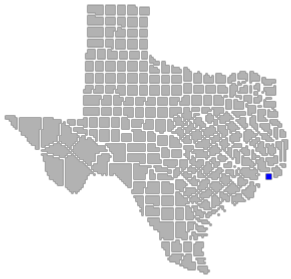
FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 1 of 3



CHAMBERS COUNTY, TX

AND INCORPORATED AREAS

COMMUNITY NAME	NUMBER
CITY OF ANAHUAC	480120
CITY OF BAYTOWN	485456
CITY OF BEACH CITY	480121
CHAMBERS COUNTY, UNINCORPORATED AREAS	480119
CITY OF COVE	481510
CITY OF MONT BELVIEU	480122
CITY OF OLD RIVER-WINFREE	481637

FEMA

PRELIMINARY

SEPTEMBER 30, 2015

REVISED

FLOOD INSURANCE STUDY NUMBER
48071CV001B

Version Number 2.3.3.2

TABLE OF CONTENTS

VOLUME 1 -

	Page
SECTION 1.0 – INTRODUCTION	1
1.1 The National Flood Insurance Program	1
1.2 Purpose of this Flood Insurance Study Report	2
1.3 Jurisdictions Included in the Flood Insurance Study Report	2
1.4 Considerations for using this Flood Insurance Study Report	5
SECTION 2.0 – FLOODPLAIN MANAGEMENT APPLICATIONS	15
2.1 Floodplain Boundaries	15
2.2 Floodways	15
2.3 Base Flood Elevations	17
2.4 Non-Encroachment Zones	23
2.5 Coastal Flood Hazard Areas	23
2.5.1 Water Elevations and the Effects of Waves	23
2.5.2 Floodplain Boundaries and BFEs for Coastal Areas	25
2.5.3 Coastal High Hazard Areas	26
2.5.4 Limit of Moderate Wave Action	27
SECTION 3.0 – INSURANCE APPLICATIONS	28
3.1 National Flood Insurance Program Insurance Zones	28
3.2 Coastal Barrier Resources System	28
SECTION 4.0 – AREA STUDIED	29
4.1 Basin Description	29
4.2 Principal Flood Problems	30
4.3 Non-Levee Flood Protection Measures	35
4.4 Levees	35
SECTION 5.0 – ENGINEERING METHODS	36
5.1 Hydrologic Analyses	36
5.2 Hydraulic Analyses	42
5.3 Coastal Analyses	48
5.3.1 Total Stillwater Elevations	50
5.3.2 Waves	51
5.3.3 Coastal Erosion	52
5.3.4 Wave Hazard Analyses	52
5.4 Alluvial Fan Analyses	67
SECTION 6.0 – MAPPING METHODS	67
6.1 Vertical and Horizontal Control	67
6.2 Base Map	68
6.3 Floodplain and Floodway Delineation	69
6.4 Coastal Flood Hazard Mapping	88
6.5 FIRM Revisions	94
6.5.1 Letters of Map Amendment	94
6.5.2 Letters of Map Revision Based on Fill	95
6.5.3 Letters of Map Revision	95
6.5.4 Physical Map Revisions	96
6.5.5 Contracted Restudies	96

	Page
6.5.6 Community Map History	96
SECTION 7.0 – CONTRACTED STUDIES AND COMMUNITY COORDINATION	98
7.1 Contracted Studies	98
7.2 Community Meetings	99
SECTION 8.0 – ADDITIONAL INFORMATION	101
SECTION 9.0 – BIBLIOGRAPHY AND REFERENCES	102

Figures

Figure 1: FIRM Panel Index	7
Figure 2: FIRM Notes to Users	8
Figure 3: Map Legend for FIRM	11
Figure 4: Floodway Schematic	16
Figure 5: Wave Runup Transect Schematic	25
Figure 6: Coastal Transect Schematic	27
Figure 7: Frequency Discharge-Drainage Area Curves	42
Figure 8: 1% Annual Chance Total Stillwater Elevations for Coastal Areas	50
Figure 9: Transect Location Map	66

Tables

Table 1: Listing of NFIP Jurisdictions	3
Table 2: Flooding Sources Included in this FIS Report	18
Table 3: Flood Zone Designations by Community	28
Table 4: Coastal Barrier Resources System Information	29
Table 5: Basin Characteristics	29
Table 6: Principal Flood Problems	30
Table 7: Historic Flooding Elevations	32
Table 8: Non-Levee Flood Protection Measures	35
Table 9: Levees	36
Table 10: Summary of Discharges	37
Table 11: Summary of Non-Coastal Stillwater Elevations	42
Table 12: Stream Gage Information used to Determine Discharges	42
Table 13: Summary of Hydrologic and Hydraulic Analyses	43
Table 14: Roughness Coefficients	48
Table 15: Summary of Coastal Analyses	49
Table 16: Tide Gage Analysis Specifics	50
Table 17: Coastal Transect Parameters	54
Table 18: Summary of Alluvial Fan Analyses	67
Table 19: Results of Alluvial Fan Analyses	67
Table 20: Countywide Vertical Datum Conversion	68
Table 21: Stream-Based Vertical Datum Conversion	68
Table 22: Base Map Sources	68
Table 23: Summary of Topographic Elevation Data used in Mapping	69
Table 24: Floodway Data	71

	Page
Table 25: Flood Hazard and Non-Encroachment Data for Selected Streams	88
Table 26: Summary of Coastal Transect Mapping Considerations	89
Table 27: Incorporated Letters of Map Change	96
Table 28: Community Map History	97
Table 29: Summary of Contracted Studies Included in this FIS Report	98
Table 30: Community Meetings	100
Table 31: Map Repositories	101
Table 32: Additional Information	102
Table 33: Bibliography and References	103

EXHIBITS

VOLUME 2 –

Exhibit 1 - Flood Profiles

Barrow Slough	Panel 01P
Cedar Bayou	Panels 02P-04P
Cedar Gully	Panel 05P
Cotton Bayou	Panel 06P
Double Bayou East Fork	Panels 07P-10P
Double Bayou West Fork	Panels 11P-12P
Hackberry Gully	Panels 13P-14P
Horsepen Bayou	Panel 15P
Labbit Creek	Panel 16P
Lee Gully	Panel 17P
Little Caney Creek	Panel 18P
Old River	Panels 19P-23P
Oyster Bayou	Panels 24P-25P
Sawpit Gully	Panel 26P
Smith Gully	Panels 27P-28P
Spindletop Bayou	Panel 29P
Spring Branch	Panels 30P-31P
Trinity River	Panel 32P
Turtle Whites Bayou	Panels 33P-34P
Whites Bayou	Panels 35P-36P

Exhibit 2 - 0.2 Percent Annual Chance Wave Envelopes

Transect 1	Panel 01P
Transect 2	Panel 02P
Transect 3	Panel 03P
Transect 4	Panels 04P-05P
Transect 5	Panels 06P-07P

EXHIBITS

VOLUME 2 continued–

Exhibit 2 - 0.2 Percent Annual Chance Wave Envelopes

Transect 6	Panel 08P
Transect 7	Panel 09P
Transect 8	Panel 10P
Transect 9	Panel 11P
Transect 10	Panel 12P
Transect 11	Panel 13P
Transect 12	Panel 14P
Transect 13	Panel 15P
Transect 14	Panel 16P
Transect 15	Panel 17P
Transect 16	Panel 18P
Transect 17	Panel 19P
Transect 18	Panel 20P
Transect 19	Panels 21P-22P
Transect 20	Panels 23P-24P
Transect 21	Panels 25P-26P
Transect 22	Panels 27P-28P
Transect 23	Panels 29P-31P
Transect 24	Panels 32P-34P
Transect 25	Panels 35P-36P
Transect 26	Panels 37P-39P
Transect 27	Panels 40P-41P
Transect 28	Panel 42P
Transect 29	Panels 43P-44P
Transect 30	Panel 45P
Transect 31	Panel 46P
Transect 32	Panel 47P
Transect 33	Panel 48P
Transect 34	Panel 49P
Transect 35	Panel 50P
Transect 36	Panel 51P
Transect 37	Panel 52P
Transect 38	Panel 53P
Transect 39	Panels 54P-55P
Transect 40	Panels 56P-57P
Transect 41	Panels 58P-59P

EXHIBITS

VOLUME 3 – May 4, 2015

Exhibit 2 - 0.2 Percent Annual Chance Wave Envelopes

Transect 42	Panels 60P-62P
Transect 43	Panels 63P-64P

EXHIBITS

VOLUME 3 continued – May 4, 2015

Exhibit 2 - 0.2 Percent Annual Chance Wave Envelopes

Transect 44	Panels 65P-66P
Transect 45	Panel 67P
Transect 46	Panel 68P
Transect 47	Panel 69P
Transect 48	Panel 70P
Transect 49	Panel 71P
Transect 50	Panel 72P
Transect 51	Panel 73P
Transect 52	Panel 74P
Transect 53	Panel 75P
Transect 54	Panel 76P
Transect 55	Panel 77P
Transect 56	Panel 78P
Transect 57	Panel 79P
Transect 58	Panels 80P-81P
Transect 59	Panels 82P-83P
Transect 60	Panels 84P-85P
Transect 61	Panels 86P-87P
Transect 62	Panels 88P-89P
Transect 63	Panels 90P-92P
Transect 64	Panels 93P-95P
Transect 65	Panels 96P-98P
Transect 66	Panels 99P-102P
Transect 67	Panels 103P-105P
Transect 68	Panels 106P-108P
Transect 69	Panels 109P-111P
Transect 70	Panels 112P-114P
Transect 71	Panels 115P-117P
Transect 72	Panels 118P-120P
Transect 73	Panels 121P-123P
Transect 74	Panels 124P-126P

Exhibit 3 – Flood Insurance Rate Map

FLOOD INSURANCE STUDY REPORT
CHAMBERS COUNTY, TX

SECTION 1.0 – INTRODUCTION

1.1 The National Flood Insurance Program

The National Flood Insurance Program (NFIP) is a voluntary Federal program that enables property owners in participating communities to purchase insurance protection against losses from flooding. This insurance is designed to provide an insurance alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods.

For decades, the national response to flood disasters was generally limited to constructing flood-control works such as dams, levees, sea-walls, and the like, and providing disaster relief to flood victims. This approach did not reduce losses nor did it discourage unwise development. In some instances, it may have actually encouraged additional development. To compound the problem, the public generally could not buy flood coverage from insurance companies, and building techniques to reduce flood damage were often overlooked.

In the face of mounting flood losses and escalating costs of disaster relief to the general taxpayers, the U.S. Congress created the NFIP. The intent was to reduce future flood damage through community floodplain management ordinances, and provide protection for property owners against potential losses through an insurance mechanism that requires a premium to be paid for the protection.

The U.S. Congress established the NFIP on August 1, 1968, with the passage of the National Flood Insurance Act of 1968. The NFIP was broadened and modified with the passage of the Flood Disaster Protection Act of 1973 and other legislative measures. It was further modified by the National Flood Insurance Reform Act of 1994 and the Flood Insurance Reform Act of 2004. The NFIP is administered by the Federal Emergency Management Agency (FEMA), which is a component of the Department of Homeland Security (DHS).

Participation in the NFIP is based on an agreement between local communities and the Federal Government. If a community adopts and enforces floodplain management regulations to reduce future flood risks to new construction and substantially improved structures in Special Flood Hazard Areas (SFHAs), the Federal Government will make flood insurance available within the community as a financial protection against flood losses. The community's floodplain management regulations must meet or exceed criteria established in accordance with Title 44 Code of Federal Regulations (CFR) Part 60.3, *Criteria for Land Management and Use*.

SFHAs are delineated on the community's Flood Insurance Rate Maps (FIRMs). Under the NFIP, buildings that were built before the flood hazard was identified on the community's FIRMs are generally referred to as "Pre-FIRM" buildings. When the NFIP was created, the U.S. Congress recognized that insurance for Pre-FIRM buildings would be prohibitively expensive if the premiums were not subsidized by the Federal Government. Congress also recognized that most of these floodprone buildings were built by individuals who did not have sufficient knowledge of the flood hazard to make informed decisions. The NFIP requires that full actuarial rates reflecting the

complete flood risk be charged on all buildings constructed or substantially improved on or after the effective date of the initial FIRM for the community or after December 31, 1974, whichever is later. These buildings are generally referred to as “Post-FIRM” buildings.

1.2 Purpose of this Flood Insurance Study Report

This Flood Insurance Study (FIS) report revises and updates information on the existence and severity of flood hazards for the study area. The studies described in this report developed flood hazard data that will be used to establish actuarial flood insurance rates and to assist communities in efforts to implement sound floodplain management.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive than the minimum Federal requirements. Contact your State NFIP Coordinator to ensure that any higher State standards are included in the community’s regulations.

1.3 Jurisdictions Included in the Flood Insurance Study Report

This FIS Report covers the entire geographic area of Chambers County, Texas.

The jurisdictions that are included in this project area, along with the Community Identification Number (CID) for each community and the 8-digit Hydrologic Unit Codes (HUC-8) sub-basins affecting each, are shown in Table 1. The Flood Insurance Rate Map (FIRM) panel numbers that affect each community are listed. If the flood hazard data for the community is not included in this FIS Report, the location of that data is identified.

The location of flood hazard data for participating communities in multiple jurisdictions is also indicated in the table.

Jurisdictions that have no identified SFHAs as of the effective date of this study are indicated in the table. Changed conditions in these communities (such as urbanization or annexation) or the availability of new scientific or technical data about flood hazards could make it necessary to determine SFHAs in these jurisdictions in the future.

Table 1: Listing of NFIP Jurisdictions

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
City of Anahuac	480120	12030203, 12040202	48071C0215E, 48071C0220F, 48071C0380E, 48071C0385E	
City of Baytown	485456	12030203, 12040203	48071C0160F, 48071C0170E, 48071C0180F, 48071C0190E, 48071C0335E, 48071C0345E, 48071C0355E, 48071C0365E	
City of Beach City	480121	12030203, 12040203	48071C0190E, 48071C0345E, 48071C0355E, 48071C0365E	
Chambers County, Unincorporated Areas	480119	12030203, 12040201, 12040202, 12040203, 12040204	48071C0015E, 48071C0020F, 48071C0040F, 48071C0045F, 48071C0065F, 48071C0070F, 48071C0100F, 48071C0125E, 48071C0150E, 48071C0155E, 48071C0160F, 48071C0170E, 48071C0180F, 48071C0185E, 48071C0190E, 48071C0195E, 48071C0205E, 48071C0210F, 48071C0215E, 48071C0220F, 48071C0230F, 48071C0250F,	

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
			48071C0270E, 48071C0275E, 48071C0300E, 48071C0325E[1], 48071C0330E, 48071C0335E, 48071C0340E[1], 48071C0345E, 48071C0355E, 48071C0360E[1], 48071C0365E, 48071C0370E[1], 48071C0380E, 48071C0385E, 48071C0390E, 48071C0395E, 48071C0425E, 48071C0450E, 48071C0475E, 48071C0500E[1], 48071C0525E[1], 48071C0530E[1], 48071C0535E, 48071C0540E[1], 48071C0545E, 48071C0555E, 48071C0560E, 48071C0565E, 48071C0570E, 48071C0580E, 48071C0585E, 48071C0590E, 48071C0595E, 48071C0605E, 48071C0610E, 48071C0615E, 48071C0630E, 48071C0640E, 48071C0675E[1]	

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
City of Cove	481510	12030203	48071C0180F, 48071C0185E, 48071C0190E, 48071C0195E	
City of Mont Belvieu	480122	12030203, 12040203	48071C0020F, 48071C0040F, 48071C0160F, 48071C0180F, 48071C0185E	
City of Old River-Winfree	481637	12030203	48071C0040F, 48071C0045F, 48071C0180F	
City of Seabrook	485507	12040204	48071C0500E[1], 48071C0525E[1]	Harris County, Texas and Incorporated Areas FIS Report, 2015

[1]Panel Not Printed

1.4 Considerations for using this Flood Insurance Study Report

The NFIP encourages State and local governments to implement sound floodplain management programs. To assist in this endeavor, each FIS Report provides floodplain data, which may include a combination of the following: 10-, 4-, 2-, 1-, and 0.2-percent annual chance flood elevations (the 1% annual chance flood elevation is also referred to as the Base Flood Elevation (BFE)); delineations of the 1% annual chance and 0.2% annual chance floodplains; and 1% annual chance floodway. This information is presented on the FIRM and/or in many components of the FIS Report, including Flood Profiles, Floodway Data tables, Summary of Non-Coastal Stillwater Elevations tables, and Coastal Transect Parameters tables (not all components may be provided for a specific FIS).

This section presents important considerations for using the information contained in this FIS Report and the FIRM, including changes in format and content. Figures 1, 2, and 3 present information that applies to using the FIRM with the FIS Report.

- Part or all of this FIS Report may be revised and republished at any time. In addition, part of this FIS Report may be revised by a Letter of Map Revision (LOMR), which does not involve republication or redistribution of the FIS Report. Refer to Section 6.5 of this FIS Report for information about the process to revise the FIS Report and/or FIRM.

  It is, therefore, the responsibility of the user to consult with community officials by contacting the community repository to obtain the most current FIS Report components. Communities participating in the NFIP have established repositories of flood hazard data for floodplain management and flood insurance purposes. Community map repository addresses are provided in Table 31, “Map Repositories,” within this FIS Report.

- New FIS Reports are frequently developed for multiple communities, such as entire counties. A countywide FIS Report incorporates previous FIS Reports for individual communities and the unincorporated area of the county (if not jurisdictional) into a single document and supersedes those documents for the purposes of the NFIP.

  The initial Countywide FIS Report for Chambers County became effective on May 4, 2015. Refer toTable 28 for information about subsequent revisions to the FIRM.

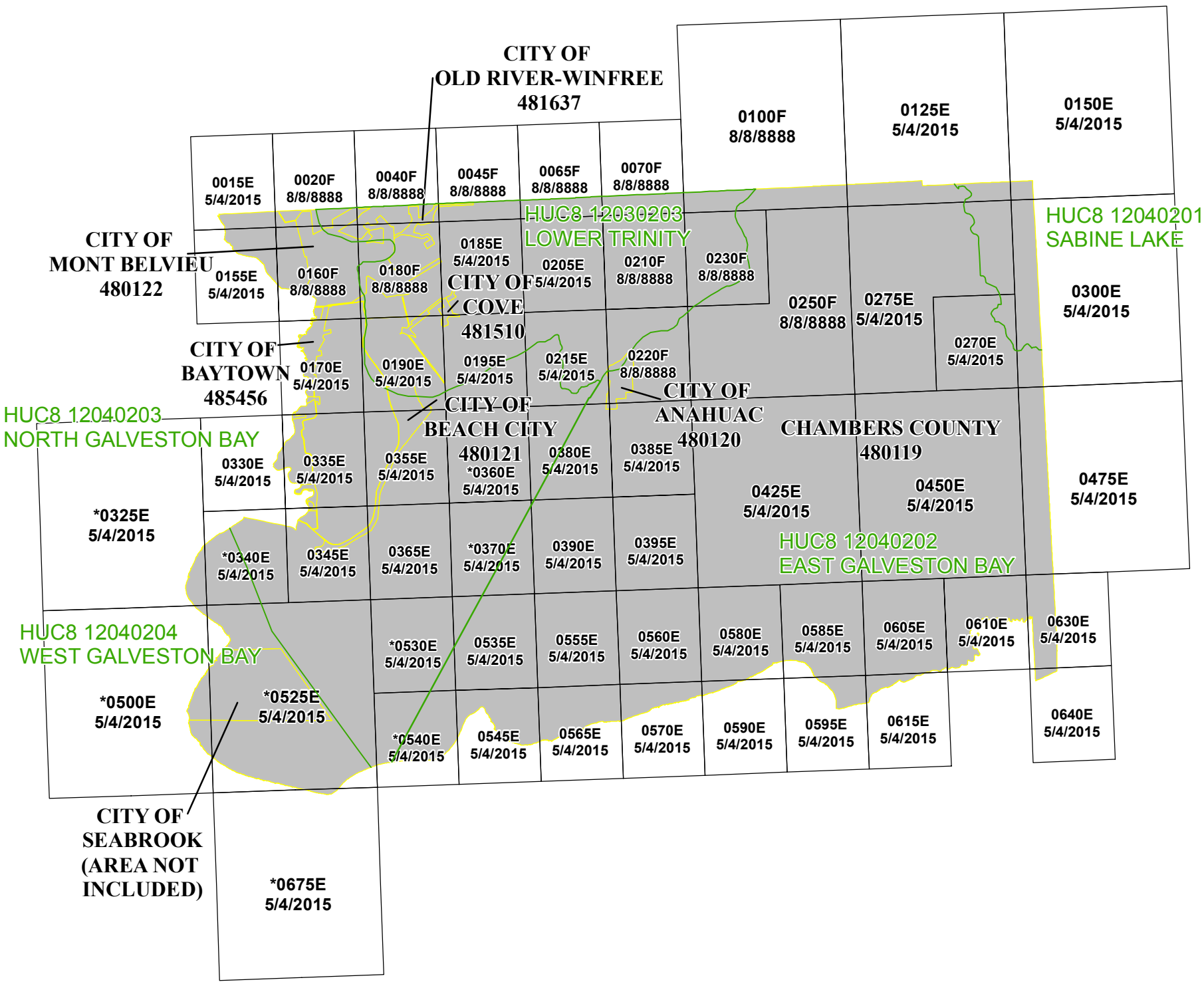
- FEMA does not impose floodplain management requirements or special insurance ratings based on Limit of Moderate Wave Action (LiMWA) delineations at this time. The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. If the LiMWA is shown on the FIRM, it is being provided by FEMA as information only. For communities that do adopt Zone VE building standards in the area defined by the LiMWA, additional Community Rating System (CRS) credits are available. Refer to Section 2.5.4 for additional information about the LiMWA.

