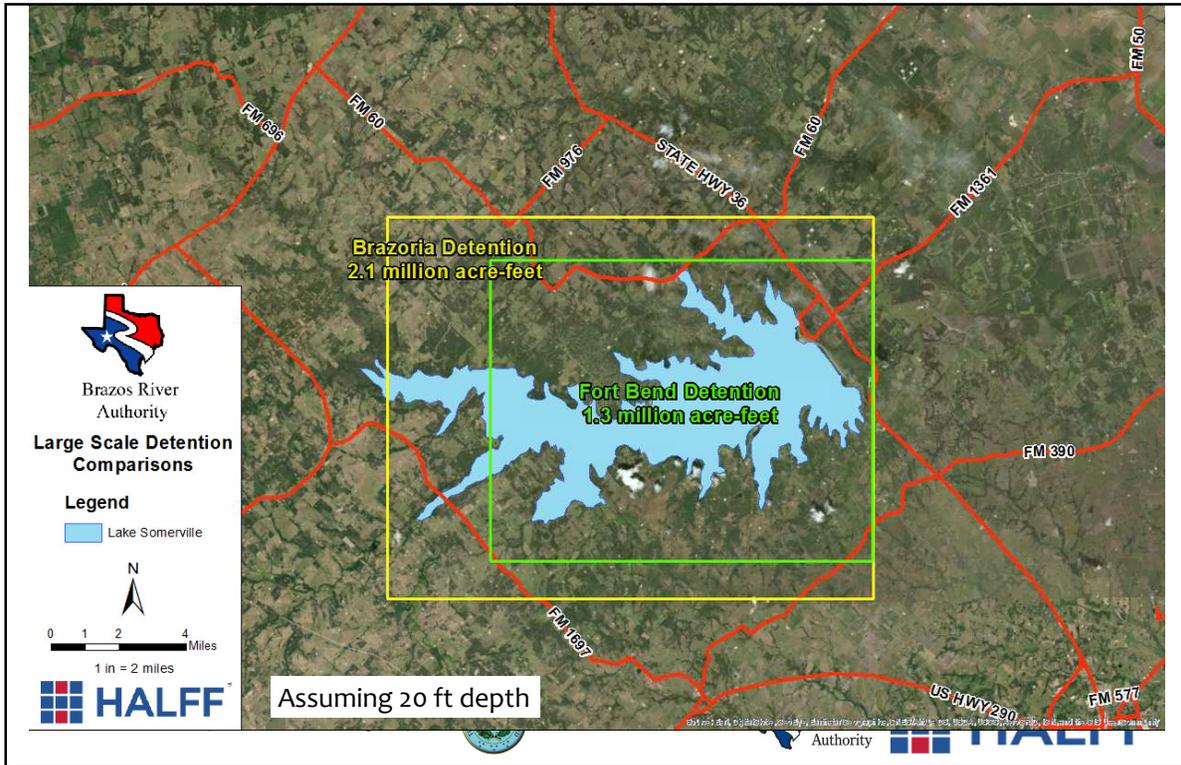
- * Lower water surface elevation
 - * Waller: 0.01 feet to 9.5 feet
 - * Brazoria: 0.01 to 7.5 feet
- * Mitigates FEMA damage centers