  The CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. Visit the FEMA Web site at http://www.fema.gov or contact your appropriate FEMA Regional Office for more information about this program.

- Previous FIS Reports and FIRMs may have included levees that were accredited as reducing the risk associated with the 1% annual chance flood based on the information available and the mapping standards of the NFIP at that time. For FEMA to continue to accredit the identified levees, the levees must meet the criteria of the Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10), titled "Mapping of Areas Protected by Levee Systems."

  Since the status of levees is subject to change at any time, the user should contact the appropriate agency for the latest information regarding levees presented in Table 9, "Levees" of this FIS Report. For levees owned or operated by the U.S. Army Corps of Engineers (USACE), information may be obtained from the USACE National Levee Database. For all other levees, the user is encouraged to contact the appropriate local community.

- FEMA has developed a *Guide to Flood Maps* (FEMA 258) and online tutorials to assist users in accessing the information contained on the FIRM. These include how to read panels and step-by-step instructions to obtain specific information. To obtain this guide and other assistance in using the FIRM, visit the FEMA Web site at http://www.fema.gov.



N

1 in = 6 miles

0 1.25 2.5 5 7.5 10 Miles

Map Projection:
Texas State Plane South Central Zone (FIPS Zone 4204); North American Datum 1983

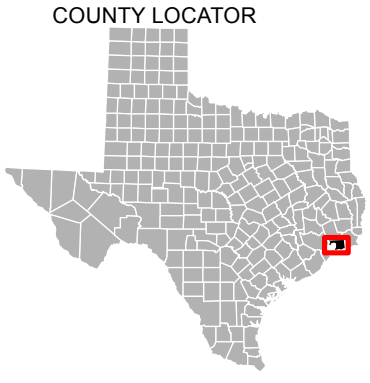
THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTP://MSC.FEMA.GOV

SEE FLOOD INSURANCE STUDY FOR ADDITIONAL INFORMATION

*PANEL NOT PRINTED - OPEN WATER AREA

COUNTY LOCATOR



NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP INDEX

CHAMBERS COUNTY, TX and Incorporated Areas

PANELS PRINTED:
0015, 0020, 0040, 0045, 0065, 0070, 0100, 0125, 0150, 0155, 0160, 0170, 0180, 0185, 0190, 0195, 0205, 0210, 0215, 0220, 0230, 0250, 0270, 0275, 0300, 0330, 0335, 0345, 0355, 0365, 0380, 0385, 0390, 0395, 0425, 0450, 0475, 0535, 0545, 0555, 0560, 0565, 0570, 0580, 0585, 0590, 0595, 0605, 0610, 0615, 0630, 0640

FEMA

MAP NUMBER
48071CIND0B

MAP REVISED

Figure 2: FIRM Notes to Users

NOTES TO USERS

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products, or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Map Service Center website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the FEMA Map Service Center website or by calling the FEMA Map Information eXchange.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Map Service Center at the number listed above.

For community and countywide map dates, refer toTable 28 in this FIS Report.

To determine if flood insurance is available in the community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

PRELIMINARY FIS REPORT: FEMA maintains information about map features, such as street locations and names, in or near designated flood hazard areas. Requests to revise information in or near designated flood hazard areas may be provided to FEMA during the community review period, at the final Consultation Coordination Officer's meeting, or during the statutory 90-day appeal period. Approved requests for changes will be shown on the final printed FIRM.

The map is for use in administering the NFIP. It may not identify all areas subject to flooding, particularly from local drainage sources of small size. Consult the community map repository to find updated or additional flood hazard information.

BASE FLOOD ELEVATIONS: For more detailed information in areas where Base Flood Elevations (BFEs) and/or floodways have been determined, consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables within this FIS Report. Use the flood elevation data within the FIS Report in conjunction with the FIRM for construction and/or floodplain management.

Coastal Base Flood Elevations shown on the map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the FIS Report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on the FIRM.

FLOODWAY INFORMATION: Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the FIS Report for this jurisdiction.

Figure 2. FIRM Notes to Users

FLOOD CONTROL STRUCTURE INFORMATION: Certain areas not in Special Flood Hazard Areas may be protected by flood control structures. Refer to Section 4.3 "Non-Levee Flood Protection Measures" of this FIS Report for information on flood control structures for this jurisdiction.

PROJECTION INFORMATION: The projection used in the preparation of the map was Texas State Plane South Central Zone (FIPS Zone 4204)**.** The horizontal datum was NAD 83 GRS 1980 Spheroid**.** Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

ELEVATION DATUM: Flood elevations on the FIRM are referenced to the North American Vertical Datum of 1988 (NAVD 88)**.** These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988 (NAVD 88)**,** visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

Local vertical monuments may have been used to create the map. To obtain current monument information, please contact the appropriate local community listed in Table 31 of this FIS Report.

BASE MAP INFORMATION: Base map information shown on the FIRM was provided by the U.S. Geological Survey, U.S. Department of Agriculture, U.S. Census Bureau, and Texas Natural Resources Information System. For information about base maps, refer to Section 6.2 “Base Map” in this FIS Report.

Corporate limits shown on the map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after the map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Figure 2. FIRM Notes to Users

NOTES FOR FIRM INDEX

REVISIONS TO INDEX: As new studies are performed and FIRM panels are updated within Chambers County, Texas, corresponding revisions to the FIRM Index will be incorporated within the FIS Report to reflect the effective dates of those panels. Please refer to Table 28 of this FIS Report to determine the most recent FIRM revision date for each community. The most recent FIRM panel effective date will correspond to the most recent index date.

SPECIAL NOTES FOR SPECIFIC FIRM PANELS

This Notes to Users section was created specifically for Chambers County, Texas, effective .

COASTAL BARRIER RESOURCES SYSTEM (CBRS): This map includes approximate boundaries of the CBRS for informational purposes only. Flood insurance is not available within CBRS areas for structures that are newly built or substantially improved on or after the date(s) indicated on the map. For more information see http://www.fws.gov/ecological-services/habitatconservation/Coastal.html, the FIS Report, or call the U.S. Fish and Wildlife Service Customer Service Center at 1-800-344-WILD.

LIMIT OF MODERATE WAVE ACTION: Zone AE has been divided by a Limit of Moderate Wave Action (LiMWA). The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. The effects of wave hazards between Zone VE and the LiMWA (or between the shoreline and the LiMWA for areas where Zone VE is not identified) will be similar to, but less severe than, those in Zone VE.

FLOOD RISK REPORT: A Flood Risk Report (FRR) may be available for many of the flooding sources and communities referenced in this FIS Report. The FRR is provided to increase public awareness of flood risk by helping communities identify the areas within their jurisdictions that have the greatest risks. Although non-regulatory, the information provided within the FRR can assist communities in assessing and evaluating mitigation opportunities to reduce these risks. It can also be used by communities developing or updating flood risk mitigation plans. These plans allow communities to identify and evaluate opportunities to reduce potential loss of life and property. However, the FRR is not intended to be the final authoritative source of all flood risk data for a project area; rather, it should be used with other data sources to paint a comprehensive picture of flood risk.

Figure 3: Map Legend for FIRM

SPECIAL FLOOD HAZARD AREAS: *The 1% annual chance flood, also known as the base flood or 100-year flood, has a 1% chance of happening or being exceeded each year. Special Flood Hazard Areas are subject to flooding by the 1% annual chance flood. The Base Flood Elevation is the water surface elevation of the 1% annual chance flood. The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights. See note for specific types. If the floodway is too narrow to be shown, a note is shown.*

	Special Flood Hazard Areas subject to inundation by the 1% annual chance flood (Zones A, AE, AH, AO, AR, A99, V and VE)
Zone A	The flood insurance rate zone that corresponds to the 1% annual chance floodplains. No base (1% annual chance) flood elevations (BFEs) or depths are shown within this zone.
Zone AE	The flood insurance rate zone that corresponds to the 1% annual chance floodplains. Base flood elevations derived from the hydraulic analyses are shown within this zone, either at cross section locations or as static whole-foot elevations that apply throughout the zone.
Zone AH	The flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot BFEs derived from the hydraulic analyses are shown at selected intervals within this zone.
Zone AO	The flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the hydraulic analyses are shown within this zone.
Zone AR	The flood insurance rate zone that corresponds to areas that were formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
Zone A99	The flood insurance rate zone that corresponds to areas of the 1% annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or flood depths are shown within this zone.
Zone V	The flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations are not shown within this zone.
Zone VE	Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations derived from the coastal analyses are shown within this zone as static whole-foot elevations that apply throughout the zone.
	Regulatory Floodway determined in Zone AE.

Figure 3: Map Legend for FIRM

OTHER AREAS OF FLOOD HAZARD	
	Shaded Zone X: Areas of 0.2% annual chance flood hazards and areas of 1% annual chance flood hazards with average depths of less than 1 foot or with drainage areas less than 1 square mile.
	Future Conditions 1% Annual Chance Flood Hazard – Zone X: The flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined based on future-conditions hydrology. No base flood elevations or flood depths are shown within this zone.
	Area with Reduced Flood Risk due to Levee: Areas where an accredited levee, dike, or other flood control structure has reduced the flood risk from the 1% annual chance flood. See Notes to Users for important information.
OTHER AREAS	
	Zone D (Areas of Undetermined Flood Hazard): The flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible
NO SCREEN	Unshaded Zone X: Areas determined to be outside the 0.2% annual chance flood hazard
FLOOD HAZARD AND OTHER BOUNDARY LINES	
(ortho) (vector)	Flood Zone Boundary (white line on ortho-photography-based mapping; gray line on vector-based mapping)
	Limit of Study
	Jurisdiction Boundary
	Limit of Moderate Wave Action (LiMWA): Indicates the inland limit of the area affected by waves greater than 1.5 feet
GENERAL STRUCTURES	
Aqueduct *Channel* *Culvert* *Storm Sewer*	Channel, Culvert, Aqueduct, or Storm Sewer
Dam *Jetty* *Weir*	Dam, Jetty, Weir

Figure 3: Map Legend for FIRM

	Levee, Dike, or Floodwall accredited or provisionally accredited to reduce the flood risk from the 1% annual chance flood.
	Levee, Dike or Floodwall not accredited to reduce the flood risk from the 1% annual chance flood.
Bridge	Bridge
COASTAL BARRIER RESOURCES SYSTEM (CBRS) AND OTHERWISE PROTECTED AREAS (OPA): *CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. See Notes to Users for important information.*	
CBRS AREA 09/30/2009	Coastal Barrier Resources System Area: Labels are shown to clarify where this area shares a boundary with an incorporated area or overlaps with the floodway.
OTHERWISE PROTECTED AREA 09/30/2009	Otherwise Protected Area
REFERENCE MARKERS	
22.0	River mile Markers
CROSS SECTION & TRANSECT INFORMATION	
B 20.2	Lettered Cross Section with Regulatory Water Surface Elevation (BFE)
5280 21.1	Numbered Cross Section with Regulatory Water Surface Elevation (BFE)
17.5	Unlettered Cross Section with Regulatory Water Surface Elevation (BFE)
8	Coastal Transect
	Profile Baseline: Indicates the modeled flow path of a stream and is shown on FIRM panels for all valid studies with profiles or otherwise established base flood elevation.
	Coastal Transect Baseline: Used in the coastal flood hazard model to represent the 0.0-foot elevation contour and the starting point for the transect and the measuring point for the coastal mapping.
513	Base Flood Elevation Line (shown for flooding sources for which no cross sections or profile are available)
ZONE AE (EL 16)	Static Base Flood Elevation value (shown under zone label)

Figure 3: Map Legend for FIRM

ZONE AO (DEPTH 2)	Zone designation with Depth
ZONE AO (DEPTH 2) (VEL 15 FPS)	Zone designation with Depth and Velocity
BASE MAP FEATURES	
Missouri Creek	River, Stream or Other Hydrographic Feature
234	Interstate Highway
234	U.S. Highway
234	State Highway
234	County Highway
MAPLE LANE	Street, Road, Avenue Name, or Private Drive if shown on Flood Profile
RAILROAD	Railroad
	Horizontal Reference Grid Line
—	Horizontal Reference Grid Ticks
+	Secondary Grid Crosshairs
Land Grant	Name of Land Grant
7	Section Number
R. 43 W. T. 22 N.	Range, Township Number
$^{42}76^{000m}$E	Horizontal Reference Grid Coordinates (UTM)
365000 FT	Horizontal Reference Grid Coordinates (State Plane)
80° 16’ 52.5”	Corner Coordinates (Latitude, Longitude)

SECTION 2.0 – FLOODPLAIN MANAGEMENT APPLICATIONS

2.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1% annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2% annual chance (500-year) flood is employed to indicate additional areas of flood hazard in the community.

Each flooding source included in the project scope has been studied and mapped using professional engineering and mapping methodologies that were agreed upon by FEMA and Chambers County as appropriate to the risk level. Flood risk is evaluated based on factors such as known flood hazards and projected impact on the built environment. Engineering analyses were performed for each studied flooding source to calculate its 1% annual chance flood elevations; elevations corresponding to other floods (e.g. 10-, 4-, 2-, 0.2-percent annual chance, etc.) may have also been computed for certain flooding sources. Engineering models and methods are described in detail in Section 5.0 of this FIS Report. The modeled elevations at cross sections were used to delineate the floodplain boundaries on the FIRM; between cross sections, the boundaries were interpolated using elevation data from various sources. More information on specific mapping methods is provided in Section 6.0 of this FIS Report.

Depending on the accuracy of available topographic data (Table 23), study methodologies employed (Section 5.0), and flood risk, certain flooding sources may be mapped to show both the 1% and 0.2% annual chance floodplain boundaries, regulatory water surface elevations (BFEs), and/or a regulatory floodway. Similarly, other flooding sources may be mapped to show only the 1% annual chance floodplain boundary on the FIRM, without published water surface elevations. In cases where the 1% and 0.2% annual chance floodplain boundaries are close together, only the 1% annual chance floodplain boundary is shown on the FIRM. Figure 3, "Map Legend for FIRM", describes the flood zones that are used on the FIRMs to account for the varying levels of flood risk that exist along flooding sources within the project area. Table 2 and Table 3 indicate the flood zone designations for each flooding source and each community within Chambers County, Texas, respectively.

Table 2, "Flooding Sources Included in this FIS Report," lists each flooding source, including its study limits, affected communities, mapped zone on the FIRM, and the completion date of its engineering analysis from which the flood elevations on the FIRM and in the FIS Report were derived. Descriptions and dates for the latest hydrologic and hydraulic analyses of the flooding sources are shown in Table 13. Floodplain boundaries for these flooding sources are shown on the FIRM (published separately) using the symbology described in Figure 3. On the map, the 1% annual chance floodplain corresponds to the SFHAs. The 0.2% annual chance floodplain shows areas that, although out of the regulatory floodplain, are still subject to flood hazards.

Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data. The procedures to remove these areas from the SFHA are described in Section 6.5 of this FIS Report.

2.2 Floodways

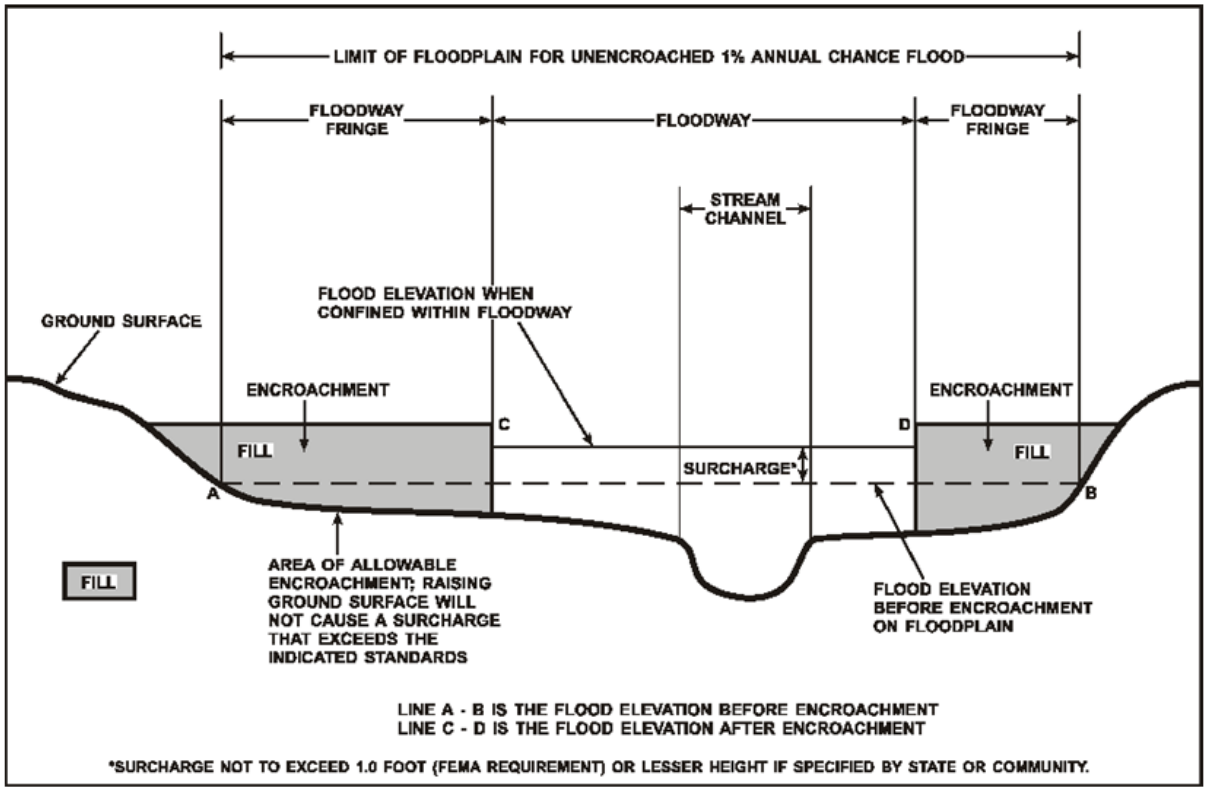
Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the

encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard.

For purposes of the NFIP, a floodway is used as a tool to assist local communities in balancing floodplain development against increasing flood hazard. With this approach, the area of the 1% annual chance floodplain on a river is divided into a floodway and a floodway fringe based on hydraulic modeling. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment in order to carry the 1% annual chance flood. The floodway fringe is the area between the floodway and the 1% annual chance floodplain boundaries where encroachment is permitted. The floodway must be wide enough so that the floodway fringe could be completely obstructed without increasing the water surface elevation of the 1% annual chance flood more than 1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 4.

To participate in the NFIP, Federal regulations require communities to limit increases caused by encroachment to 1.0 foot, provided that hazardous velocities are not produced. Regulations for Texas require communities in Chambers County to limit increases caused by encroachment to 0.5 foot and several communities have adopted additional restrictions. The floodways in this project are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway projects.

Figure 4: Floodway Schematic



Floodway widths presented in this FIS Report and on the FIRM were computed at cross sections.

Between cross sections, the floodway boundaries were interpolated. For certain stream segments, floodways were adjusted so that the amount of floodwaters conveyed on each side of the floodplain would be reduced equally. The results of the floodway computations have been tabulated for selected cross sections and are shown in Table 24, "Floodway Data."

All floodways that were developed for this FIS project are shown on the FIRM using the symbology described in Figure 3. In cases where the floodway and l% annual chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown on the FIRM. For information about the delineation of floodways on the FIRM, refer to Section 6.3.

2.3 Base Flood Elevations

The hydraulic characteristics of flooding sources were analyzed to provide estimates of the elevations of floods of the selected recurrence intervals. The Base Flood Elevation (BFE) is the elevation of the 1% annual chance flood. These BFEs are most commonly rounded to the whole foot, as shown on the FIRM, but in certain circumstances or locations they may be rounded to 0.1 foot. Cross section lines shown on the FIRM may also be labeled with the BFE rounded to 0.1 foot. Whole-foot BFEs derived from engineering analyses that apply to coastal areas, areas of ponding, or other static areas with little elevation change may also be shown at selected intervals on the FIRM.

Cross sections with BFEs shown on the FIRM correspond to the cross sections shown in the Floodway Data table and Flood Profiles in this FIS Report. BFEs are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS Report in conjunction with the data shown on the FIRM.