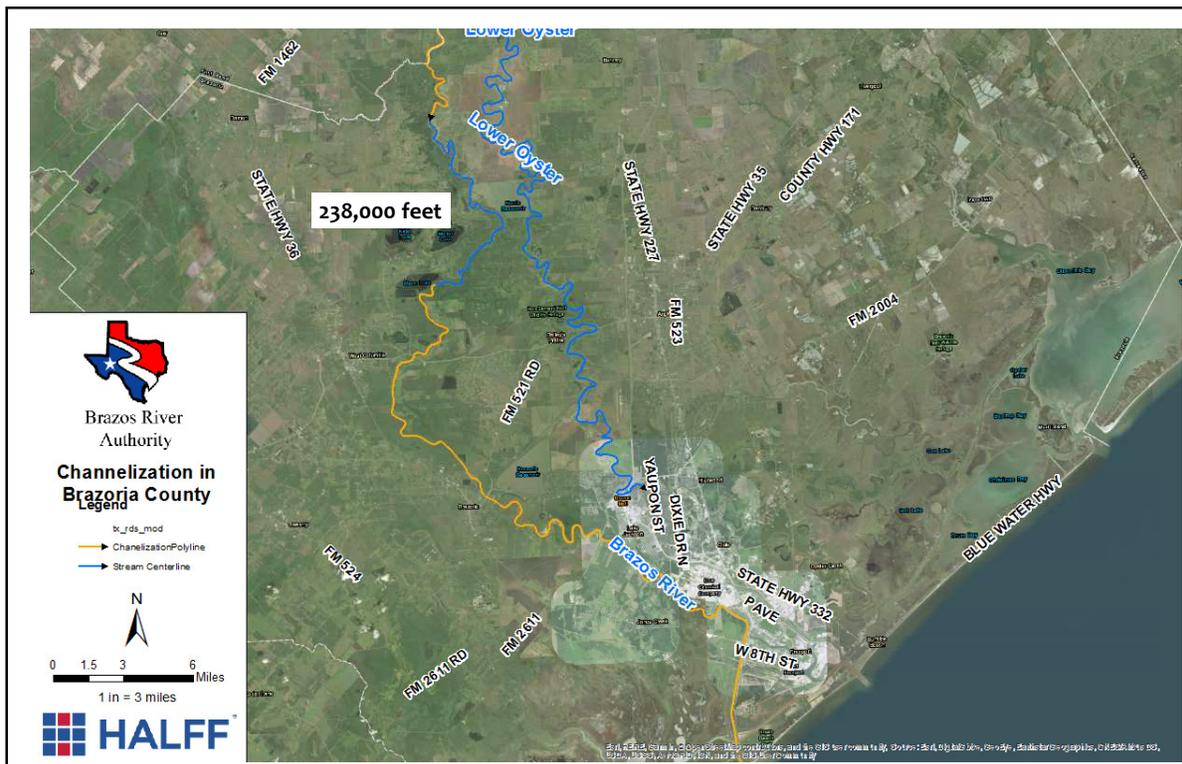
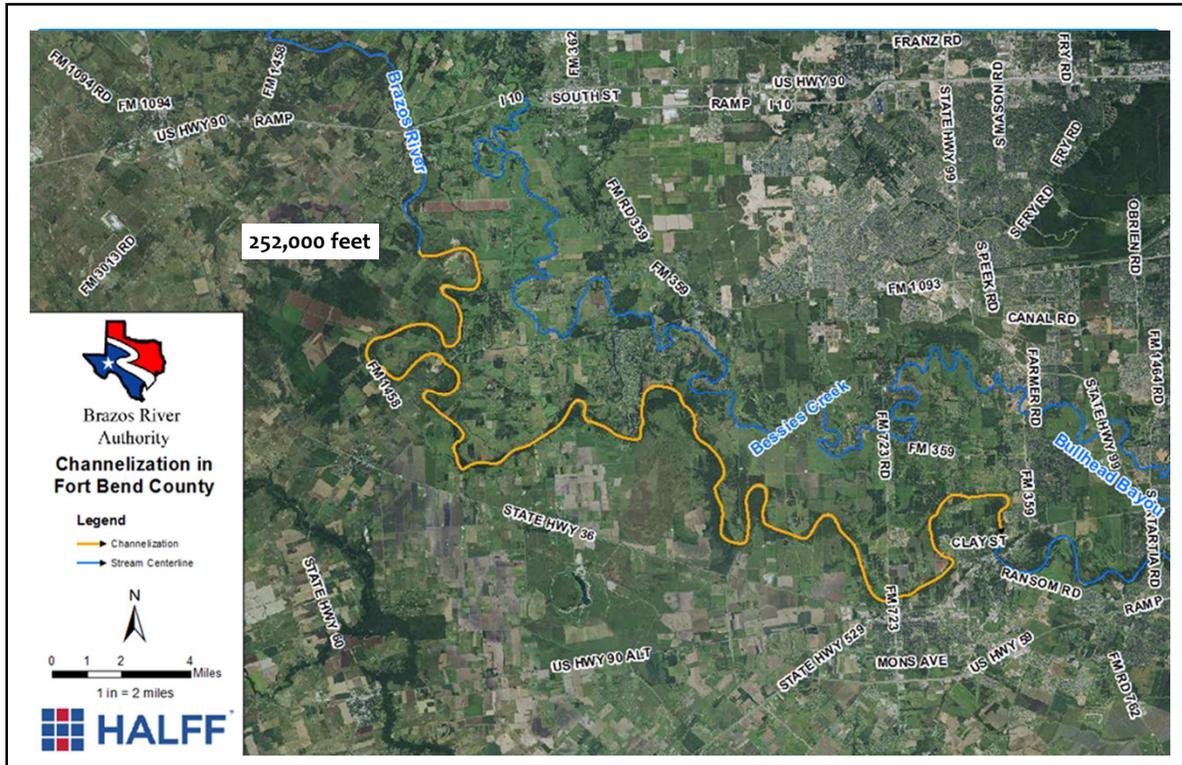
Constraints

- * Volume Require
 - * Waller: 1.3 million acre-feet
 - * Brazoria: 2.1 million acre-feet
- * Inefficient Impacts
 - * "Over-mitigates" some areas
 - * "Under-mitigates" some areas
- * Land Acquisition
 - * Waller – 65,000 acres
 - * Brazoria – 105,000 acres
- * Pumping required to divert flow
- * Potential groundwater issue

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Channelization

Benefits

- * Lower water surface elevation
 - * Fort Bend: decrease of 0.01 feet to 10.98 feet from San Felipe to Richmond
 - * Brazoria: 0.01 to 7.25 feet from Sienna Plantation to the Gulf
- * Mitigates FEMA damage centers

Constraints

- * Adverse impacts in downstream
 - * Fort Bend: increases of 0.01 to 0.22 feet from Richmond to the Gulf
 - * Brazoria: increases of 0.1 to 1.55 feet at Rosharon and near Lake Jackson
- * Conflicts with development
- * Large amount of excavation
 - * Fort Bend: 1.7 billion cubic yards
 - * Brazoria: 1.76 billion cubic yards
- * Structure conflicts

Lower Brazos River Floodplain Protection Planning Study

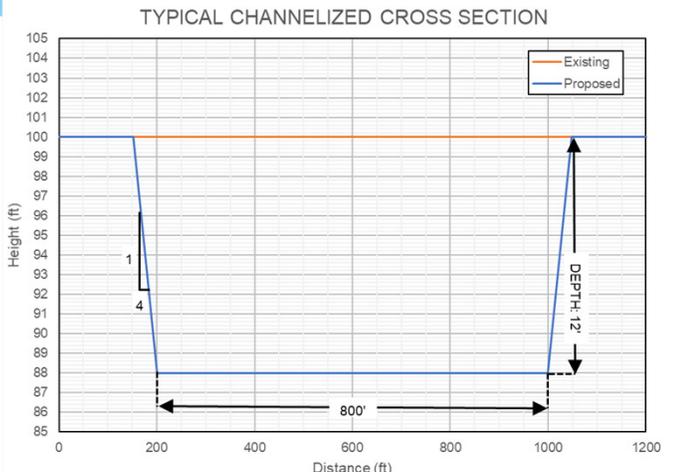





Bypass Channel

- * Analyzed a bypass channel from Fort Bend County to the Gulf of Mexico
- * 61 mile long channel
- * Channel Geometry
 - * Trapezoidal section
 - * 800 foot bottom width
 - * 4:1 Side Slope