Table 2: Flooding Sources Included in this FIS Report

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Barrow Slough	Chambers County	The confluence with Whites Bayou, South of Interstate Highway 10	Approximately 0.5 mile upstream of White Barrow Road	12030203	1.9	*	Y	AE	1981
Cedar Bayou	Chambers County, City of Baytown, City of Mont Belvieu	The confluence with Galveston Bay	The Chambers/Harris County boundary	12040203	24.5	*	Y	AE	2007
Cedar Gully	Chambers County	The confluence with Trinity Bay	Cedar Bayou Bay Road	12040203	0.9	*	Y	AE	1981
Cherry Point Gully	Chambers County, City of Mont Belvieu	The confluence with Old River	Approximately 3,095 feet upstream of Cherry Point Road	12030203	3.2	*	N	A	2014
Cherry Point Gully Tributary 1	Chambers County, City of Mont Belvieu	The confluence with Cherry Point Gully	Approximately 4,670 feet upstream of the confluence with Cherry Point Gully	12030203	0.9	*	N	A	2014
Cherry Point Tributary	City of Mont Belvieu	The confluence with Cherry Point Gully	Approximately 1,530 feet upstream of the confluence with Cherry Point Gully	12030203	0.3	*	N	A	2014
Cotton Bayou	Chambers County, City of Cove	The confluence with Trinity Bay	Interstate Highway 10	12030203	3.8	*	Y	AE	1981

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Cotton Bayou	Chambers County, City of Mont Belvieu	Interstate Highway 10	Approximately 3,710 feet upstream of Lakes of Champions Boulevard	12030203	1.96	*	N	A	2014
Crooked Bayou	Chambers County	The confluence with Whites Bayou	Chambers/Liberty County boundary	12030203	3.72	*	N	A	2014
Crooked Marsh	Chambers County	The confluence with Crooked Bayou	Chambers/Liberty County boundary	12030203	1.14	*	N	A	2014
Double Bayou East Fork	Chambers County	The confluence with Trinity Bay	Farm to Market (FM) 1663	12040202	21.5	*	Y	AE	1981
Double Bayou West Fork	Chambers County	The confluence with Trinity Bay	State Highway 562	12040202	13.3	*	Y	AE	1981
East Bay	Chambers County	Coastal Transect number 48	Coastal Transect number 65	12040202	27.6	*	N	VE	2011
Gulf of Mexico	Chambers County	Coastal Transect number 66	Coastal Transect number 74	12040202	20.9	*	N	VE	2011
Hackberry Gully	Chambers County, City of Cove	The confluence with Cotton Bayou	Interstate Highway 10	12030203	2.8	*	Y	AE	1981
Hackberry Gully	Chambers County, City of Mont Belvieu	Interstate Highway 10	Approximately 5,645 feet upstream of Interstate 10	12030203	2.3	*	N	A	2014
Horsepen Bayou	Chambers County, City of Baytown	The confluence with Cedar Bayou	Southern Pacific Railroad	12040203	1.1	*	Y	AE	1981

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Labbit Creek	Chambers County, City of Old River-Winfree	Approximately 1,825 feet downstream of County Road 401	The Chambers/Liberty County boundary	12030203	0.2	*	Y	AE	2014
Lee Gully	Chambers County	The confluence with Turtle Whites Bayou	Speights Road (FM 1663)	12030203	0.9	*	Y	AE	1981
Lee Gully	Chambers County	Speights Road (FM 1663)	Chambers/Liberty County boundary	12030203	2.9	*	N	A	2014
Little Caney Creek	Chambers County, City of Old River-Winfree	Approximately 8,120 feet downstream of FM 1409	Chambers/Liberty County boundary	12030203	2.1	*	Y	AE	2014
Old Ditch	Chambers County, City of Mont Belvieu	The confluence with Old River	Just downstream of River Ridge Drive	12030203	0.7	*	N	A	2014
Old River	Chambers County, City of Mont Belvieu, City of Old River-Winfree	Approximately 8,350 feet downstream of FM 1409	The Chambers/Liberty County Boundary	12030203	5.3	*	Y	AE	2014
Old River Tributary 1	Chambers County	Approximately 2,450 feet downstream of FM 565	Approximately 1,180 feet upstream of FM 565	12030203	0.7	*	N	A	2014
Old River Tributary 1A	Chambers County, City of Old River-Winfree	The confluence with Old River Tributary 1	Approximately 7,540 feet upstream of the confluence with Old River Tributary 1	12030203	1.4	*	N	A	2014

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Old River Tributary 2	City of Old River-Winfree	The confluence with Old River	Approximately 1,340 feet upstream of Woodland Lane	12030203	0.5	*	N	A	2014
Old River Tributary 3	Chambers County	The confluence with Old River	Chambers/Liberty County boundary	12030203	0.7	*	N	A	2014
Oyster Bayou	Chambers County	The confluence with Lone Star Canal	Approximately 1.4 miles upstream of State Highway 65	12040202	3.6	*	Y	AE	1981
Sawpit Gully	Chambers County, City of Baytown	The confluence with Cedar Bayou	Approximately 0.7 mile upstream of Southern Pacific Railroad	12040203	1.9	*	Y	AE	1981
Smith Gully	City of Mont Belvieu	FM 146	Winfree Road	12040203	2.6	*	Y	AE	1981
Spindletop Bayou	Chambers County	State Highway 124	State Highway 65	12040202	4.4	*	Y	AE	1981
Spring Branch	Chambers County	The confluence with Turtle Whites Bayou	Approximately 2 miles upstream of Speights Road	12030203	2.5	*	Y	AE	1981
Spring Branch	Chambers County	Approximately 2 miles upstream of Speights Road	Chambers/Liberty County boundary	12030203	1.4	*	N	A	2014
Tabbs Bay	Chambers County	Coastal Transect number 1	Coastal Transect number 5	12040203	6.9	*	N	VE	2011
The Cutoff Tributary 1	Chambers County, City of Old River-Winfree	Approximately 2,745 feet downstream of County Road 401	Chambers/Liberty County boundary	12030203	0.4	*	N	A	2014

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
The Cutoff Tributary 2	Chambers County, City of Old River-Winfree	Approximately 3,070 feet downstream of County Road 401	Chambers/Liberty County boundary	12030203	0.4	*	N	A	2014
Trinity Bay	City of Beach City, Chambers County	Coastal Transect number 6	Coastal Transect number 47	12030203 12040202 12040203	61.9	*	N	VE	2011
Trinity River	Chambers County	The confluence with Trinity Bay	Chambers/Liberty County boundary	12030203	4.1	*	Y	AE	1986
Turtle Bayou	Chambers County	The confluence with Turtle Whites Bayou	Chambers/Liberty County boundary	12030203	4.8	*	N	A	2014
Turtle Whites Bayou	Chambers County	The confluence with Lake Anahuac	FM 1663	12030203	4.5	*	Y	AE	1981
Whites Bayou	Chambers County	The confluence with Turtle White Bayou	Approximately 0.9 mile upstream of State Highway 61	12030203	3.8	*	Y	AE	1981
Whites Bayou	Chambers County	Approximately 0.9 mile upstream of State Highway 61	The confluence with Turtle Whites Bayou	12030203	3.3	*	N	A	2014
Whites Bayou	Chambers County	FM 1663	Chambers/Liberty County boundary	12030203	2.8	*	N	A	2014
Whites Bayou Tributary 1	Chambers County	Confluence with Whites Bayou	Chambers/Liberty County boundary	12030203	1.6	*	N	A	2014

*Not calculated for this FIS project

2.4 Non-Encroachment Zones

Some States and communities use non-encroachment zones to manage floodplain development. For flooding sources with medium flood risk, field surveys are often not collected and surveyed bridge and culvert geometry is not developed. Standard hydrologic and hydraulic analyses are still performed to determine BFEs in these areas. However, floodways are not typically determined, since specific channel profiles are not developed. To assist communities with managing floodplain development in these areas, a "non-encroachment zone" may be provided. While not a FEMA designated floodway, the non-encroachment zone represents that area around the stream that should be reserved to convey the 1% annual chance flood event. As with a floodway, all surcharges must fall within the acceptable range in the non-encroachment zone.

General setbacks can be used in areas of lower risk (e.g. unnumbered Zone A), but these are not considered sufficient where unnumbered Zone A is replaced by Zone AE. The NFIP requires communities to ensure that any development in a non-encroachment area causes no increase in BFEs. Communities must generally prohibit development within the area defined by the non-encroachment width to meet the NFIP requirement. Regulations for Texas require communities in Chambers County to limit increases caused by encroachment to 0.5 foot and several communities have adopted additional restrictions for non-encroachment areas.

Non-encroachment determinations may be delineated where it is not possible to delineate floodways because specific channel profiles with bridge and culvert geometry were not developed. Any non-encroachment determinations for this FIS project have been tabulated for selected cross sections and are shown in Table 25, "Flood Hazard and Non-Encroachment Data for Selected Streams." Areas for which non-encroachment zones are provided show BFEs and the 1% annual chance floodplain boundaries mapped as zone AE on the FIRM but no floodways.

2.5 Coastal Flood Hazard Areas

For most areas along rivers, streams, and small lakes, BFEs and floodplain boundaries are based on the amount of water expected to enter the area during a 1% annual chance flood and the geometry of the floodplain. Floods in these areas are typically caused by storm events. However, for areas on or near ocean coasts, large rivers, or large bodies of water, BFE and floodplain boundaries may need to be based on additional components, including storm surges and waves. Communities on or near ocean coasts face flood hazards caused by offshore seismic events as well as storm events.

Coastal flooding sources that are included in this FIS project are shown in Table 2.

2.5.1 Water Elevations and the Effects of Waves

Specific terminology is used in coastal analyses to indicate which components have been included in evaluating flood hazards.

The stillwater elevation (SWEL or still water level) is the surface of the water resulting from astronomical tides, storm surge, and freshwater inputs, but excluding wave setup contribution or the effects of waves.

- *Astronomical tides* are periodic rises and falls in large bodies of water caused by the

rotation of the earth and by the gravitational forces exerted by the earth, moon and sun.

- *Storm surge* is the additional water depth that occurs during large storm events. These events can bring air pressure changes and strong winds that force water up against the shore.
- *Freshwater inputs* include rainfall that falls directly on the body of water, runoff from surfaces and overland flow, and inputs from rivers.

The 1% annual chance stillwater elevation is the stillwater elevation that has been calculated for a storm surge from a 1% annual chance storm. The 1% annual chance storm surge can be determined from analyses of tidal gage records, statistical study of regional historical storms, or other modeling approaches. Stillwater elevations for storms of other frequencies can be developed using similar approaches.

The total stillwater elevation (also referred to as the mean water level) is the stillwater elevation plus wave setup contribution but excluding the effects of waves.

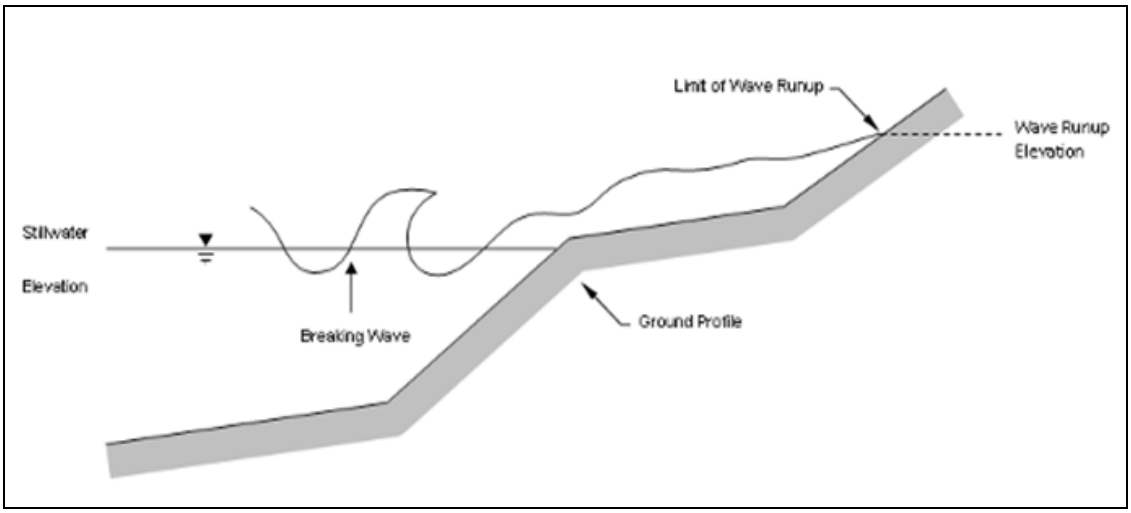
- *Wave setup* is the increase in stillwater elevation at the shoreline caused by the reduction of waves in shallow water. It occurs as breaking wave momentum is transferred to the water column.

Like the Stillwater elevation, the total Stillwater elevation is based on a storm of a particular frequency, such as the 1% annual chance storm. Wave setup is typically estimated using standard engineering practices or calculated using models, since tidal gages are often sited in areas sheltered from wave action and do not capture this information.

Coastal analyses may examine the effects of overland waves by analyzing storm-induced erosion, overland wave propagation, wave runup, and/or wave overtopping.

- *Storm-induced erosion* is the modification of existing topography by erosion caused by a specific storm event, as opposed to general erosion that occurs at a more constant rate.
- *Overland wave propagation* describes the combined effects of variation in ground elevation, vegetation, and physical features on wave characteristics as waves move onshore.
- *Wave runup* is the uprush of water from wave action on a shore barrier. It is a function of the roughness and geometry of the shoreline at the point where the Stillwater elevation intersects the land.
- *Wave overtopping* refers to wave runup that occurs when waves pass over the crest of a barrier.

Figure 5: Wave Runup Transect Schematic



2.5.2 Floodplain Boundaries and BFEs for Coastal Areas

For coastal communities along the Atlantic and Pacific Oceans, the Gulf of Mexico, the Great Lakes, and the Caribbean Sea, flood hazards must take into account how storm surges, waves, and extreme tides interact with factors such as topography and vegetation. Storm surge and waves must also be considered in assessing flood risk for certain communities on rivers or large inland bodies of water.

Beyond areas that are affected by waves and tides, coastal communities can also have riverine floodplains with designated floodways, as described in previous sections.

Floodplain Boundaries

In many coastal areas, storm surge is the principle component of flooding. The extent of the 1% annual chance floodplain in these areas is derived from the total stillwater elevation (stillwater elevation including storm surge plus wave setup) for the 1% annual chance storm. The methods that were used for calculation of total stillwater elevations for coastal areas are described in Section 5.3 of this FIS Report. Location of total stillwater elevations for coastal areas are shown in Figure 8, "1% Annual Chance Total Stillwater Levels for Coastal Areas."

In some areas, the 1% annual chance floodplain is determined based on the limit of wave runup or wave overtopping for the 1% annual chance storm surge. The methods that were used for calculation of wave hazards are described in Section 5.3 of this FIS Report.

Table 26, Summary of Coastal Transect Mapping Considerations, presents the types of coastal analyses that were used in mapping the 1% annual chance floodplain in coastal areas.

Coastal BFEs

Coastal BFEs are calculated as the total stillwater elevation (stillwater elevation including storm surge plus wave setup) for the 1% annual chance storm plus the additional flood hazard from overland wave effects (storm-induced erosion, overland wave propagation, wave runup and wave overtopping).

Where they apply, coastal BFEs are calculated along transects extending from offshore to the limit of coastal flooding onshore. Results of these analyses are accurate until local topography, vegetation, or development type and density within the community undergoes major changes.

Parameters that were included in calculating coastal BFEs for each transect included in this FIS Report are presented in Table 17, "Coastal Transect Parameters." The locations of transects are shown in Figure 9, "Transect Location Map." More detailed information about the methods used in coastal analyses and the results of intermediate steps in the coastal analyses are presented in Section 5.3 of this FIS Report. Additional information on specific mapping methods is provided in Section 6.4 of this FIS Report.

2.5.3 Coastal High Hazard Areas

Certain areas along the open coast and other areas may have higher risk of experiencing structural damage caused by wave action and/or high-velocity water during the 1% annual chance flood. These areas will be identified on the FIRM as Coastal High Hazard Areas.

- *Coastal High Hazard Area (CHHA)* is a SFHA extending from offshore to the inland limit of the primary frontal dune (PFD) or any other area subject to damages caused by wave action and/or high-velocity water during the 1% annual chance flood.
- *Primary Frontal Dune (PFD)* is a continuous or nearly continuous mound or ridge of sand with relatively steep slopes immediately landward and adjacent to the beach. The PFD is subject to erosion and overtopping from high tides and waves during major coastal storms.

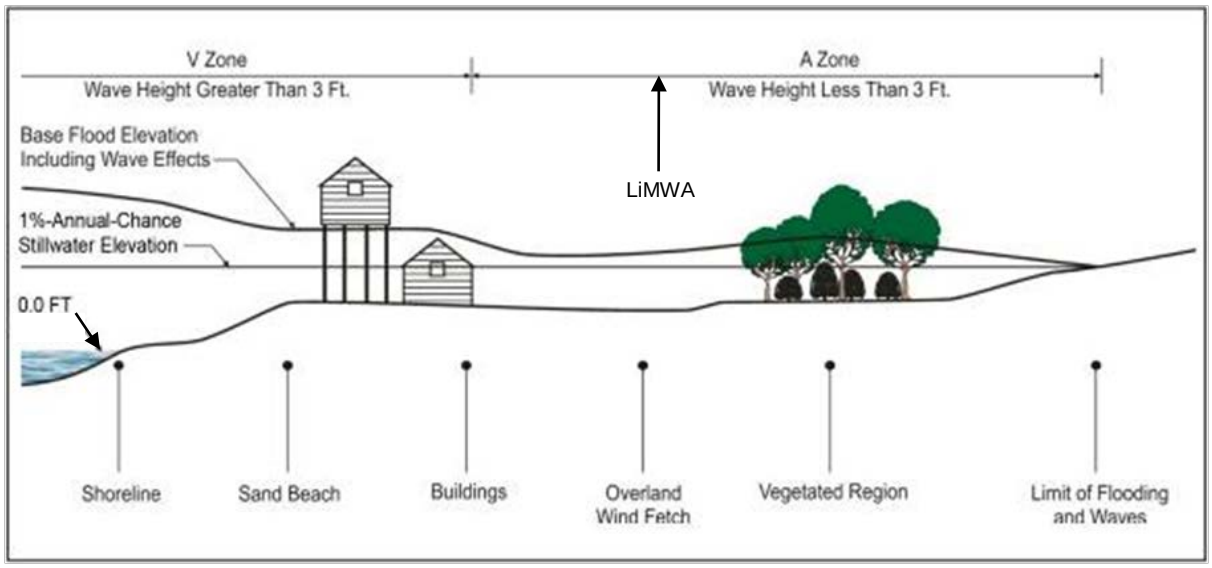
CHHAs are designated as "V" zones (for "velocity wave zones") and are subject to more stringent regulatory requirements and a different flood insurance rate structure. The areas of greatest risk are shown as VE on the FIRM. Zone VE is further subdivided into elevation zones and shown with BFEs on the FIRM.

The landward limit of the PFD occurs at a point where there is a distinct change from a relatively steep slope to a relatively mild slope; this point represents the landward extension of Zone VE. Areas of lower risk in the CHHA are designated with Zone V on the FIRM. More detailed information about the identification and designation of Zone VE is presented in Section 6.4 of this FIS Report.

Areas that are not within the CHHA but are SFHAs may still be impacted by coastal flooding and damaging waves; these areas are shown as "A" zones on the FIRM.

Figure 6, "Coastal Transect Schematic," illustrates the relationship between the base flood elevation, the 1% annual chance stillwater elevation, and the ground profile as well as the location of the Zone VE and Zone AE areas in an area without a PFD subject to overland wave propagation. This figure also illustrates energy dissipation and regeneration of a wave as it moves inland.

Figure 6: Coastal Transect Schematic



Methods used in coastal analyses in this FIS project are presented in Section 5.3 and mapping methods are provided in Section 6.4 of this FIS Report.

Coastal floodplains are shown on the FIRM using the symbology described in Figure 3, "Map Legend for FIRM." In many cases, the BFE on the FIRM is higher than the stillwater elevations shown in Table 17 due to the presence of wave effects. The higher elevation should be used for construction and/or floodplain management purposes.

2.5.4 Limit of Moderate Wave Action

Laboratory tests and field investigations have shown that wave heights as little as 1.5 feet can cause damage to and failure of typical Zone AE building construction. Wood-frame, light gage steel, or masonry walls on shallow footings or slabs are subject to damage when exposed to waves less than 3 feet in height. Other flood hazards associated with coastal waves (floating debris, high velocity flow, erosion, and scour) can also damage Zone AE construction.

Therefore, a LiMWA boundary may be shown on the FIRM as an informational layer to assist coastal communities in safe rebuilding practices. The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. The location of the LiMWA relative to Zone VE and Zone AE is shown in Figure 6.