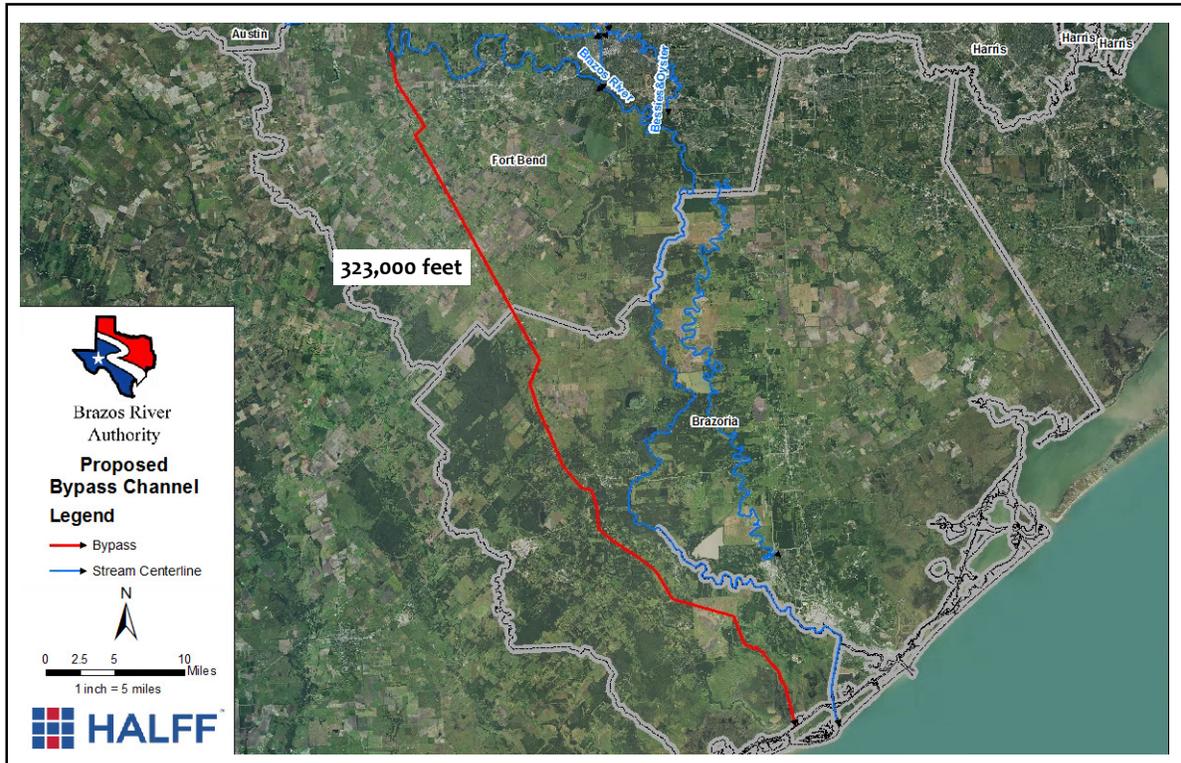
TYPICAL CHANNELIZED CROSS SECTION



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Bypass Channel

Benefits

- * Lower water surface elevations
 - * Decrease from 0.26 to 10.63 feet from the Waller County Line to the Gulf
- * Mitigates all FEMA damage centers

Constraints

- * Large scale excavation – 121,650,000 cubic yards
- * Conflicts with several structures
- * Channel would encroach upon existing floodplains
- * Substantial amount of land acquisition