The effects of wave hazards in Zone AE between Zone VE (or the shoreline where Zone VE is not identified) and the limit of the LiMWA boundary are similar to, but less severe than, those in Zone VE where 3-foot or greater breaking waves are projected to occur during the 1% annual chance flooding event. Communities are therefore encouraged to adopt and enforce more stringent floodplain management requirements than the minimum NFIP requirements in the LiMWA. The NFIP CRS provides credits for these actions.

Where wave runup elevations dominate over wave heights, there is no evidence to date of significant damage to residential structures by runup depths less than 3 feet. Examples of these

areas include areas with steeply sloped beaches, bluffs, or flood protection structures that lie parallel to the shore. In these areas, the FIRM shows the LiMWA immediately landward of the VE/AE boundary. Similarly, in areas where the zone VE designation is based on the presence of a primary frontal dune or wave overtopping, the LiMWA is delineated immediately landward of the Zone VE/AE boundary.

SECTION 3.0 – INSURANCE APPLICATIONS

3.1 National Flood Insurance Program Insurance Zones

For flood insurance applications, the FIRM designates flood insurance rate zones as described in Figure 3, "Map Legend for FIRM." Flood insurance zone designations are assigned to flooding sources based on the results of the hydraulic or coastal analyses. Insurance agents use the zones shown on the FIRM and depths and base flood elevations in this FIS Report in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

The 1% annual chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (e.g. Zones A, AE, V, VE, etc.), and the 0.2% annual chance floodplain boundary corresponds to the boundary of areas of additional flood hazards.

Table 3 lists the flood insurance zones in the unincorporated and incorporated areas of Chambers County.

Table 3: Flood Zone Designations by Community

Community	Flood Zone(s)
Anahuac, City of	AE, VE, X
Baytown, City of	AE, VE, X
Beach City, City of	AE, VE, X
Chambers County, Unincorporated Areas	A, AE, OPEN WATER, VE, X
Cove, City of	AE, VE, X
Mont Belvieu, City of	A, AE, X
Old River-Winfree, City of	A, AE, X

3.2 Coastal Barrier Resources System

The Coastal Barrier Resources Act (CBRA) of 1982 was established by Congress to create areas along the Atlantic and Gulf coasts and the Great Lakes, where restrictions for Federal financial assistance including flood insurance are prohibited. In 1990, Congress passed the Coastal Barrier Improvement Act (CBIA), which increased the extent of areas established by the CBRA and added "Otherwise Protected Areas" (OPA) to the system. These areas are collectively referred to as the John H. Chafee Coastal Barrier Resources System (CBRS). The CBRS boundaries that have been identified in the project area are in Table 4, "Coastal Barrier Resource System Information."

Table 4: Coastal Barrier Resources System Information

Primary Flooding Source	CBRS/OPA Type	Date CBRS Area Established	FIRM Panel Number(s)
Gulf of Mexico	CBRS	11/16/1990	0610
Gulf of Mexico	CBRS	10/1/1983	0605, 0610, 0630, 0640

SECTION 4.0 – AREA STUDIED

4.1 Basin Description

Table 5 contains a description of the characteristics of the HUC-8 sub-basins within which each community falls. The table includes the main flooding sources within each basin, a brief description of the basin, and its drainage area.

Table 5: Basin Characteristics

HUC-8 Sub-Basin Name	HUC-8 Sub-Basin Number	Primary Flooding Source	Description of Affected Area	Drainage Area (square miles)
Lower Trinity	12030203	Trinity River	Begins at Trinity Bay and extends north, affecting almost one sixth of Chambers County.	767
Sabine Lake	12040201	Sabine Lake	Begins at the Gulf of Mexico. Covers a small northeast portion of Chambers County.	987
East Galveston Bay	12040202	Galveston Bay	Begins at the Gulf of Mexico and extends northeast, affecting almost half of Chambers County.	818
North Galveston Bay	12040203	Galveston Bay	Begins at the Gulf of Mexico and extends northwest, affecting almost one fourth of Chambers County.	357

4.2 Principal Flood Problems

Table 6 contains a description of the principal flood problems that have been noted for Chambers County by flooding source.

Table 6: Principal Flood Problems

Flooding Source	Description of Flood Problems
Coastal	A severe hurricane that occurred from September 7 to 10, 1900 originated in the Cape Verde region and passed inland southwest of City of Galveston. Central pressure of this hurricane was 27.64 inches, and the peak of storm surge was 14.5 feet NAVD88. At Boliviar Point, wharves and buildings were crushed. The Gulf and Interstate railroad track from Bolivar to Beaumont was washed away in places, and water in pastures between High Island and White's Branch was reported to be about 14 feet deep.
Coastal	A hurricane that occurred from August 16 to 19, 1915 which originated in the Cape Verde region and made landfall near the City of Matogorda. It had a radius of 32 nautical miles; its central pressure was 28.01 inches with 28.64 inches at Galveston. Maximum wind gusts were reported to be 120 miles per hour (mph) at Galveston. The reported storm surge at Galveston Bay was over 15 feet above NAVD88. All the rice and corn crops on the east side of the bay were ruined. Water was reported at 22 feet above normal near the City of Anahuac. It was reported that 17 lives were lost at Anahuac.
Coastal	A hurricane occurred on September 14, 1919. Although this hurricane, which practically paralleled the coast, passed about 240 miles south of Chambers County, it caused tides reported at 10.0 feet at the City of Anahuac.
Coastal	A hurricane that occurred from May 24 to 31, 1946 dropped a total of 30.2 inches of rain and caused severe flooding in the area. The City of Anahuac was isolated for 12 hours. Highway 65 to the City of Stowell was closed for 4 days, and Highway 61 to the Community of Hankamer was closed for 2 days. The area suffered heavy rice crop damage.
Coastal	A hurricane that occurred from October 2 to 3, 1949 originated in the Pacific Ocean near El Salvador, moved across Guatemala and northward into the Gulf of Mexico, and landed at the City of Freeport in Brazonia County. Surges from this storm exceeded 11 feet at several locations along the Texas coast and reached 9 feet at the City of Anahuac. Chambers County suffered heavy losses of rice crops, which were still uncut and flat on the ground in mud and water.
Coastal	Hurricane Gladys, which occurred in September of 1955, dropped 9.5 inches of rain of the City of Anahuac in 10.5 hours. The east side of the city was inundated by 12 to 18 inches of water.

Flooding Source	Description of Flood Problems
Coastal	Hurricane Carla, which occurred September 9 to 12, 1961, struck the Texas coast about 110 miles southwest of the City of Baytown Chambers/Harris County. It was accompanied by driving rains and spawned 26 tornadoes. Maximum storm surges in the Galveston Bay system were recorded in the area of Burnett, Crystal, and Scott Bays, adjoining West Baytown, where the surge was 14.7 feet. Parts of the residential area bordering these bays were severely damaged. Extensive land erosion occurred along the west shore of Trinity Bay. A still high water elevation of 11.5 feet was recorded on Cedar Bay at Baytown, where tide levels reached 14.1. Still high water reached 13.4 feet at the City of Anahuac, and tides were 12.4 feet. Carla flooded 255 square miles of land in Chambers County (41 percent of the county's total land area). Most of the southern portion of the county was inundated. Total damages in Chambers County were estimated at $8.9 million, of which about $4.4 million (1961) were attributed to tidal overflow.
Coastal	Hurricane Beulah, occurred September 20, 1967, spawned in the Atlantic and was characterized by intense rainfall. It moved inland between Brownsville and the mouth of the Rio Grande causing flooding in the north shore of East Bay, Houston Point, and Trinity Bay area; the lower reaches of Cedar Bayou, Double Bayou, the Old River, and the Trinity River; and the whole western shore of Lake Anahuac.
Coastal	Occurring July 25, 1979, Tropical Storm "Claudette", was from an upper air low pressure cell, which originated in the Atlantic near Puerto Rico and moved westward into the Gulf of Mexico. It brought gale-force winds and heavy rainfall to many parts of southeastern Texas, causing severe flooding along streams and coastal areas. Estimated tides were between 4 and 5 feet in Galveston Bay and its upper reaches, and about 3 feet along Galveston Island and Bolivar Peninsula. Some homes in low-lying areas on the west side of Trinity Bay near City of Beach City were flooded. In Chambers County, a total of 27 homes sustained major damage. Interstate Highway 10 at State Route 146 in the western part of the county was underwater. Rice, soybean, and hay crops in the county suffered major damage.
Coastal	Late on the June 4, 1981, a tropical storm depression formed over the western Gulf of Mexico. Thunderstorms spawned by the depression brought heavy rains over the southeast of Texas on the 5th, and then moved eastward into the Gulf of Mexico and Louisiana. The ground throughout the southeast of Texas had already been saturated by recent rains thereby increasing the flooding from this storm. Many communities suffered extensive flood damage. The heaviest rainfall and most of the flooding was reported in communities near the coast: Galveston, Texas City, Baytown, Paseden, Bay City, Wharton, Liberty, and Pearland. The western end of Galveston Island recorded 9 inches of rainfall; the City of Dickinson recorded 7 inches; Alta Loma in Galveston County recorded 5.65 inches; and the City of Hitchcock recorded 7.38 inches. In Baytown, where 9 inches of rainfall was reported, most arterial roads were under water on the 5th of June, 1981. Several tornadoes were generated by the depression. One touched down at Smith's Point and caused damage to several homes. No injuries were reported.

Flooding Source	Description of Flood Problems
Coastal	Hurricane Ike occurred September 13, 2008. Chambers County bore the brunt of the dirty side of Ike and the surge that wiped Bolivar clean crested there on the banks of Trinity Bay. It's probably safe to say that other than the communities on the Bolivar Peninsula, no places in Texas were ravaged worse by Hurricane Ike than the bayside Chambers County towns of Oak Island and Smith Point. The Hurricane caused $450 million in damage to public infrastructure and buildings, not counting private property. An 8- to 9-foot storm surge from Trinity Bay during Hurricane Ike leveled most of Oak Island. Out of 350 homes on Oak Island, 300 were completely washed away. At least 1,000 homes throughout the county were either destroyed or are uninhabitable. Roof damage and water damage to countless others. More than 700 head of cattle died from the lack of access to fresh water after the storm. Besides housing for displaced families, the biggest issue that faced Chambers County was approximately 13,015,500 million cubic yards of debris, which washed in from Galveston County. These massive debris piles (dubbed "debris fields") were composed of approximately 3,300 homes from Bolivar Peninsula. Containing hazardous materials, gasoline cans, refrigerators, pesticides, and even human remains, these large accumulations of storm debris plagued landowners, farmers, and ranchers. In addition, another 608,021 cubic yards of debris covered residential properties and roadways of Chambers County.

Table 7 contains information about historic flood elevations in the communities within Chambers County.

Table 7: Historic Flooding Elevations

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
Gulf of Mexico	Coastal storm surge	14.5	1900	*	May 4, 2015 Chambers County, Texas and Incorporated Areas FIS Report
Gulf of Mexico	Pastures between High Island and White's Bayou	14	1900	*	May 4, 2015 Chambers County, Texas and Incorporated Areas FIS Report

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
Galveston Bay	Storm Surge in Galveston Bay	15	1915	*	May 4, 2015 Chambers County, Texas and Incorporated Areas FIS Report
Galveston Bay	Near the City of Anahuac	22	1915	*	May 4, 2015 Chambers County, Texas and Incorporated Areas FIS Report
Gulf of Mexico	City of Anahuac	10	1919	*	May 4, 2015 Chambers County, Texas and Incorporated Areas FIS Report
Gulf of Mexico	Coastal storm surge	11	1949	*	May 4, 2015 Chambers County, Texas and Incorporated Areas FIS Report
Gulf of Mexico	City of Anahuac	9	1949	*	May 4, 2015 Chambers County, Texas and Incorporated Areas FIS Report
Galveston Bay	Storm Surges in West Baytown	14.7	1961	*	May 4, 2015 Chambers County, Texas and Incorporated Areas FIS Report

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
Cedar Bay	Baytown	11.5	1961	*	May 4, 2015 Chambers County, Texas and Incorporated Areas FIS Report
Gulf of Mexico	City of Anahuac	13.4	1961	*	May 4, 2015 Chambers County, Texas and Incorporated Areas FIS Report
East Bay	29.526794, -94.771424	6.5	2005	*	
Trinity Bay	29.755744, -94.68885	4.5	2005	*	
Trinity Bay	29.65763, -94.697554	4.8	2005	*	
Trinity Bay	Storm surge on Oak Island	8-9	2008	*	May 4, 2015 Chambers County, Texas and Incorporated Areas FIS Report
Gulf of Mexico	29.7729, -94.68562	15.69	2008	*	State of Texas
Gulf of Mexico	29.83786, -94.75883	13.8	2008	*	State of Texas
Gulf of Mexico	29.8476, -94.80437	12.92	2008	*	State of Texas
Gulf of Mexico	29.87549, -94.82955	14.75	2008	*	State of Texas
Gulf of Mexico	29.7486, -94.82523	15.39	2008	*	State of Texas
Gulf of Mexico	29.67929, -94.92541	12.51	2008	*	State of Texas
Gulf of Mexico	29.65988, -94.9165	12.93	2008	*	State of Texas
Gulf of Mexico	29.69445, -94.86541	17.15	2008	*	State of Texas
Gulf of Mexico	29.65843, -94.68949	13.52	2008	*	State of Texas
Gulf of Mexico	29.72815, -94.69016	16.55	2008	*	State of Texas

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
Gulf of Mexico	29.68164, -94.64151	11.63	2008	*	State of Texas
Gulf of Mexico	29.66346, -94.62407	15.4	2008	*	State of Texas
Gulf of Mexico	29.53801, -94.76138	10.53	2008	*	State of Texas
Gulf of Mexico	29.52599, -94.75813	12.44	2008	*	State of Texas
Gulf of Mexico	29.63195, -94.7023	15.28	2008	*	State of Texas
Gulf of Mexico	29.6135, -94.5332	14.53	2008	*	State of Texas
Gulf of Mexico	29.71494, -94.37549	16.86	2008	*	State of Texas
Gulf of Mexico	29.70399, -94.48374	17.48	2008	*	State of Texas

4.3 Non-Levee Flood Protection Measures

Table 8 contains information about non-levee flood protection measures within Chambers County such as dams, jetties, and or dikes. Levees are addressed in Section 4.4 of this FIS Report.

Table 8: Non-Levee Flood Protection Measures

Flooding Source	Structure Name	Type of Measure	Location	Description of Measure
Double Bayou East Fork	Dam	Dam	Approximately 5,325 feet upstream of Interstate 10	Dam
Double Bayou East Fork	Dam	Dam	Approximately 4,185 feet downstream of Fairview Road on Double Bayou East Fork	Dam

4.4 Levees

This section is not applicable to this FIS Project

Table 9: Levees

[Not Applicable to this FIS Project]

SECTION 5.0 – ENGINEERING METHODS

For the flooding sources in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded at least once on the average during any 10-, 25-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 25-, 50-, 100-, and 500-year floods, have a 10-, 4-, 2-, 1-, and 0.2% annual chance, respectively, of being equaled or exceeded during any year.

Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1-percent chance of annual exceedance) during the term of a 30-year mortgage is approximately 26 percent (about 3 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

The engineering analyses described here may incorporate the results of previously issued Letters of Map Change (LOMCs) listed in Table 27, "Incorporated Letters of Map Change", which include Letters of Map Revision (LOMRs). For more information about LOMRs, refer to Section 6.5, "FIRM Revisions."

5.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak elevation-frequency relationships for floods of the selected recurrence intervals for each flooding source studied. Hydrologic analyses are typically performed at the watershed level. Depending on factors such as watershed size and shape, land use and urbanization, and natural or man-made storage, various models or methodologies may be applied. A summary of the hydrologic methods applied to develop the discharges used in the hydraulic analyses for each stream is provided in Table 13. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

A summary of the discharges is provided in Table 10. Frequency Discharge-Drainage Area Curves used to develop the hydrologic models may also be shown in Figure 7 for selected flooding sources. A summary of stillwater elevations developed for non-coastal flooding sources is provided in Table 11. (Coastal stillwater elevations are discussed in Section 5.3 and shown in Table 17.) Stream gage information is provided in Figure 7: Frequency Discharge-Drainage Area Curves.

Table 10: Summary of Discharges

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (CFS)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Barrow Slough	At the confluence with Whites Bayou South of Interstate Highway 10	4.5	1,770	*	2,300	2,480	2,970
Cedar Bayou	At mouth	199.00	6,286	*	10,301	12,646	20,442
Cedar Bayou	Downstream of the Cedar Bayou diversion channel	187.96	5,688	*	8,948	10,891	17,604
Cedar Bayou	Upstream of the Cedar Bayou diversion channel	187.96	14,328	*	20,658	24,193	36,237
Cedar Bayou	At confluence of Pine Gully	186.23	14,250	*	20,381	23,722	35,341
Cedar Bayou	At confluence of Sutton Gully	180.27	14,078	*	20,146	22,770	32,170
Cedar Bayou	At confluence of Saw Pit Gully	170.49	13,244	*	18,837	21,361	30,016
Cedar Bayou	At confluence of Horsepen Bayou	160.57	12,865	*	18,306	20,876	29,610
Cedar Bayou	At confluence of McGee Gully	156.20	12,612	*	17,933	20,503	29,226
Cedar Bayou	At IH 10	148.32	12,189	*	17,302	19,844	28,427

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (CFS)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Cedar Bayou	At Dayton-Goose Creek Railroad	145.98	11,995	*	17,019	19,562	28,302
Cedar Bayou	At stream mile 19.77	142.04	11,717	*	16,716	19,306	28,249
Cedar Bayou	At stream mile 22.45	129.83	11,142	*	15,677	18,112	26,144
Cedar Bayou	At confluence of Clawson Ditch	127.46	11,175	*	15,519	17,918	25,316
Cedar Gully	At confluence with Trinity Bay	2.6	1,500	*	1,900	2,000	2,400
Cotton Bayou	At Cotton Lake	14.8	2,570	*	3,420	3,870	4,700
Cotton Bayou	At Highway 565	5.1	1,830	*	2,400	2,580	3,100
Double Bayou	At confluence with Trinity Bay	80.4	5,300	*	7,450	8.800	10,700
Double Bayou East Fork	At confluence with Double Bayou West Fork	63.8	4,350	*	6,100	7,200	8,700
Double Bayou East Fork	At Interstate Highway 10	14.5	2,550	*	3,390	3,800	4,670
Double Bayou West Fork	At confluence with Double Bayou East Fork	24.8	3,070	*	4,150	4,700	5,750

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (CFS)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Double Bayou West Fork	At Sykes Road	13.9	2,540	*	3,350	3,780	4,600
Hackberry Gully	At Junction with Cotton Creek	5.0	1,700	*	2,200	2,350	2,800
Hackberry Gully	At Highway 565	3.1	1,570	*	2,010	2,150	2,550
Horsepen Bayou	At Cedar Bayou	2.5	1,600	*	2,050	2,200	2,610
Labbit Creek	Approximately 225 feet upstream of the confluence with Labbit Creek_61	2	580	746	876	1,020	1,385
Lee Gully	At the confluence with Whites Bayou South of Interstate Highway 10	4.7	1,780	*	2,320	2,500	3,000
Little Caney Creek	Approximately 7,990 feet downstream of Farm to Market 1409 Road	3.4	718	925	1,086	1,262	1,709
Old River	Approximately 8,380 feet downstream of Farm to Market 1409 Road	70	4,836	6,539	7,939	9,491	13,582
Old River	Approximately 1,012 feet upstream of Farm to Market 1409 Road	69	4,894	6,632	8,065	9,656	13,862
Old River	Approximately 445 feet upstream of the confluence with Cherry Point Gully	64	4,754	6,453	7,855	9,417	13,555

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (CFS)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Old River	Approximately 260 feet upstream of the confluence with Old River Tributary 3	63	4,797	6,523	7,951	9,544	13,773
Old River	Approximately 240 feet upstream of Farm to Market 1409 Road	25	1,372	1,890	2,326	2,814	4,119
Old River	Approximately 385 feet upstream of the confluence with Old Ditch	23	1,320	1,824	2,250	2,728	4,011
Oyster Bayou	At Lone Star Canal	10.9	1,170	*	1,520	1,690	2,050
Saw Pit Gully	At confluence with Cedar Branch	2.8	1,530	*	1,940	2,060	2,450
Spindletop Bayou	At Highway 124	59.2	4,480	*	6,300	7,400	9,000
Spring Branch	At Whites Bayou South of Interstate Highway 10	3.8	1,670	*	2,150	2,310	2,750
Turtle Whites Bayou	At Lake Anahuac	123.4	6,900	*	9,800	11,500	14,000
Turtle Whites Bayou	Upstream of Whites Bayou	122.6	6,200	*	9,000	10,500	12,600
Trinity River	At U.S. Route 10	17,468	72,000	*	110,000	127,000	265,000
Whites Bayou	South of Interstate Highway 10 Above Turtle Bayou	45.4	3,880	*	5,450	6,400	7,650

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (CFS)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Whites Bayou	Upstream of Lee Gully	39.7	3,620	*	5,100	6,000	7,200
Whites Bayou	Upstream of Spring Branch	*	3,430	*	4,800	5,700	6,800
Whites Bayou	Above Crooked Bayou	23.7	3,000	*	4,080	4,630	5,650

*Not calculated for this FIS project

Figure 7: Frequency Discharge-Drainage Area Curves

[Not Applicable to this Flood Risk Project]

Table 11: Summary of Non-Coastal Stillwater Elevations

[Not Applicable to this FIS Project]

Table 12: Stream Gage Information used to Determine Discharges

[Not Applicable to this FIS Project]

5.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. BFEs on the FIRM represent the elevations shown on the Flood Profiles and in the Floodway Data tables in the FIS Report. Rounded whole-foot elevations may be shown on the FIRM in coastal areas, areas of ponding, and other areas with static BFEs. These whole-foot elevations may not exactly reflect the elevations derived from the hydraulic analyses. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS Report in conjunction with the data shown on the FIRM. The hydraulic analyses for this FIS were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

For streams for which hydraulic analyses were based on cross sections, locations of selected cross sections are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 6.3), selected cross sections are also listed on Table 24, “Floodway Data.”