Localized Alternatives

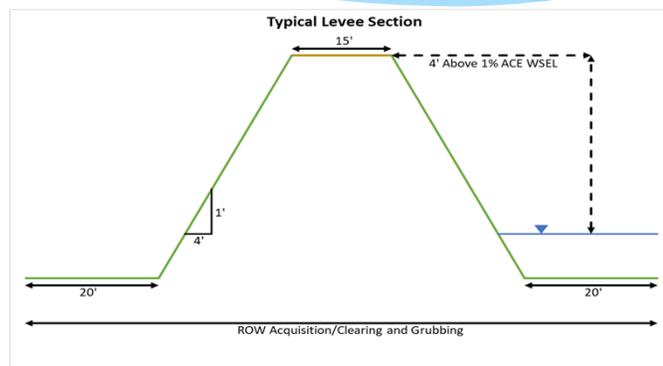
- * Preferred results – Large decreases in water surface elevations along the Brazos
- * Identified Repetitive Loss Areas along the Brazos River to help determine flood alternative locations
- * Require large scale coordination from multiple municipalities
- * Require substantial analysis, land acquisition, and funding
- * Considerable amount of environmental analyses, impacts, and permitting

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Localized Alternatives

- * Ring Levee at Simonton
- * Ring Levee at Weston Lakes
- * Bullhead Bayou Levee near Pecan Grove
- * Columbia Lakes Levee
- * Brazoria Reservoir – Oyster Creek Levee



Lower Brazos River Floodplain Protection Planning Study



Levee Benefits and Constraints

Benefits

- * Remove property from the 1% ACE Floodplain

Constraints

- * Levee compliance and permitting
- * Environmental Impacts:
 - * Potential wetlands
 - * Waters of the US
 - * Endangered species
- * Internal drainage challenges
- * Levee alignments may require buyout of homes
- * Potential adverse impacts to surrounding developments

Lower Brazos River Floodplain Protection Planning Study



Ring Levee at Simonton

- * Protect Brazos Valley Development
 - * Between Bessie's Creek and Brazos River
- * Average levee height = 7 feet
- * Max levee height = 9 feet
- * Length 23,700 feet (4.5 miles)
- * Internal drainage system to mitigate 582 acres
- * Right of way acquisition - 141 acres

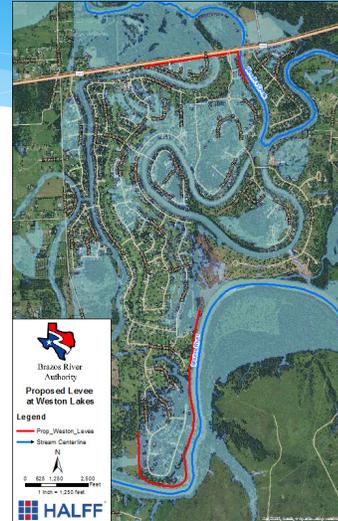


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Weston Lakes Levees

- * 2 separate levees protecting Weston Lakes Subdivision
 - * Brazos River – 10,600 feet (2 miles)
 - * Average levee height = 7 feet
 - * Maximum levee height = 15 feet
 - * Bessie's Creek - 5,100 feet (0.96 miles)
 - * Average levee height = 5.4 feet
 - * Maximum levee height = 11 feet
- * Endangered Species – record of Bald Eagle occurrence
- * Right-of-way Acquisition – 37 acres

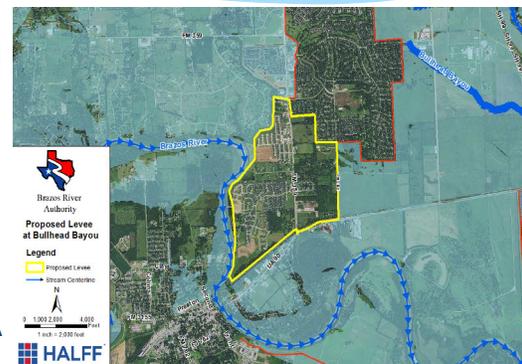


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Bullhead Bayou Levee near Pecan Grove

- * Ring levee around Bullhead Bayou and Pecan Grove
 - * Tributary through the neighborhood would need to be gated
- * Estimated average height of levee 7 feet
- * Maximum height of levee 17.5 feet
- * Length = 26,000 feet (5 miles)
- * Internal drainage system to mitigate 966 acres
- * Pitts Road would need to be closed off and replaced between Pecan Grove and US 90A
- * Right-of-way Acquisition – 68.9 acres