A summary of the methods used in hydraulic analyses performed for this project is provided in Table 13. Roughness coefficients are provided in Table 14. Roughness coefficients are values representing the frictional resistance water experiences when passing overland or through a channel. They are used in the calculations to determine water surface elevations. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

Table 13: Summary of Hydrologic and Hydraulic Analyses

Flooding Source	Study Limits		Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
	Downstream Limit	Upstream Limit					
Barrow Slough	The confluence with Whites Bayou, South of Interstate Highway 10	Approximately 0.5 mile upstream of White Barrow Road	HEC-1	HEC-2	1981	AE with floodway	
Cedar Bayou	The confluence with Galveston Bay	The Chambers/Harris County boundary	HCFCD Hydrology	HEC-RAS 3.0.1	2007	AE with floodway	
Cedar Gully	The confluence with Trinity Bay	Cedar Bayou Bay Road	HEC-1	HEC-2	1981	AE with floodway	
Cherry Point Gully	The confluence with Old River	Approximately 3,095 feet upstream of Cherry Point Road	Regression Analysis	HEC-RAS 3.1.1 and up	2014	A	Hydrology was taken from the Cherry Creek Drainage Study for Liberty County
Cherry Point Gully Tributary 1	The confluence with Cherry Point Gully	Approximately 4,670 feet upstream of the confluence with Cherry Point Gully	Regression Equations	HEC-RAS 3.1.1 and up	2014	A	
Cherry Point Tributary	The confluence with Cherry Point Gully	Approximately 1,530 feet upstream of the confluence with Cherry Point Gully	Study Flows developed using HEC-HMS	HEC-RAS 3.1.1 and up	2014	A	Hydrology was taken from the Cherry Creek Drainage Study for Liberty County
Cotton Bayou	The confluence with Trinity Bay	Interstate Highway 10	HEC-1	HEC-2	1981	AE with floodway	

Flooding Source	Study Limits		Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
	Downstream Limit	Upstream Limit					
Cotton Bayou	Interstate Highway 10	Approximately 3,710 feet upstream of Lakes of Champions Boulevard	Rainfall Runoff method HEC-HMS	HEC-RAS 3.1.1 and up	2014	A	Hydrology was taken from the Cherry Creek Drainage Study for Liberty County
Crooked Bayou	The confluence with Whites Bayou	Chambers/Liberty County boundary	XP-SWMM 8.52 and up	XP-SWMM 8.52 and up	2014	A	
Crooked Marsh	The confluence with Crooked Bayou	Chambers/Liberty County boundary	XP-SWMM 8.52 and up	XP-SWMM 8.52 and up	2014	A	
Double Bayou East Fork	The confluence with Trinity Bay	Farm to Market (FM) 1663	HEC-1	HEC-2	1981	AE with floodway	
Double Bayou West Fork	The confluence with Trinity Bay	State Highway 562	HEC-1	HEC-2	1981	AE with floodway	
Hackberry Gully	The confluence with Cotton Bayou	Interstate Highway 10	HEC-1	HEC-2	1981	AE with floodway	
Hackberry Gully	Interstate Highway 10	Approximately 5,645 feet upstream of Interstate 10	Rainfall Runoff method HEC-HMS	HEC-RAS 3.1.1 and up	2014	A	Hydrology was taken from the Cherry Creek Drainage Study for Liberty County
Horsepen Bayou	The confluence with Cedar Bayou	Southern Pacific Railroad	HEC-1	HEC-2	1981	AE with floodway	
Labbit Creek	Approximately 1,825 feet downstream of County Road 401	The Chambers/Liberty County boundary	Regression Equations	HEC-RAS 3.1.1 and up	2014	AE with floodway	

Flooding Source	Study Limits		Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
	Downstream Limit	Upstream Limit					
Lee Gully	The confluence with Turtle Whites Bayou	Speights Road (FM 1663)	HEC-1	HEC-2	1981	AE with floodway	
Lee Gully	Speights Road (FM 1663)	Chambers/Liberty County boundary	XP-SWMM 8.52 and up	XP-SWMM 8.52 and up	2014	A	
Little Caney Creek	Approximately 8,120 feet downstream of FM 1409	Approximately 1,230 feet upstream of County Road 411	Regression Equations	HEC-RAS 3.1.1 and up	2014	AE with floodway	
Old Ditch	The confluence with Old River	Just downstream of River Ridge Drive	Rainfall Runoff method HEC-HMS	HEC-RAS 3.1.1 and up	2014	A	Hydrology was taken from the Cherry Creek Drainage Study for Liberty County
Old River	Approximately 8,350 feet downstream of FM 1409	The Chambers/Liberty County boundary	Regression Equations	HEC-RAS 3.1.1 and up	2014	AE with floodway	
Old River Tributary 1	Approximately 2,450 feet downstream of FM 565	Approximately 1,180 feet upstream of FM 565	Regression Equations	HEC-RAS 3.1.1 and up	2014	A	
Old River Tributary 1A	The confluence with Old River Tributary 1	Approximately 7,540 feet upstream of the confluence with Old River Tributary 1	Regression Equations	HEC-RAS 3.1.1 and up	2014	A	
Old River Tributary 2	The confluence with Old River	Approximately 1,340 feet upstream of Woodland Lane	Regression Equations	HEC-RAS 3.1.1 and up	2014	A	

Flooding Source	Study Limits		Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
	Downstream Limit	Upstream Limit					
Old River Tributary 3	The confluence with Old River	Approximately 3,560 feet upstream of the confluence with Old River	Regression Equations	HEC-RAS 3.1.1 and up	2014	A	
Oyster Bayou	The confluence with Lone Star Canal	Approximately 1.4 miles upstream of State Highway 65	HEC-1	HEC-2	1981	AE with floodway	
Sawpit Gully	The confluence with Cedar Bayou	Approximately 0.7 mile upstream of Southern Pacific Railroad	HEC-1	HEC-2	1981	AE with floodway	
Smith Gully	FM 146	Winfree Road	HEC-1	HEC-2	1981	AE with floodway	
Spindletop Bayou	State Highway 124	State Highway 65	HEC-1	HEC-2	1981	AE with floodway	
Spring Branch	The confluence with Turtle Whites Bayou	Approximately 2 miles upstream of Speights Road	HEC-1	HEC-2	1981	AE with floodway	
Spring Branch	Approximately 2 miles upstream of Speights Road	Approximately 1,015 feet upstream of Hankamer Loop Road	XP-SWMM 8.52 and up	XP-SWMM 8.52 and up	2014	A	
The Cutoff Tributary 1	Approximately 2,745 feet downstream of County Road 401	Chambers/Liberty County boundary	Regression Equations	HEC-RAS 3.1.1 and up	2014	A	

Flooding Source	Study Limits		Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
	Downstream Limit	Upstream Limit					
The Cutoff Tributary 2	Approximately 3,070 feet downstream of County Road 401	Chambers/Liberty County boundary	Regression Equations	HEC-RAS 3.1.1 and up	2014	A	
Trinity River	The confluence with Trinity Bay	Chambers/Liberty County boundary	HEC-1	HEC-2	1986	AE with floodway	
Turtle Bayou	The confluence with Turtle Whites Bayou	Chambers/Liberty County boundary	XP-SWMM 8.52 and up	XP-SWMM 8.52 and up	2014	A	
Turtle Whites Bayou	The confluence with Lake Anahuac	FM 1663	HEC-1	HEC-2	1981	AE with floodway	
Whites Bayou	The confluence with Turtle White Bayou	Approximately 0.9 mile upstream of State Highway 61	HEC-1	HEC-2	1981	AE with floodway	
Whites Bayou	Approximately 0.9 mile upstream of State Highway 61	The confluence with Turtle Whites Bayou	XP-SWMM 8.52 and up	XP-SWMM 8.52 and up	2014	A	
Whites Bayou	FM 1663	Chambers/Liberty County boundary	XP-SWMM 8.52 and up	XP-SWMM 8.52 and up	2014	A	
Whites Bayou Tributary 1	Confluence with Whites Bayou	Chambers/Liberty County boundary	XP-SWMM 8.52 and up	XP-SWMM 8.52 and up	2014	A	

Table 14: Roughness Coefficients

Flooding Source	Channel "n"	Overbank "n"
Barrow Slough	0.025-0.050	0.070-0.200
Cedar Bayou	0.025-0.050	0.070-0.200
Cherry Point Gully Tributary 1	0.055	0.10-0.16
Cotton Bayou	0.025-0.050	0.070-0.200
Double Bayou East Fork	0.025-0.050	0.070-0.200
Double Bayou West Fork	0.025-0.050	0.070-0.200
Hackberry Gully	0.025-0.050	0.070-0.200
Labbit Creek	0.05-0.08	0.04-0.12
Lee Gully	0.025-0.050	0.070-0.200
Little Caney Creek	0.05-0.15	0.04-012
Old River Tributary 1	0.055	0.10-0.16
Old River Tributary 1A	0.055	0.10-0.16
Old River Tributary 2	0.055	0.08-0.12
Old River Tributary 3	0.055	0.10-0.16
Oyster Bayou	0.025-0.050	0.070-0.200
Smith Gully	0.025-0.050	0.070-0.200
Spring Branch	0.025-0.050	0.070-0.200
The Cutoff Tributary 1	0.055	0.08-0.12
The Cutoff Tributary 2	0.055	0.08-0.12
Trinity River	0.040-0.060	0.070-0.250
Turtle Whites Bayou	0.025-0.050	0.070-0.200
Whites Bayou	0.025-0.050	0.070-0.200

5.3 Coastal Analyses

For the areas of Chambers County that are impacted by coastal flooding processes, coastal flood hazard analyses were performed to provide estimates of coastal BFEs. Coastal BFEs reflect the increase in water levels during a flood event due to extreme tides and storm surge as well as overland wave effects.

The following subsections provide summaries of how each coastal process was considered for this FIS Report. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation. Table 15 summarizes the methods and/or models used for the coastal analyses. Refer to Section 2.5.1 for descriptions of the terms used in this section.

Table 15: Summary of Coastal Analyses

Flooding Source	Study Limits From	Study Limits To	Hazard Evaluated	Model or Method used	Date Analysis was Completed
East Bay, Gulf of Mexico, Tabbs Bay, and Trinity Bay	Entire coastline of Chambers County	Entire coastline of Chambers County	Storm Surge	ADCIRC	2011
East Bay, Gulf of Mexico, Tabbs Bay, and Trinity Bay	Entire coastline of Chambers County	Entire coastline of Chambers County	Storm Surge	RUNUP 2.0	2011
East Bay, Gulf of Mexico, Tabbs Bay, and Trinity Bay	Entire coastline of Chambers County	Entire coastline of Chambers County	Storm Surge	STWAVE	2011
East Bay, Gulf of Mexico, Tabbs Bay, and Trinity Bay	Entire coastline of Chambers County	Entire coastline of Chambers County	Storm Surge	JPM-OS	2011
East Bay, Gulf of Mexico, Tabbs Bay, and Trinity Bay	Entire coastline of Chambers County	Entire coastline of Chambers County	Wave run up	WHAFIS 4.0	2011

Flooding Source	Study Limits From	Study Limits To	Hazard Evaluated	Model or Method used	Date Analysis was Completed
East Bay, Gulf of Mexico, Tabbs Bay, and Trinity Bay	Entire coastline of Chambers County	Entire coastline of Chambers County	Storm Surge	TAW method	2011

5.3.1 Total Stillwater Elevations

The total stillwater elevations (stillwater including storm surge plus wave setup) for the 1% annual chance flood were determined for areas subject to coastal flooding. The models and methods that were used to determine storm surge and wave setup are listed in Table 15. The stillwater elevation that was used for each transect in coastal analyses is shown in Table 17, "Coastal Transect Parameters." Figure 8 shows the total stillwater elevations for the 1% annual chance flood that was determined for this coastal analysis.

Figure 8: 1% Annual Chance Total Stillwater Elevations for Coastal Areas

[Not Applicable to this FIS Project]

Astronomical Tide

Astronomical tidal statistics were generated directly from local tidal constituents by sampling the predicted tide at random times throughout the tidal epoch.

Storm Surge Statistics

Storm surge is modeled based on characteristics of actual storms responsible for significant coastal flooding. The characteristics of these storms are typically determined by statistical study of the regional historical record of storms or by statistical study of tidal gages.

When historic records are used to calculate storm surge, characteristics such as the strength, size, track, etc., of storms are identified by site. Storm data was used in conjunction with numerical hydrodynamic models to determine the corresponding storm surge levels. An extreme value analysis was performed on the storm surge modeling results to determine a stillwater elevation for the 1% annual chance event.

Table 16: Tide Gage Analysis Specifics

[Not Applicable to this FIS Project]

Combined Riverine and Tidal Effects

Riverine and surge rates for the lower reaches of the Trinity River were combined by developing curves for rate of occurrence vs. flood level for each flood source.

Wave Setup Analysis

Wave setup was computed during the storm surge modeling through the methods and models listed in Table 15 and included in the frequency analysis for the determination of the total Stillwater elevations.

5.3.2 Waves

The study area has experienced a significant storm surge event in September 2008 (Hurricane Ike) that has eroded the beach and dune system. The ground elevations recorded in the post-Hurricane Ike 2009 LiDAR data reflect the eroded condition, and have been included in the terrain model. Therefore, MAPVI used the transects cut from the current conditions LiDAR data as the eroded profile. Therefore, no additional storm-induced erosion assessment was applied to transects which touch the Gulf of Mexico (67-74). In addition, all other transects have no primary frontal dune, and were mostly wetland; erosion was therefore not applied to these transects.

A primary input to the WHAFIS model is a profile consisting of station (distance in feet) and elevation (in feet above NAVD88 datum) pairs that represent the bare-earth ground elevation along the transect, accompanied by the SWEL. For each of the 74 transects, detailed ground profiles were extracted from the high-resolution terrain. As these ground profiles contain thousands of data points, the first step in wave height modeling was to clean and construct a profile with appropriate resolution, eliminating redundancy and negligible variations such as unusual peaks or low points.

The July 15, 2011 FEMA Technical Memorandum, recommends that the "IE card to be placed at 0 ft. contour elevation using best available topographic data". The first point in the WHAFIS profile is the initial elevation, the IE card. The model begins with an IE station located at an elevation of zero based on bathymetry data. A shapefile of the transect starting point, 0 foot contour, was generated from the bathymetry data and can be used as a shoreline reference. This shapefile is included in the attached digital data. The 2011 land use raster data was obtained from the NLCD, published by U.S. Geological Survey. The 2011 land cover data, the latest aerial imagery, and the field reconnaissance notes were used to determine the land use coverage along each transect. In some areas where the transition from marsh land to inland fetch cannot be determined from aerial imagery, the 2011 land data will be used. The land use parameters for each WHAFIS points were determined and entered manually. The parameters and selection of other WHAFIS cards are discussed in the following.

Linear structures such as roads that have relative height above adjacent areas of 3 feet or greater, maximum widths of approximately 100 feet, and length of at least 300 feet were modeled. According to the July 15, 2011 FEMA Technical Memorandum, this modeling was done by placing a dune card (DU) at the crest of a raised linear feature in the transect profile if it is below the SWEL. A rise linear feature shapefile was provided with the storm surge data. The shapefile was used to identify rise features that intersect the transects. Notes that the shapefile did not capture all rise linear features in the county, other features were identified by examining the topographic data.

The building card (BU) contains information on numbers of row buildings and open space ratio. The numbers of rows and open space ratio were determined by using the field reconnaissance notes. Where building descriptions in the field notes were insufficient to determine the parameters, aerial imagery was utilized to count rows of buildings and determine the ratio of open area. BU cards were used where the building type was slab-on-grade or garage-on-grade and were treated as obstructions. Elevated buildings with lowest floor higher than the SWEL were treated as 100-percent open space. With transects facing the Gulf of Mexico (64-74), the first row of buildings along the coast was excluded from the count of the row of buildings, With estuary transects (1-63), the first row of buildings was included in the count of building rows.

The rigid vegetation card (VE) contains information for dry and thick vegetation such as bushes, tress, and shrubs. Field reconnaissance information for vegetation was used to determine parameters such as average diameter, average height, average spacing, and drag coefficient. Where field notes are unavailable, information from the nearest rigid vegetation area was consulted with use of aerial imagery to determine vegetation parameters.

The marsh vegetation card (VH) contains information for wetland vegetation. This included parameters such as region, plant type, drag coefficient, coverage ratio, unflexed stem height, density of plants, stem diameters (base, mid, top), and frontal area ratio. The primary region of the study area was Chenier Plain. This selection was based on Figure D.2.7-3 in the Guideline and Specification. (44) According to Tables D.2.7-3 and D.2.7-4 in the Guideline and Specification, dominant species in the Chenier Plain region were Spartina Alterniflora and S. Patens. Based on field reconnaissance and aerial imagery inspection, the marsh plants were similar to S. Alterniflora. MAPVI used the average parameters that generally represents the area around the transects. The average parameters from the field reconnaissance notes were also comparable to the values in Appendix D. Average stem diameter and height are used for the VH card for all transects. The overwater fetch (OF) card was for offshore area and open coast. The inland fetch (IF) card was used in the locations where buildings or significant vegetation were not present. IF card was also used where the wind speeds are expected to be lower, such as inland water bodies. Appendix B in this TSDN includes detailed information on the WHAFIS card that were used for the transects.

Especially along expanses of OF or IF cards, the WHAFIS model is sensitive to frequent changes of the topographic peaks and depression due to the fetch distance required to regenerate waves. The elevation profile was simplified to not include insignificant topographic fluctuations, approximately 100-20 feet in length of the peak/depression. The WHAFIS profiles therefore do not include all of the elevation profile points, but do follow the general trend of the topography.

5.3.3 Coastal Erosion

A single storm episode can cause extensive erosion in coastal areas. Storm-induced erosion was evaluated to determine the modification to existing topography that is expected to be associated with flooding events. Erosion was evaluated using the methods listed in Table 15. The post-event eroded profile was used for the subsequent transect-based onshore wave hazard analyses.

5.3.4 Wave Hazard Analyses

Overland wave hazards were evaluated to determine the combined effects of ground elevation, vegetation, and physical features on overland wave propagation and wave runup. These

analyses were performed at representative transects along all shorelines for which waves were expected to be present during the floods of the selected recurrence intervals. The results of these analyses were used to determine elevations for the 1% annual chance flood.

Transect locations were chosen with consideration given to the physical land characteristics as well as development type and density so that they would closely represent conditions in their locality. Additional consideration was given to changes in the total Stillwater elevation. Transects were spaced close together in areas of complex topography and dense development or where total Stillwater elevations varied. In areas having more uniform characteristics, transects were spaced at larger intervals. Transects shown on Figure 9, "Transect Location Map," are also depicted on the FIRM. Table 17 provides the location, Stillwater elevations, and starting wave conditions for each transect evaluated for overland wave hazards. In this table, "starting" indicates the parameter value at the beginning of the transect.

Wave Height Analysis

Wave height analyses were performed to determine wave heights and corresponding wave crest elevations for the areas inundated by coastal flooding and subject to overland wave propagation hazards. Refer to Figure 6 for a schematic of a coastal transect evaluated for overland wave propagation hazards.

Wave heights and wave crest elevations were modeled using the methods and models listed in Table 15, "Summary of Coastal Analyses".

Wave Runup Analysis

Wave runup analyses were performed to determine the height and extent of runup beyond the limit of Stillwater inundation for the 1% annual chance flood. Wave runup elevations were modeled using the methods and models listed in Table 15.

Table 17: Coastal Transect Parameters

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88)) Range of Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88))				
		Significant Wave Height H_s (FT)	Peak Wave Period T_p (SEC)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Tabbs Bay	1	19.5	*	8.7	*	10.9	13.8 VE	18.0
Tabbs Bay	2	19.6	*	*	*	*	*	*
Tabbs Bay	3	19.5	*	8.4	*	10.5	13.3 VE	17.4
Tabbs Bay	4	19.1	*	8.4 0.0	*	10.5 10.5	13.2 VE 12.3 AE	17.3 17.1
Tabbs Bay	5	19.0	*	8.3 0.0	*	10.3 VE 0.0 AE	13.1 VE 11.6 AE	17.1 16.9
Trinity Bay	6	19.0	*	8.2 0.0	*	10.2 0.0	12.9 VE 11.5 AE	16.9 17.9
Trinity Bay	7	19.1	*	8.1	*	10.1	12.7 VE	16.7
Trinity Bay	8	19.0	*	8.1	*	10.0	12.7 VE	16.6
Trinity Bay	9	18.6	*	8.1	*	9.9	12.6 VE	16.6

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88)) Range of Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88))				
		Significant Wave Height H_s (FT)	Peak Wave Period T_p (SEC)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Trinity Bay	10	18.6	*	8.1	*	9.9	12.6 VE	16.6
Trinity Bay	11	18.9	*	8.2	*	10.0	12.8 VE	16.8
Trinity Bay	12	18.9	*	8.2	*	10.1	12.8 VE	17.0
Trinity Bay	13	18.9	*	8.2	*	10.1	12.9 VE	17.0
Trinity Bay	14	19.2	*	8.2	*	10.2	13.0 VE	17.1
Trinity Bay	15	19.2	*	8.3	*	10.2	13.0 VE	17.2
Trinity Bay	16	19.2	*	8.3	*	10.2	13.0 VE	17.2
Trinity Bay	17	19.2	*	8.3	*	10.2	13.0 VE	17.2
Trinity Bay	18	19.0	*	8.3	*	10.2	13.0 VE	17.2

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88)) Range of Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88))				
		Significant Wave Height H_s (FT)	Peak Wave Period T_p (SEC)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Trinity Bay	19	19.4	*	8.4 0.0 4.2	*	10.5 0.0 8.8	13.3 VE 12.9 AE 13.5 VE	17.7 19.5 19.0
Trinity Bay	20	19.3	*	8.3 4.1	*	10.2 8.7	13.0 VE 13.5 AE	17.3 19.1
Trinity Bay	21	19.4	*	8.3 3.9 0.0	*	10.2 8.7 8.6	12.9 VE 13.5 VE 14.0 VE	17.2 19.2 20.4
Trinity Bay	22	19.1	*	8.3 0.0 3.9 0.0 8.3	*	10.2 0.0 8.6 0.0 10.4	12.9 VE 13.1 AE 13.5 VE 13.1 AE 13.3 VE	17.2 19.4 19.0 19.8 17.7
Trinity Bay	23	18.8	*	8.2 8.3	*	10.2 10.4	13.0 VE 13.3 AE	17.4 17.8
Trinity Bay	24	18.7	*	8.1 7.7 7.5	*	10.0 9.5 9.3	12.8 VE 12.0 VE 11.7 AE	17.0 16.5 16.1

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88)) Range of Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88))				
		Significant Wave Height H_s (FT)	Peak Wave Period T_p (SEC)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Trinity Bay	25	18.6	*	8.0 8.1 7.1 7.2	*	9.9 10.1 8.9 9.0	12.6 VE 12.8 AE 11.1 AE 11.3 VE	16.8 17.1 15.5 15.6
Trinity Bay	26	18.4	*	8.0 7.1 6.8	*	9.9 8.9 8.6	12.6 VE 11.2 AE 10.6 AE	16.8 16.3 14.8
Trinity Bay	27	18.3	*	8.0 5.9	*	9.7 8.2	12.3 VE 10.4 AE	16.6 14.7
Trinity Bay	28	18.3	*	7.9 2.4 7.7	*	9.6 5.1 9.3	12.1 VE 10.4 AE 11.6 AE	16.3 17.4 16.7
Trinity Bay	29	18.1	*	7.9 2.2 2.1	*	9.5 5.0 4.7	12.1 VE 11.1 AE 10.2 VE	16.2 17.1 16.8
Trinity Bay	30	18.0	*	7.8 2.1	*	9.5 4.6	12.0 VE 10.0 AE	16.1 16.8
Trinity Bay	31	18.0	*	7.8 2.1	*	9.5 4.6	12.0 VE 9.9 AE	16.1 16.7

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88)) Range of Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88))				
		Significant Wave Height H_s (FT)	Peak Wave Period T_p (SEC)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Trinity Bay	32	17.8	*	7.8	*	9.4	11.9 VE	16.0
Trinity Bay	33	17.6	*	7.7	*	9.4	11.9 VE	16.0
Trinity Bay	34	17.6	*	7.7	*	9.4	11.9 VE	16.0
Trinity Bay	35	17.6	*	7.7	*	9.3	11.8 VE	15.9
Trinity Bay	36	17.5	*	7.7	*	9.3	11.8 VE	15.8
Trinity Bay	37	17.2	*	7.6	*	9.2	11.7 VE	15.8
Trinity Bay	38	17.1	*	7.5	*	9.1	11.5 VE	15.6
Trinity Bay	39	16.8	*	7.4 0.0	*	9.0 0.0	11.3 VE 10.2 AE	15.3 15.2

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88)) Range of Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88))				
		Significant Wave Height H_s (FT)	Peak Wave Period T_p (SEC)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Trinity Bay	40	16.5	*	7.3 0.0 6.1 0.0 0.0	*	8.8 7.9 8.5 7.7 0.0	11.2 VE 10.7 AE 11.1 VE 10.4 AE 9.6 AE	15.1 16.5 15.5 16.2 14.6
Trinity Bay	41	16.4	*	7.2 0.0 0.0	*	8.6 0.0 0.0	11.0 VE 10.0 AE 9.4 AE	14.9 15.0 14.4
Trinity Bay	42	16.1	*	7.1 0.0	*	8.6 0.0	10.9 VE 9.7 AE	14.7 14.2
Trinity Bay	43	15.9	*	7.2 6.7 6.1	*	8.6 8.5 8.4	10.8 VE 10.6 AE 10.5 VE	14.6 14.4 13.9
Trinity Bay	44	15.8	*	7.1 6.8	*	8.5 8.3	10.6 VE 10.3 AE	14.4 13.9
Trinity Bay	45	15.7	*	7.0 6.8 0.0	*	8.3 8.1 7.9	10.4 VE 10.1 AE 9.5 AE	14.1 13.8 14.6

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88)) Range of Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88))				
		Significant Wave Height H_s (FT)	Peak Wave Period T_p (SEC)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Trinity Bay	46	15.5	*	6.9 0.0	*	8.3 0.0	10.3 VE 9.4 AE	13.9 13.7
Trinity Bay	47	14.6	*	6.9 0.0 0.0	*	8.2 7.7 0.0	10.2 VE 10.4 AE 9.0 AE	13.7 14.3 13.7
East Bay	48	15.8	*	7.0 6.8 7.0	*	8.5 8.3 8.3	10.5 VE 10.2 AE 10.3 VE	14.2 13.7 13.7
East Bay	49	16.0	*	7.0	*	8.5	10.5 VE	14.1
East Bay	50	16.0	*	6.9 0.0	*	8.7 8.3	10.7 VE 10.9 AE	14.7 15.7
East Bay	51	16.0	*	6.9 6.2 0.0	*	8.7 8.3 0.0	10.8 VE 10.9 AE 9.9 AE	14.7 16.4 15.5
East Bay	52	15.8	*	6.8 6.9 0.0	*	8.6 8.8 0.0	10.6 VE 10.9 AE 10.3 AE	14.5 14.8 15.8

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88)) Range of Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88))				
		Significant Wave Height H_s (FT)	Peak Wave Period T_p (SEC)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
East Bay	53	15.7	*	6.6 6.6 6.7 6.9 0.0	*	8.5 8.5 8.6 8.9 0.0	10.5 VE 10.6 AE 10.7 VE 11.0 AE 10.6 AE	14.2 14.3 14.4 14.7 15.9
East Bay	54	15.5	*	6.5 6.7 6.7 0.0	*	8.5 8.6 8.8 0.0	10.5 VE 10.7 AE 10.9 VE 10.4 AE	14.1 14.3 14.5 15.5
East Bay	55	15.7	*	6.4 6.4 0.0	*	8.3 8.6 0.0	10.4 VE 10.7 VE 10.2 AE	13.9 14.2 14.0
East Bay	56	15.5	*	6.3	*	8.3	10.3 VE	13.7
East Bay	57	15.4	*	6.2 6.1	*	8.3 8.1	10.3 VE 10.1 AE	13.7 13.5
East Bay	58	15.4	*	6.1 5.8 5.6 0.0	*	8.2 8.0 7.9 0.0	10.2 VE 10.0 AE 10.7 AE 10.2 AE	13.6 13.6 15.9 14.5

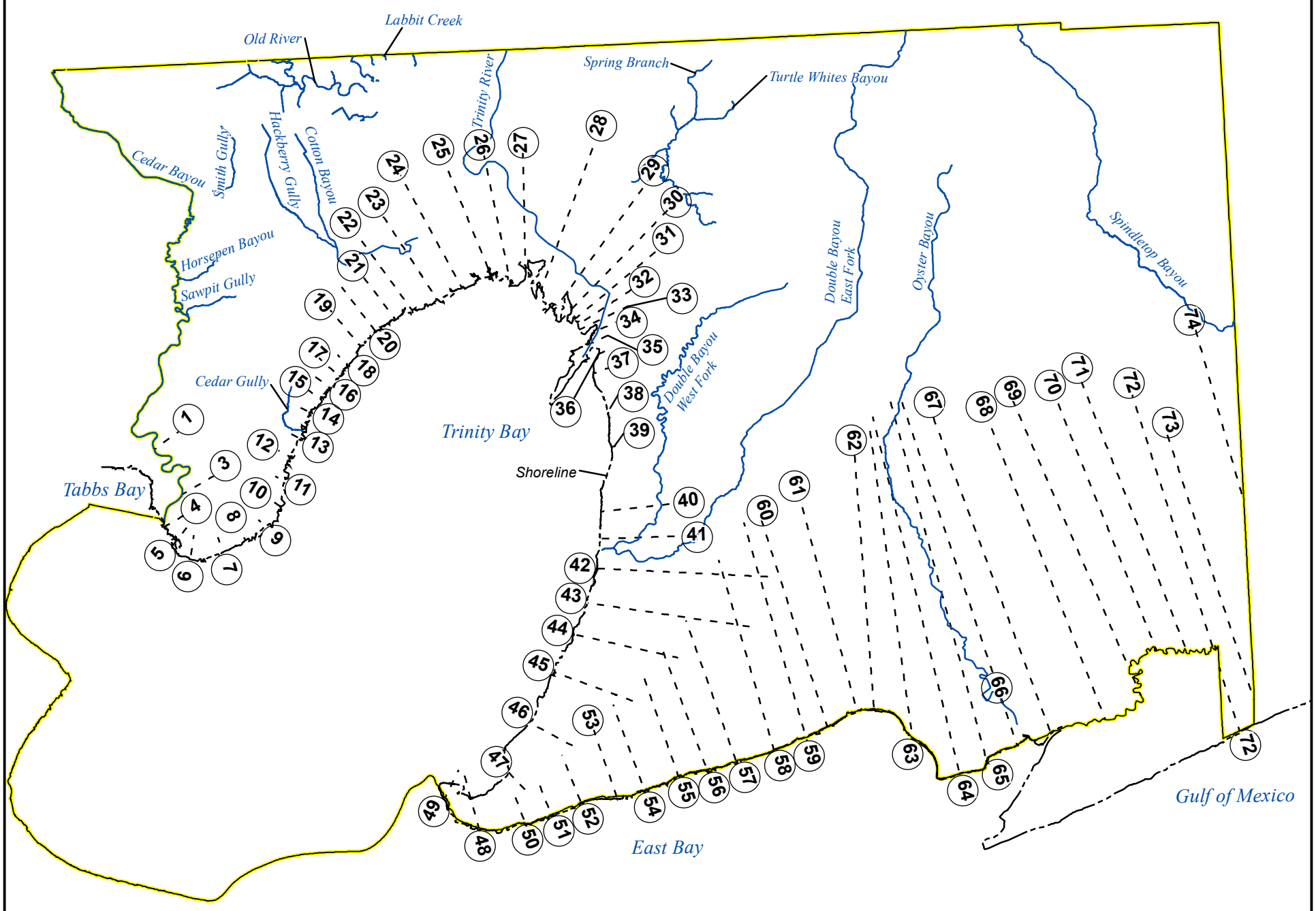
Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88)) Range of Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88))				
		Significant Wave Height H_s (FT)	Peak Wave Period T_p (SEC)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
East Bay	59	15.4	*	6.0 5.5 5.6 5.7 4.7 0.0	*	8.3 8.0 8.0 8.2 8.4 8.4	10.2 VE 9.8 AE 10.0VE 10.5 AE 11.0 VE 10.4 AE	13.7 13.3 13.3 13.8 14.7 15.2
East Bay	60	15.4	*	6.0 5.6 5.6 5.6 5.6	*	8.2 7.9 8.0 8.3 8.3	10.2 VE 9.9 AE 10.0 VE 10.4 AE 11.2 VE	13.7 13.2 13.3 13.9 14.8
East Bay	61	15.5	*	5.9 5.5 5.5	*	8.3 8.2 8.5	10.3 VE 10.4 AE 11.0 VE	13.7 13.7 15.0
East Bay	62	15.5	*	5.8 5.5 0.0	*	8.2 8.1 7.4	10.3 VE 10.4 AE 10.1 AE	13.7 13.7 15.0
East Bay	63	15.1	*	5.6 5.4 0.0	*	8.0 8.2 7.2	10.0 VE 10.2 AE 9.9 AE	13.4 13.6 14.5

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88)) Range of Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88))				
		Significant Wave Height H_s (FT)	Peak Wave Period T_p (SEC)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
East Bay	64	15.4	*	5.3 0.0 0.0	*	8.0 7.8 7.1	10.2 VE 10.4 VE 9.9 AE	13.7 14.0 14.8
East Bay	65	15.5	*	5.3 5.0 0.0 0.0	*	8.2 8.1 7.8 7.1	10.3 VE 10.3 AE 10.2 VE 9.8 AE	13.9 13.8 14.0 14.6
Gulf of Mexico	66	20.9	*	7.8 6.0 5.1 4.9 0.0 0.0	*	10.5 9.2 8.1 8.1 8.0 7.2	13.1 VE 11.6 VE 10.3 VE 10.2 AE 10.3 VE 9.8 AE	16.7 15.6 13.9 13.9 14.4 15.0
Gulf of Mexico	67	21.1	*	8.0 6.5 5.0 4.9 0.0 0.0	*	10.9 10.0 8.2 8.1 8.0 0.0	13.7 VE 12.7 VE 10.5 AE 10.3 VE 10.7 VE 10.0 AE	17.3 16.6 14.2 14.0 15.0 14.5

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88)) Range of Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88))				
		Significant Wave Height H_s (FT)	Peak Wave Period T_p (SEC)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Gulf of Mexico	68	21.1	*	8.1 5.6 5.8 5.0 0.0	*	11.0 9.6 9.6 8.3 0.0	13.8 VE 12.7 VE 12.2 AE 10.8 AE 10.2 AE	17.6 17.5 16.4 14.9 15.7
Gulf of Mexico	69	21.1	*	8.0 5.4 5.3 5.0 0.0	*	11.0 9.9 9.2 8.5 0.0	13.8 VE 12.9 VE 11.8 AE 10.9 VE 10.0 AE	18.1 17.2 16.3 14.9 15.1
Gulf of Mexico	70	21.1	*	8.0 6.1 5.6 4.9 0.0	*	11.1 11.1 9.2 8.5 0.0	13.9 VE 14.2 VE 11.5 AE 11.0 AE 10.0 AE	17.7 18.9 15.7 15.0 15.9
Gulf of Mexico	71	21.1	*	6.4 6.4 4.7 0.0	*	11.0 10.3 8.6 7.9	14.0 VE 13.0 AE 11.0 AE 10.5 AE	18.2 17.0 15.4 16.0

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88)) Range of Stillwater Elevations (FT North American Vertical Datum of 1988 (NAVD 88))				
		Significant Wave Height H_s (FT)	Peak Wave Period T_p (SEC)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Gulf of Mexico	72	21.1	*	6.5 6.4 5.2 4.7 0.0	*	10.9 10.4 9.1 8.6 0.0	13.9 VE 13.1 VE 11.7 AE 11.1 VE 10.5 AE	18.6 17.4 16.2 15.7 16.6
Gulf of Mexico	73	21.0	*	6.4 6.4 5.3 4.6 0.0	*	10.9 10.5 9.2 8.6 0.0	13.9 VE 13.1 VE 11.9 AE 11.2 AE 10.7 AE	18.6 17.4 16.4 15.8 16.9
Gulf of Mexico	74	21.1	*	6.4 6.7 5.2 0.0 0.0	*	10.7 10.6 9.6 8.6 0.0	13.9 VE 13.3 VE 12.5 AE 11.5 VE 10.9 AE	18.4 17.7 17.3 16.6 17.0

*Not calculated for this FIS project



1 in = 6 miles

N

0 1.25 2.5 5 7.5 10 Miles

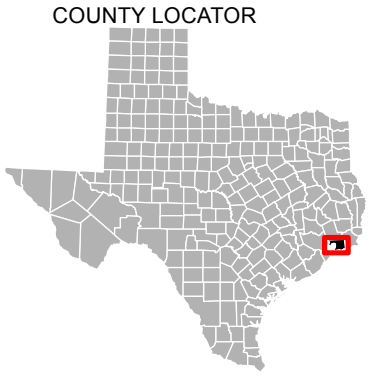
Map Projection:
Texas State Plane South Central Zone (FIPS Zone 4204); North American Datum 1983

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTP://MSC.FEMA.GOV

SEE FLOOD INSURANCE STUDY FOR ADDITIONAL INFORMATION

COUNTY LOCATOR



NATIONAL FLOOD INSURANCE PROGRAM

TRANSECT LOCATION MAP

PANELS WITH TRANSECTS:
0185, 0190, 0195, 0205, 0210, 0215, 0220, 0335, 0345, 0355, 0365, 0380, 0390, 0395, 0425, 0450, 0475, 0545, 0555, 0560, 0565, 0570, 0580, 0585, 0590, 0595, 0605, 0610, 0615, 0630, 0640

FEMA

5.4 Alluvial Fan Analyses

This section is not applicable to this FIS Project

Table 18: Summary of Alluvial Fan Analyses

[Not Applicable to this FIS Project]

Table 19: Results of Alluvial Fan Analyses

[Not Applicable to this FIS Project]

SECTION 6.0 – MAPPING METHODS

6.1 Vertical and Horizontal Control

All FIS Reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS Reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD29). With the completion of the North American Vertical Datum of 1988 (NAVD88), many FIS Reports and FIRMs are now prepared using NAVD88 as the referenced vertical datum.

Flood elevations shown in this FIS Report and on the FIRMs are referenced to North American Vertical Datum of 1988 (NAVD 88). These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between NGVD29 and NAVD88 or other datum conversion, visit the National Geodetic Survey website at www.ngs.noaa.gov, or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the archived project documentation associated with the FIS Report and the FIRM for this community. Interested individuals may contact FEMA to access these data.

To obtain current elevation, description, and/or location information for benchmarks in the area, please contact Information Services Branch of the NGS at (301) 713-3242, or visit their website at www.ngs.noaa.gov.

The datum conversion locations and values that were calculated for Chambers County are provided in Table 20.

Table 20: Countywide Vertical Datum Conversion

[Not Applicable to this FIS Project]

The datum conversion factor from NGVD29 to NAVD88 in Chambers County is 0 feet.

Table 21: Stream-by-Stream Vertical Datum Conversion

[Not Applicable to this FIS Project]

6.2 Base Map

The FIRMs and FIS Report for this project have been produced in a digital format. The flood hazard information was converted to a Geographic Information System (GIS) format that meets FEMA's FIRM database specifications and geographic information standards. This information is provided in a digital format so that it can be incorporated into a local GIS and be accessed more easily by the community. The FIRM Database includes most of the tabular information contained in the FIS Report in such a way that the data can be associated with pertinent spatial features. For example, the information contained in the Floodway Data table and Flood Profiles can be linked to the cross sections that are shown on the FIRMs. Additional information about the FIRM Database and its contents can be found in FEMA's *FIRM Database Technical Reference*.

Base map information shown on the FIRM was derived from the sources described in Table 22.

Table 22: Base Map Sources

Data Type	Data Provider	Data Date	Data Scale	Data Description
7.5-Minute Series Topographic Maps	U.S. Geological Survey	1989	1:24000	Grid of FIRM panels was derived from USGS quadrangles
Political Boundaries	Texas Natural Resources Information System	2002	1:24000	Spatial and attribute information for political boundaries
Surface Water Features	U.S. Geological Survey	2004	1:24000	Waterline and water area geometry and attribute information derived from NHD data
Digital Orthophoto	U.S. Department of Agriculture	2010	1:12000	Chambers County Digital Orthophotography (NAIP)

Data Type	Data Provider	Data Date	Data Scale	Data Description
Transportation Features	U.S. Department of Commerce, U.S. Census Bureau, Geography Division	2014	1:12000	Spatial and attribute information for transportation features derived from TIGER data

6.3 Floodplain and Floodway Delineation

The FIRM shows tints, screens, and symbols to indicate floodplains and floodways as well as the locations of selected cross sections used in the hydraulic analyses and floodway computations.