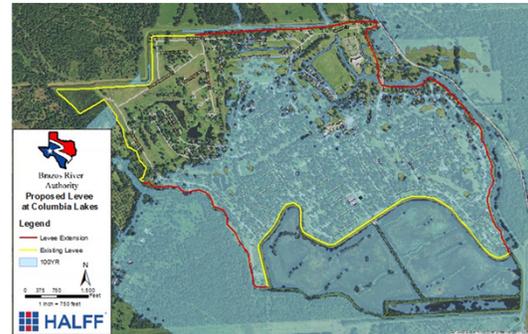


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Columbia Lakes Levee

- * Levee was overtopped during Hurricane Harvey
- * Alternative to raise existing levee to meet FEMA freeboard requirements
- * Approximately 16,750 feet (3.2 miles) of levee would need to be raised
 - * Raised an average of 4 feet to meet FEMA freeboard requirements

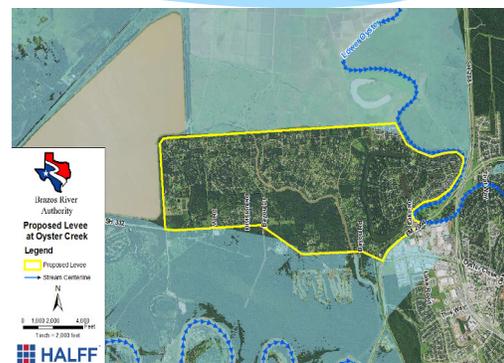


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Brazoria Reservoir – Oyster Creek Levee

- * Ring levee placed around Lake Jackson Farms between Brazoria Reservoir and Oyster Creek.
 - * Tributary through the neighborhood would need to be gated.
- * Estimated average height of levee 7 feet
- * Maximum height of levee 13.5 feet
- * Length = 49,000 feet (9 miles)
- * Internal drainage system to mitigate 2,650 acres
- * Levee could potentially disrupt industrial activities
- * Right-of-way Acquisition – 122 acres



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Local Analysis Summary

- * Additional analysis required
 - * High level feasibility study
 - * Remove structures from 1% ACE floodplain
 - * Land acquisition and cost are substantial
 - * Potential wetlands
 - * Waters of the US
 - * Endangered Species
- * Estimated Cost
 - * Simonton: \$57 million
 - * Weston Lakes: \$15 million
 - * Bullhead Bayou: \$76 million
 - * Columbia Lakes: \$10.5 million
 - * Brazoria: \$160 million

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Flood Damage Analysis

- * Statistical analysis to determine annual flood damages
 - * Utilized HEC-RAS Hydraulic Modeling Results
 - * Developed a building layer to determine potential flood damages
 - * Utilized current data from appraisal districts in Brazoria, Fort Bend, Waller, Austin and Washington Counties
 - * Estimated building elevations based on LiDAR
- * Benefit Cost Ratio = Estimated Annual Cost of Alternatives vs Average Annual Damages

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Environmental Constraint Analysis

- * Desk level environmental analysis was completed to determine environmental sensitive areas
- * Environmental evaluations were completed to determine the impacts of the localized alternatives

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Final Steps

- * Draft Report – August 2018
- * Final Report – December 2018

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Potential Next Steps

- * Update model with Post Harvey Topography
- * Extend the hydraulic modeling to College Station
- * Develop a hydraulic model of the Navasota River
- * Model inflows/outflows and operations at the reservoirs
- * Develop a Lower Brazos River Coalition to maintain the model of the Brazos and adopt similar criteria where applicable
- * Engage the NWS to enhance flood warning capabilities using the new model
- * Engage the USACE to further develop the hydraulic model and flood warning capabilities
- * Expand the stream gage network along the lower Brazos and develop add'l rating curves
- * Evaluate development impacts in basin by considering projected growth and flow volumes
- * Update Hazard Mitigation Plans in region
- * Additional steps required for FEMA Floodplain modeling and mapping

Lower Brazos River Floodplain Protection Planning Study



Questions?

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