For all riverine flooding sources, the mapped floodplain boundaries shown on the FIRM have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using the topographic elevation data described in Table 23. For each coastal flooding source studied as part of this FIS Report, the mapped floodplain boundaries on the FIRM have been delineated using the flood and wave elevations determined at each transect; between transects, boundaries were delineated using land use and land cover data, the topographic elevation data described in Table 23, and knowledge of coastal flood processes. In ponding areas, flood elevations were determined at each junction of the model; between junctions, boundaries were interpolated using the topographic elevation data described in Table 23.

In cases where the 1% and 0.2% annual chance floodplain boundaries are close together, only the 1% annual chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

The floodway widths presented in this FIS Report and on the FIRM were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. Table 2 indicates the flooding sources for which floodways have been determined. The results of the floodway computations for those flooding sources have been tabulated for selected cross sections and are shown in Table 24, “Floodway Data.”

Table 23: Summary of Topographic Elevation Data used in Mapping

Community	Flooding Source	Source of Topographic Elevation Data			
		Description	Scale	Contour Interval	Citation
Chambers County	All flooding sources in Lower Trinity HUC-8	2006 Chambers County LiDAR	*	*	Texas Water Development Board LiDAR

* Not Provided for this Flood Risk Project

BFEs shown at cross sections on the FIRM represent the 1% annual chance water surface elevations shown on the Flood Profiles and in the Floodway Data tables in the FIS Report. Rounded whole-foot elevations may be shown on the FIRM in coastal areas, areas of ponding, and other areas with static BFEs.

Table 24: Floodway Data

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE	WIDTH (FT)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BARROW SLOUGH								
A	1,600[1]	77	335	3.6	20.5	18.5[2]	18.5[2]	0.0
B	5,115[1]	84	573	1.9	20.8	20.8	21.2	0.4
C	7,290[1]	200	929	1.2	21.3	21.3	21.8	0.5
D	8,600[1]	200	1330	0.7	21.7	21.7	22.7	1.0
E	9,860[1]	200	1245	0.7	21.7	21.7	22.7	1.0
CEDAR BAYOU								
A	1,797[3]	2,996 / 1,791[4]	8,741	1.4	*	1.5	2.5	1.0
B	5,808[3]	2,255 / 604[4]	6,254	2.0	*	3.4	3.6	0.2
C	9,776[3]	483 / 216[4]	3,614	3.5	*	4.8	4.9	0.1
D	18,888[3]	935 / 83[4]	6,470	1.8	*	6.3	6.7	0.4
E	20,092[3]	1,343 / 137[4]	8,958	1.3	*	6.4	6.9	0.5
F	20,926[3]	1,052 / 262[4]	6,967	1.6	*	6.4	7.0	0.6
G	22,040[3]	390 / 180[4]	3,831	2.9	*	6.5	7.1	0.6
H	23,242[3]	478 / 212[4]	4,811	2.3	*	6.7	7.2	0.5
I	24,187[3]	542 / 307[4]	6,202	2.1	*	6.8	7.3	0.5
J	25,299[3]	510 / 198[4]	6,026	4.0	*	6.9	7.3	0.4
K	26,325[3]	451 / 118[4]	7,458	3.2	*	7.1	7.6	0.5

[1]Stream distance in feet above confluence with Whites Bayou
[2]Elevations computed without backwater effects from Whites Bayou
[3]Stream distance in feet above confluence with Galveston Bay
[4]Total width / width within county limits
*Controlled by coastal flooding – see Flood Insurance Rate Map for applicable elevations

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

Chambers County, Texas

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: BARROW SLOUGH – CEDAR BAYOU

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FT) [2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
CEDAR BAYOU (CONTINUED)								
L	27,388	492 / 263	5,908	4.1	*	7.2	7.7	0.5
M	28,382	465 / 211	5,740	4.2	*	7.4	7.9	0.5
N	29,470	447 / 212	5,818	4.2	*	7.7	8.2	0.5
O	30,586	467 / 257	6,121	4.0	*	8.0	8.4	0.4
P	31,751	343 / 170	5,987	3.9	*	8.4	8.8	0.4
Q	33,212	438 / 217	7,682	3.0	*	8.6	9.1	0.5
R	34,326	529 / 375	6,911	3.4	*	8.7	9.2	0.5
S	35,491	612 / 249	6,689	3.5	*	8.8	9.3	0.5
T	36,778	871 / 340	8,660	2.7	*	9.1	9.6	0.5
U	37,939	992 / 623	9,634	2.4	*	9.2	9.7	0.5
V	38,871	1,300 / 330	9,967	2.3	*	9.4	9.8	0.4
W	39,966	1,600 / 486	10,534	2.2	*	9.5	9.9	0.4
X	40,959	1,500 / 785	8,288	2.8	*	9.7	10.1	0.4
Y	42,270	1,032 / 749	10,109	2.3	*	9.9	10.3	0.4
Z	43,345	820 / 405	7,068	3.2	*	9.9	10.3	0.4
AA	44,199	719 / 189	7,771	2.9	*	10.0	10.5	0.5
AB	45,364	840 / 211	8,277	2.7	*	10.2	10.7	0.5
AC	46,386	703 / 379	7,733	2.9	*	10.4	10.8	0.4

[1]Stream distance in feet above confluence with Galveston Bay
[2]Total width / width within county limits
*Controlled by coastal flooding – see Flood Insurance Rate Map for applicable elevations

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

Chambers County, Texas

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: CEDAR BAYOU

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FT) [2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
CEDAR BAYOU (CONTINUED)								
AD	47,746	741 / 350	7,619	2.9	*	10.5	10.9	0.4
AE	48,723	253 / 96	4,563	4.9	*	10.6	11.0	0.4
AF	49,907	423 / 232	5,093	4.4	*	10.9	11.4	0.5
AG	50,893	284 / 108	4,775	4.7	*	11.2	11.6	0.4
AH	51,769	280 / 138	4,064	5.5	*	11.3	11.8	0.5
AI	53,006	346 / 105	4,717	4.7	*	11.8	12.2	0.4
AJ	54,002	571 / 295	6,571	3.4	*	12.1	12.5	0.4
AK	54,943	767 / 144	7,130	3.1	*	12.3	12.7	0.4
AL	56,588	1,013 / 110	9,746	2.3	*	12.4	13.0	0.6
AM	57,445	647 / 104	6,625	3.4	*	12.4	13.0	0.6
AN	58,272	391 / 137	4,771	4.4	*	12.5	13.4	0.9
AO	59,436	639 / 372	9,042	2.3	15.2[3]	13.1	13.9	0.8
SP	61,783	444 / 68	4,991	4.2	15.2[3]	13.2	14.1	0.9
AQ	62,630	556 / 256	6,120	3.4	15.4[3]	13.6	14.4	0.8
AR	63,893	594 / 81	6,861	3.0	15.5[3]	13.7	14.6	0.9
AS	64,961	757 / 98	8,155	2.6	15.7[3]	14.1	14.9	0.8
AT	65,959	685 / 263	7,739	2.7	15.8[3]	14.3	15.1	0.8
AU	66,947	544 / 92	7,485	2.8	15.9[3]	14.5	15.3	0.8

[1]Stream distance in feet above confluence with Galveston Bay
[2]Total width / width within county limits
[3]Combined probability for storm surge from Galveston Bay and Cedar Bayou
*Controlled by coastal flooding – see Flood Insurance Rate Map for applicable elevations

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

Chambers County, Texas

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: CEDAR BAYOU

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FT) [2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY[3]	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
CEDAR BAYOU (CONTINUED)								
AV	68,105	772 / 297	9,022	2.3	16.1	14.7	15.5	0.8
AW	69,033	625 / 486	10,050	2.0	16.2	14.9	15.7	0.8
AX	70,127	523 /346	6,602	3.1	16.3	15.0	15.8	0.8
AY	71,226	591 / 355	7,662	2.7	16.6	15.4	16.1	0.7
AZ	72,488	866 / 174	10,870	1.9	16.9	15.8	16.5	0.7
BA	73,499	646 / 277	7,407	2.8	16.9	15.9	16.6	0.7
BB	74,963	760 / 320	8,579	2.4	17.2	16.4	17.1	0.7
BC	76,035	884 / 335	10,939	1.9	17.5	16.7	17.4	0.7
BD	77,250	477 / 139	6,146	3.3	17.6	16.9	17.5	0.6
BE	78,275	310 / 208	4,707	4.3	17.8	17.1	17.7	0.6
BF	79,255	486 / 146	6,259	3.2	18.1	17.5	18.2	0.7
BG	80,360	665 / 111	7,531	2.7	18.5	18.0	18.5	0.5
BH	81,180	567 / 150	8,218	2.5	18.7	18.2	18.8	0.6
BI	82,191	428 / 302	6,057	3.3	19.1	18.6	19.2	0.6
BJ	83,548	447 / 254	4,980	4.1	19.4	19.0	19.6	0.6
BK	84,444	522 / 114	7,191	2.8	19.7	19.4	19.9	0.5
BL	85,468	950 / 751	10,953	1.9	19.9	19.7	20.3	0.6
BM	87,008	1,010 / 135	11,790	1.7	20.2	20.0	20.6	0.6

[1]Stream distance in feet above confluence with Galveston Bay
[2]Total width / width within county limits
[3]Combined probability for storm surge from Galveston Bay and Cedar Bayou

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

Chambers County, Texas

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: CEDAR BAYOU

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FT)[2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
CEDAR BAYOU (CONTINUED)								
BN	88,135	889 / 69	7,497	2.7	20.4[3]	20.2	20.7	0.5
BO	89,326	1,087 / 483	9,160	2.2	20.9[3]	20.7	21.3	0.6
BP	90,763	800 / 913	9,146	2.2	21.2[3]	21.3	21.8	0.5
BQ	91,609	1,025 / 615	11,384	1.8	21.7[3]	21.6	22.2	0.6
BR	92,418	352 / 216	5,869	3.4	22.3[3]	22.2	22.8	0.6
BS	93,327	494 / 277	6,895	2.9	22.6[3]	22.5	23.1	0.6
BT	94,047	594 / 435	7,971	2.5	23.0[3]	23.0	23.6	0.6
BU	95,180	223 / 56	4,239	4.7	24.1[3]	24.0	24.5	0.5
BV	96,105	1,110 / 826	12,011	1.7	24.9	24.9	25.5	0.6
BW	97,382	857 / 243	8,604	2.3	25.1	25.1	25.8	0.7
BX	98,357	524 / 83	5,912	3.3	25.4	25.4	26.1	0.7
BY	99,259	439 / 94	3,890	5.0	25.8	25.8	26.5	0.7
BZ	100,335	1,121 / 914	5,447	3.6	26.7	26.7	27.2	0.5
CA	101,377	1,681 / 1211	12,967	1.5	27.1	27.1	27.8	0.7
CB	102,491	1,453 / 1308	11,427	1.7	27.2	27.2	28.0	0.8
CC	103,452	1,882 / 1680	10,786	1.8	27.6	27.6	28.3	0.7
CD	104,393	1,305 / 890	9,265	2.1	27.9	27.9	28.7	0.8
CE	105,320	1,408 / 546	7,089	2.7	28.2	28.2	29.0	0.8

[1]Stream distance in feet above confluence with Galveston Bay
[2]Total width / width within county limits
[3]Combined probability for storm surge from Galveston Bay and Cedar Bayou

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

Chambers County, Texas

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: CEDAR BAYOU

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FT) [2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
CEDAR BAYOU (CONTINUED)								
CF	106,890	1,932 / 473	9,319	2.1	28.9	28.9	29.8	0.9
CG	107,907	1,563 / 355	11,869	1.6	29.3	29.3	30.3	1.0
CH	108,969	2,291 / 1,234	13,362	1.4	29.6	29.6	30.6	1.0
CI	110,135	1,035 / 887	8,731	2.2	30.2	30.2	31.0	0.8
CJ	110,747	439 / 89	6,876	2.8	30.5	30.5	31.3	0.8
CK	111,566	939 / 154	7,096	2.7	30.6	30.6	31.4	0.8
CL	112,571	1,442 / 299	9,244	2.1	31.3	31.3	32.1	0.8
CM	113,600	2,042 / 924	13,059	1.5	31.8	31.8	32.6	0.8
CN	114,661	3,010 / 1,649	19,040	1.0	32.0	32.0	32.9	0.9
CO	115,684	2,260 / 1,298	14,374	1.3	32.2	32.2	33.0	0.8
CP	116,575	2,600 / 1,802	17,295	1.1	32.4	32.4	33.2	0.8
CQ	117,495	1,634 / 1,146	10,636	1.8	32.4	32.4	33.3	0.9
CR	118,522	854 / 458	5,923	3.1	33.1	33.1	33.8	0.7
CS	119,832	2,800 / 1,007	17,943	1.0	33.7	33.7	34.6	0.9
CT	120,696	2,572 / 610	16,097	1.1	33.9	33.9	34.7	0.8
CU	121,854	2,117 / 138	13,284	1.4	34.0	34.0	34.9	0.9
CV	122,942	2,739 / 116	14,928	1.2	34.3	34.3	35.2	0.9
CW	123,942	2,524 / 47	12,853	1.4	34.6	34.6	35.5	0.9

[1]Stream distance in feet above confluence with Galveston Bay
[2]Total width / width within county limits

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

Chambers County, Texas

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: CEDAR BAYOU

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE	WIDTH (FT)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
CEDAR BAYOU (CONTINUED)								
CX	12,5221[1]	2,660 / 508[2]	16,971	0.7	34.9	34.9	35.8	0.9
CY	12,6202[1]	3,032 / 1,076[2]	16,547	0.7	35.0	35.0	35.9	0.9
CZ	12,7123[1]	2,542 / 1,421[2]	11,723	1.0	35.1	35.1	36.0	0.9
DA	12,8346[1]	1,913 / 1,300[2]	9,501	1.2	35.4	35.4	36.4	1.0
CEDAR GULLY								
A	4,550[3]	56	611	3.0	12.6[4]	11.7	12.6	0.9
B	6,550[3]	35	232	6.4	16.2[4]	16.2	17.2	1.0
C	8,750[3]	142	612	2.2	24.8	24.8	25.7	0.9
COTTON BAYOU								
A[5]	2,800[3]	393	3,123	1.2	12.9[6]	7.5	8.5	1.0
B[5]	8,650[3]	271	2,506	1.5	12.9[6]	8.6	9.6	1.0
C[5]	9,600[3]	323	2,329	1.3	12.9[6]	9.0	10.0	1.0
D	12,200[3]	54	366	7.0	14.8[6]	14.6	15.0	0.4
E	16,050[3]	117	715	3.2	20.3	20.3	20.6	0.3
F	19,830[3]	118	414	5.1	28.8	28.8	28.9	0.1

[1]Stream distance in feet above confluence with Galveston Bay
[2]Total width / width within county limits
[3]Stream distance in feet above confluence with Trinity Bay
[4]Combined probability for storm surge from Trinity Bay and Cedar Gully
[5]Flood profiles not shown, Trinity Bay surge dominates flooding at these locations
[6]Combined probability for storm surge from Trinity Bay and Cotton Bayou

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

Chambers County, Texas

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: CEDAR BAYOU – CEDAR GULLY – COTTON BAYOU

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FT)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
DOUBLE BAYOU EAST FORK								
A	21,500	439	2,504	2.7	10.5[2]	9.9	10.9	1.0
B	23,350	438	2,826	2.4	11.2[2]	10.4	11.4	1.0
C	24,250	111	1,450	4.7	11.1[2]	10.6	11.6	1.0
D	26,600	1,038	5,035	1.3	11.9[2]	11.4	12.4	1.0
E	27,650	1,262	5,900	1.1	11.9[2]	11.6	12.6	1.0
F	29,900	1,444	7,295	0.9	12.1[2]	11.8	12.8	1.0
G	33,450	735	4,244	1.6	12.5[2]	12.3	13.3	1.0
H	40,050	1,209	5,509	1.2	14.0[2]	13.9	14.9	1.0
I	44,800	1,528	6,542	0.9	14.7	14.7	15.6	0.9
J	53,800	616	3,186	1.8	16.6	16.6	17.6	1.0
K	57,850	1,058	4,622	1.2	18.0	18.0	18.9	0.9
L	64,550	1,105	5,241	1.0	18.9	18.9	19.9	1.0
M	67,150	1,688	5,833	0.9	19.5	19.5	20.5	1.0
N	69,000	1,653	5,907	0.9	19.9	19.9	20.9	1.0
O	73,700	1,254	4,570	1.2	21.7	21.7	22.7	1.0
P	75,400	78	1,199	4.2	22.0	22.0	22.9	0.9
Q	79,363	1,640	6,452	0.7	23.3	23.3	24.2	0.9
R	80,665	1,679	6,339	0.7	23.4	23.4	24.3	0.9

[1]Stream distance in feet above confluence with Trinity Bay
[2]Combined probability for storm surge from Trinity Bay and Double Bayou East Fork

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

Chambers County, Texas

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: DOUBLE BAYOU EAST FORK

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FT)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
DOUBLE BAYOU EAST FORK (CONTINUED)								
S	82,650	995	3,501	1.3	23.7	23.7	24.6	0.9
T	83,350	669	2,778	1.7	23.8	23.8	24.7	0.9
U	85,100	757	3,060	1.5	24.8	24.8	25.7	0.9
V	88,950	440	1,212	3.5	26.5	26.5	27.4	0.9
W	92,900	1,478	4,892	0.8	27.9	27.9	28.8	0.9
X	97,900	1,212	4,301	0.9	28.3	28.3	29.3	1.0
Y	103,050	773	2,631	1.4	29.3	29.3	30.2	0.9
Z	105,450	724	3,702	1.0	31.3	31.3	32.1	0.8
AA	108,750	1,208	5,204	0.7	31.4	31.4	32.4	1.0
AB	111,200	1,804	5,187	0.7	31.6	31.6	32.6	1.0
AC	113,050	1,011	3,117	1.2	32.0	32.0	32.9	0.9

[1]Stream distance in feet above confluence with Trinity Bay

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

Chambers County, Texas

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: DOUBLE BAYOU EAST FORK

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FT)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
DOUBLE BAYOU WEST FORK								
A	24,400	90	1,138	3.5	10.6[2]	8.2	8.8	0.6
B	27,600	85	1,083	3.7	10.4[2]	8.9	9.6	0.7
C	30,800	109	1,194	3.3	10.6[2]	9.6	10.3	0.7
D	32,700	168	1,716	2.3	10.9[2]	10.0	10.7	0.7
E	34,400	152	1,427	2.8	11.2[2]	10.2	10.9	0.7
F	39,750	187	1,335	2.8	11.7[2]	11.1	12.0	0.9
G	42,350	706	4,728	0.8	11.9[2]	11.5	12.5	1.0
H	46,750	202	1,493	2.5	12.4[2]	12.0	13.0	1.0
I	52,100	78	933	3.6	13.6[2]	13.5	14.4	0.9
J	57,200	96	1,025	3.3	14.8[2]	14.7	15.6	0.9
K	62,300	111	1,061	3.2	15.8[2]	15.8	16.6	0.8
L	67,400	242	1,013	3.1	17.6	17.6	18.5	0.9
M	70,050	187	920	3.1	18.8	18.8	19.6	0.8

[1]Stream distance in feet above confluence with Trinity Bay
[2]Combined probability for storm surge from Trinity Bay and Double Bayou West Fork

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

Chambers County, Texas

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: DOUBLE BAYOU WEST FORK

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE	WIDTH (FT)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
HACKBERRY GULLY								
A	3,150[1]	45	185	11.6	14.0[3]	11.7	11.7	0.0
B	6,700[1]	76	412	4.5	23.9	23.9	23.9	0.0
C	9,300[1]	232	1,118	1.4	25.6	25.6	25.6	0.0
D	14,800[1]	59	168	8.9	28.0	28.0	28.2	0.2
HORSEPEN BAYOU								
A	1,200[2]	99	358	6.1	16.5[4]	10.7	11.0	0.3
B	1,780[2]	52	470	4.7	17.4[4]	16.3	16.3	0.0
C	5,180[2]	65	388	5.7	21.6	21.6	22.2	0.6
D	5,580[2]	51	386	5.7	22.5	22.5	23.0	0.5
LABBIT CREEK								
A	-886[5]	126	630	1.6	15.4	7.5[6]	8.5	1.0
B	-192[5]	47	230	4.4	15.4	7.7[6]	8.7	1.0

[1]Stream distance in feet above confluence with Cotton Bayou
[2]Stream distance in feet above confluence with Cedar Bayou
[3]Combined probability for storm surge from Trinity Bay and Hackberry Gully
[4]Combined probability for storm surge from Galveston Bay and Horsepen Bayou
[5]Feet from Chambers/Liberty County boundary
[6]Elevation computed without consideration of backwater effects from Trinity River

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

Chambers County, Texas

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: HACKBERRY GULLY – HORSEPEN BAYOU – LABBIT CREEK

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE	WIDTH (FT)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
LEE GULLY								
A	300[1]	111	864	2.9	14.2[3]	11.4	12.4	1.0
B	2,200[1]	105	601	4.2	15.3	15.3	15.6	0.3
C	4,300[1]	82	609	3.9	20.3	20.3	20.3	0.0
LITTLE CANEY CREEK								
A	-4,688[2]	393	926	1.4	15.4	3.8[4]	4.8	1.0
B	-3,989[2]	240	733	1.7	15.4	5.2[4]	6.1	0.9
C	-2,882[2]	64	321	3.9	15.4	7.0[4]	7.7	0.7
D	-2,708[2]	64	421	3.0	15.4	8.7[4]	9.1	0.4
E	-1,924[2]	123	706	1.8	15.4	9.5[4]	9.8	0.3
F	-968[2]	84	459	2.7	15.4	9.9[4]	10.4	0.5
OLD RIVER								
A	-27,626[2]	1,290	6,564	0.4	15.0	5.7[4]	6.7	1.0
B	-25,873[2]	443	2,519	1.1	15.0	5.8[4]	6.7	0.9
C	-24,493[2]	211	1,773	1.5	15.0	5.9[4]	6.8	0.9
D	-21,596[2]	912	4,667	0.6	15.0	6.1[4]	7.0	0.9
E	-19,442[2]	195	1,893	1.4	15.0	6.2[4]	7.1	0.9

[1]Stream distance in feet above confluence with Turtle Whites Bayou
[2]Feet from Chambers/Liberty County boundary
[3]Flooding controlled by Trinity Bay
[4]Elevations computed without consideration of backwater effects from Trinity River

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

Chambers County, Texas

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: LEE GULLY – LITTLE CANEY CREEK – OLD RIVER

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FT)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
OLD RIVER (CONTINUED)								
F	-19,169	195	2,052	1.3	15.0	6.2[2]	7.2	1.0
G	-18,504	152	1,723	1.6	15.0	6.3[2]	7.2	0.9
H	-18,031	167	1,769	1.5	15.0	6.3[2]	7.2	0.9
I	-16,879	178	1,799	1.5	15.0	6.4[2]	7.3	0.9
J	-15,658	176	1,777	1.5	15.0	6.5[2]	7.4	0.9
K	-14,555	169	1,662	1.6	15.0	6.6[2]	7.5	0.9
L	-13,676	148	1,633	1.7	15.0	6.6[2]	7.5	0.9
M	-12,888	201	1,864	1.5	15.0	6.7[2]	7.6	0.9
N	-12,191	159	1,667	1.6	15.0	6.8[2]	7.6	0.8
O	-10,800	204	1,951	1.2	15.0	6.9[2]	7.7	0.8
P	-9,887	185	1,734	1.4	15.0	6.9[2]	7.8	0.9
Q	-8,462	110	1,340	1.8	15.0	7.0[2]	7.8	0.8
R	-8,233	111	1,341	1.8	15.0	7.0[2]	7.8	0.8
S	-6,745	127	1,427	1.5	15.0	7.1[2]	7.9	0.8
T	-5,338	196	1,574	1.3	15.0	7.2[2]	8.0	0.8
U	-3,183	184	1,271	1.7	15.0	7.5[2]	8.2	0.7
V	-1,463	63	695	3.1	15.0	7.7[2]	8.5	0.8

[1]Feet from Chambers/Liberty County boundary
[2]Elevations computed without consideration of backwater effects from Trinity River

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

Chambers County, Texas

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: OLD RIVER

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FT)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
OYSTER BAYOU								
A	778[1]	770	3,716	0.5	22.5	22.5	23.4	0.9
B	5,197[1]	170	964	1.1	22.8	22.8	23.8	1.0
C	8,978[1]	811	2,714	0.4	23.0	23.0	24.0	1.0
D	11,442[1]	459	1,824	0.6	23.9	23.9	24.7	0.8
E	13,818[1]	465	1,511	0.7	24.2	24.2	25.1	0.9
F	17,898[1]	68	442	2.7	25.2	25.2	26.1	0.9
SAWPIT GULLY								
A	1,435[2]	300	1,646	1.2	15.2[3]	9.2	10.2	1.0
B	3,270[2]	55	336	5.9	15.4[3]	11.7	12.2	0.5
C	5,295[2]	60	445	4.1	17.8	17.8	18.2	0.4
D	6,460[2]	100	701	2.4	24.4	24.4	24.5	0.1
E	7,830[2]	264	1,659	1.0	24.5	24.5	25.2	0.7
F	10,020[2]	350	1,535	1.0	25.5	25.5	26.2	0.7

[1]Stream distance in feet above confluence with Lone Star Canal
[2]Stream distance in feet above confluence with Cedar Bayou
[3]Combined probability for storm surge from Galveston Bay and Cedar Bayou

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

Chambers County, Texas

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: OYSTER BAYOU – SAWPIT GULLY

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE	WIDTH (FT)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
SMITH GULLY								
A	4,095[1]	83	566	4.1	24.2	24.2	24.2	0.0
B	6,300[1]	87	632	3.2	26.0	26.0	26.0	0.0
C	9,400[1]	30	112	11.1	31.4	31.4	31.4	0.0
D	9,627[1]	37	217	5.7	34.6	34.6	34.6	0.0
E	10,702[1]	38	170	6.5	38.3	38.3	38.3	0.0
F	12,552[1]	51	231	4.8	45.5	45.5	45.7	0.2
G	15,252[1]	130	419	2.2	49.8	49.8	50.0	0.2
H	17,953[1]	600	1,230	0.6	52.6	52.6	53.4	0.8
SPINDLETOP BAYOU								
A	200[2]	126	1,285	5.8	14.9	14.9	15.7	0.8
B	2,700[2]	167	1,872	4.0	16.0	16.0	16.7	0.7
C	7,200[2]	125	1,401	5.3	17.3	17.3	17.9	0.6
D	8,400[2]	147	2,213	3.3	17.9	17.9	18.4	0.5
E	9,800[2]	133	1,362	5.4	18.1	18.1	18.6	0.5
F	16,500[2]	135	1,589	4.5	20.5	20.5	20.8	0.3
G	23,200[2]	115	1,446	5.0	22.0	22.0	22.5	0.5

[1]Stream distance in feet above confluence with Cedar Bayou
[2]Stream distance in feet above State Highway 124

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

Chambers County, Texas

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: SMITH GULLY – SPINDLETOP BAYOU

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE	WIDTH (FT)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
SPRING BRANCH								
A	450[1]	31	397	5.8	17.5	17.3[3]	18.3[3]	1.0
B	2,150[1]	52	456	5.0	23.9	23.9	24.8	0.9
C	4,695[1]	182	947	2.4	27.9	27.9	28.9	1.0
D	7,245[1]	878	2,766	0.8	28.8	28.8	29.7	0.9
E	9,715[1]	588	2,396	0.9	29.7	29.7	30.4	0.7
F	12,890[1]	219	924	2.0	32.6	32.6	33.4	0.8
G	13,115[1]	249	1,106	1.7	32.9	32.9	33.8	0.9
TRINITY RIVER								
A	-15,740[2]	27,512	228,455	0.6	14.9[4]	14.1	14.1	0.0
B	-5,634[2]	23,577	215,122	0.6	15.4[4]	14.7	14.7	0.0

[1]Stream distance in feet above confluence with Turtle Whites Bayou
[2]Feet from Chambers/Liberty County boundary
[3]Elevations computed without backwater effects from Turtle Whites Bayou
[4]Combined probability for storm surge from Trinity Bay and Trinity River

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

Chambers County, Texas

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: SPRING BRANCH – TRINITY RIVER

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE	WIDTH (FT)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
TURTLE WHITES BAYOU								
A	0[1]	310	2,778	4.1	11.0[3]	9.4	10.4	1.0
B	3,433[1]	458	4,675	2.5	11.8[3]	10.6	11.4	0.8
C	5,433[1]	343	3,858	2.9	12.0[3]	11.0	11.7	0.7
D	7,633[1]	261	2,511	4.2	12.7[3]	12.0	12.7	0.7
E	9,213[1]	150	2,045	3.1	13.6[3]	12.8	13.8	1.0
F	11,125[1]	191	1,839	3.5	14.3[3]	13.8	14.7	0.9
G	15,825[1]	85	885	6.4	18.2	18.2	18.5	0.3
H	19,025[1]	98	898	6.4	22.4	22.4	22.5	0.1
I	23,564[1]	208	1,474	3.1	27.4	27.4	28.3	0.9
WHITES BAYOU								
A	700[2]	147	1,875	1.6	12.4[4]	9.9	10.9	1.0
B	3,400[2]	100	1,093	2.7	12.4[4]	10.8	11.7	0.9
C	6,400[2]	90	751	4.0	14.0[4]	12.6	13.2	0.6
D	12,500[2]	93	765	3.9	18.0[4]	17.7	17.8	0.1
E	14,699[2]	160	1,189	2.5	19.5	19.5	20.1	0.6
F	15,499[2]	270	1,226	2.4	20.3	20.3	20.7	0.4
G	17,960[2]	290	2,282	1.3	21.1	21.1	21.9	0.8
H	20,160[2]	170	1,523	2.0	21.5	21.5	22.3	0.8

[1]Stream distance in feet above confluence with Lake Anahuac
[2]Stream distance in feet above confluence with Turtle Whites Bayou
[3]Combined probability for storm surge from Trinity Bay and Turtle Whites Bayou
[4]Combined probability for storm surge from Trinity Bay and Whites Bayou

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

Chambers County, Texas

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: TURTLE WHITES BAYOU – WHITES BAYOU

Table 25: Flood Hazard and Non-Encroachment Data for Selected Streams

[Not Applicable to this FIS Project]

6.4 Coastal Flood Hazard Mapping

Flood insurance zones and BFEs including the wave effects were identified on each transect based on the results from the onshore wave hazard analyses. Between transects, elevations were interpolated using topographic maps, land-use and land-cover data, and knowledge of coastal flood processes to determine the aerial extent of flooding. Sources for topographic data are shown in Table 23.

Zone VE is subdivided into elevation zones and BFEs are provided on the FIRM.

The limit of Zone VE shown on the FIRM is defined as the farthest inland extent of any of these criteria (determined for the 1% annual chance flood condition):

- The *primary frontal dune zone* is defined in 44 CFR Section 59.1 of the NFIP regulations. The primary frontal dune represents a continuous or nearly continuous mound or ridge of sand with relatively steep seaward and landward slopes that occur immediately landward and adjacent to the beach. The primary frontal dune zone is subject to erosion and overtopping from high tides and waves during major coastal storms. The inland limit of the primary frontal dune zone occurs at the point where there is a distinct change from a relatively steep slope to a relatively mild slope.

- The *wave runup zone* occurs where the (eroded) ground profile is 3.0 feet or more below the 2-percent annual chance wave runup elevation.

- The *wave overtopping splash zone* is the area landward of the crest of an overtopped barrier, in cases where the potential 2-percent annual chance wave runup exceeds the barrier crest elevation by 3.0 feet or more.

- The *breaking wave height zone* occurs where 3-foot or greater wave heights could occur (this is the area where the wave crest profile is 2.1 feet or more above the total stillwater elevation).

- The *high-velocity flow zone* is landward of the overtopping splash zone (or area on a sloping beach or other shore type), where the product of depth of flow times the flow velocity squared (hv^2) is greater than or equal to 200 ft^3/sec^2. This zone may only be used on the Pacific Coast.

The SFHA boundary indicates the limit of SFHAs shown on the FIRM as either “V” zones or “A” zones.

Table 26 indicates the coastal analyses used for floodplain mapping and the criteria used to determine the inland limit of the open-coast Zone VE and the SFHA boundary at each transect.

Table 26: Summary of Coastal Transect Mapping Considerations

Coastal Transect	Primary Frontal Dune (PFD) Identified	Wave Runup Analysis	Wave Height Analysis	Zone VE Limit	SFHA Boundary
		Zone Designation and BFE (ft NAVD 88)	Zone Designation and BFE (ft NAVD 88)		
1	*	*	VE 19 AE 14-16	*	*
2[1]	*	*	*	*	*
3	*	*	VE 15-19** AE 14	*	*
4	*	*	VE 16-19 AE 14	*	*
5	*	*	VE 16-19 AE 13	*	*
6	*	*	VE 15-19 AE 13	*	*
7	*	VE 19-21 AE 21	*	*	*
8	*	VE 19-21 AE 21	*	*	*
9	*	VE 19-20 AE 20	*	*	*
10	*	VE 14-19	*	*	*
11	*	VE 18-19	AE 13	*	*
12	*	VE 17-19	*	*	*
13	*	VE 16-19	*	*	*
14	*	VE 19-20	*	*	*
15	*	VE 19-22	*	*	*
16	*	VE 19-21	*	*	*
17	*	VE 19	*	*	*
18	*	VE 17-19	*	*	*
19	*	*	VE 16-19 AE 15 VE 16-18	*	*
20	*	VE 16-19	VE 17-19 AE 15	*	*
21	*	VE 21	VE 17-19 AE 15 VE 16-18	*	*
22	*	*	VE 16-19 AE 15 VE 16-18 AE 15 VE 15-19	*	*

Coastal Transect	Primary Frontal Dune (PFD) Identified	Wave Runup Analysis Zone Designation and BFE (ft NAVD 88)	Wave Height Analysis Zone Designation and BFE (ft NAVD 88)	Zone VE Limit	SFHA Boundary
23	*	*	VE 15-19 AE 13	*	*
24	*	*	VE 15-19 VE 14-17 AE 12	*	*
25	*	*	VE 15-19 AE 14-15 AE 11-13 VE 12-15 AE 12	*	*
26	*	*	VE 15-18 AE 14-15 AE 10-11 AE 11-13 VE 13	*	*
27	*	*	VE 14-18 AE 12-14 AE 10-12 VE 13	*	*
28	*	*	VE 14-18 AE 14 AE 12 VE 13-15 AE 13-14 VE 14	*	*
29	*	*	VE 14-18 AE 13-14 AE 12 VE 12-15 AE 12	*	*
30	*	*	VE 14-18 AE 13-14 AE 12 VE 12-15	*	*
31	*	*	VE 14-18 AE 13-14 AE 12 VE 12-14	*	*
32	*	*	VE 14-18 AE 13-14	*	*
33	*	*	VE 14-18 AE 14	*	*
34	*	*	VE 14-18	*	*
35	*	*	VE 14-18	*	*
36	*	*	VE 14-17	*	*
37	*	VE 14-18	*	*	*

Coastal Transect	Primary Frontal Dune (PFD) Identified	Wave Runup Analysis Zone Designation and BFE (ft NAVD 88)	Wave Height Analysis Zone Designation and BFE (ft NAVD 88)	Zone VE Limit	SFHA Boundary
38	*	VE 17	*	*	*
39	*	*	VE 14-17 AE 11	*	*
40	*	*	VE 13-15 AE 11-13 VE 13 AE 11-13 AE 9-10	*	*
41	*	*	VE 13-15 AE 11-13 AE 10-11 AE 9	*	*
42	*	*	VE 13-15 AE 12-13 AE 10-11	*	*
43	*	*	VE 13-15 AE 12-13 VE 13	*	*
44	*	*	VE 13-15 AE 12-13	*	*
45	*	*	VE 12-15 AE 12 VE 12-13 AE 11-12	*	*
46	*	*	VE 12-16 AE 12 AE 10-11	*	*
47	*	*	VE 15 AE 11-12 AE 9-10	*	*
48	*	*	VE 14-15 AE 10-12 VE 14-15	*	*
49	*	*	VE 13-16	*	*
50	*	*	VE 13-16 AE 11-13	*	*
51	*	*	VE 13-16 AE 12-13 AE 10-11	*	*
52	*	*	VE 13-16 AE 13 AE 10-12	*	*
53	*	*	VE 13-16 AE 12-13 VE 13-14 AE 12-13 AE 11	*	*

Coastal Transect	Primary Frontal Dune (PFD) Identified	Wave Runup Analysis	Wave Height Analysis	Zone VE Limit	SFHA Boundary
		Zone Designation and BFE (ft NAVD 88)	Zone Designation and BFE (ft NAVD 88)		
54	*	*	VE 12-16 AE 13 VE 13-14 AE 10-13	*	*
55	*	*	VE 13-16 AE 12-13 VE 13-14 AE 10-13	*	*
56	*	*	VE 13-16 AE 12	*	*
57	*	*	VE 12-15 AE 10-12	*	*
58	*	*	VE 12-15 AE 12 AE 13 VE 12-13 AE 10	*	*
59	*	*	VE 12-15 AE 11-12 VE 12-13 AE 12-13 VE 13-14 AE 10-13	*	*
60	*	*	VE 12-15 AE 11-12 VE 12-13 AE 12-13 VE 13-14	*	*
61	*	*	VE 12-16 AE 12-13 VE 13-14 AE 11-13	*	*
62	*	*	VE 12-15 AE 12-13 AE 10-11	*	*
63	*	*	VE 12-15 AE 12 AE 10-12	*	*
64	*	*	VE 12-15 AE 11-12 VE 12-13 AE 10-12	*	*
65	*	*	VE 12-15 AE 12 VE 12-13 AE 12 AE 10-11	*	*

Coastal Transect	Primary Frontal Dune (PFD) Identified	Wave Runup Analysis Zone Designation and BFE (ft NAVD 88)	Wave Height Analysis Zone Designation and BFE (ft NAVD 88)	Zone VE Limit	SFHA Boundary
66	*	*	VE 15-20** VE 13-14** VE 12-14 AE 12 VE 12-13 AE 10-12	*	*
67	*	*	VE 18-20** VE 15-17** AE 11-12** VE 12-13 AE 12-13 VE 13 AE 10-12	*	*
68	*	*	VE 20** VE 14-1**8 AE 14** AE 12-13 VE 13 AE 10-11	*	*
69	*	*	VE 18-20** VE 14-17** AE 14** VE 13-1**4 AE 12-13 AE 10-12	*	*
70	*	*	VE 20** VE 16-1**9 AE 12-14** AE 12-13 VE 13-14 AE 10-12	*	*
71	*	*	VE 16-20** AE 15** VE 14-15 AE 12-13 VE 13-14 AE 10-13	*	*
72	*	*	VE 17-20 VE 15-16 AE 13-14 VE 14 VE 13-15 AE 12-13 AE 10-11	*	*

Coastal Transect	Primary Frontal Dune (PFD) Identified	Wave Runup Analysis	Wave Height Analysis	Zone VE Limit	SFHA Boundary
		Zone Designation and BFE (ft NAVD 88)	Zone Designation and BFE (ft NAVD 88)		
73	*	*	VE 17-20** VE 15-16 AE 14 VE 14 AE 13 VE 13-15 AE 10-12	*	*
74	*	*	VE 17-20** VE 15-16** AE 15** AE 14-15** VE 13-15 AE 13-14 AE 11-12	*	*

[1]Transect is located outside of Chambers County
* Not calculated for this Flood Risk Project
**Includes flood hazard information outside of Chambers County

A LiMWA boundary has also been added in coastal areas subject to wave action for use by local communities in safe rebuilding practices. The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. To simplify representation, the LiMWA was continued immediately landward of the VE/AE boundary in areas where wave runup elevations dominate. Similarly, in areas where the Zone VE designation is based on the presence of a primary frontal dune or wave overtopping, the LiMWA was delineated immediately landward of the Zone VE/AE boundary.

6.5 FIRM Revisions

This FIS Report and the FIRM are based on the most up-to-date information available to FEMA at the time of its publication; however, flood hazard conditions change over time. Communities or private parties may request flood map revisions at any time. Certain types of requests require submission of supporting data. FEMA may also initiate a revision. Revisions to FIS projects may take several forms, including Letters of Map Amendment (LOMAs), Letters of Map Revision Based on Fill (LOMR-Fs), Letters of Map Revision (LOMRs) (referred to collectively as Letters of Map Change (LOMCs)), Physical Map Revisions (PMRs), and FEMA-contracted restudies. These types of revisions are further described below. Some of these types of revisions do not result in the republishing of the FIS Report. To assure that any user is aware of all revisions, it is advisable to contact the community repository of flood-hazard data (shown in Table 31, “Map Repositories”).

6.5.1 Letters of Map Amendment

A LOMA is an official revision by letter to an effective NFIP map. A LOMA results from an administrative process that involves the review of scientific or technical data submitted by the owner or lessee of property who believes the property has incorrectly been included in a designated SFHA. A LOMA amends the currently effective FEMA map and establishes that a specific property is not located in a SFHA. A LOMA cannot be issued for properties located on

the PFD (primary frontal dune).

To obtain an application for a LOMA, visit http://www.fema.gov and download the form "MT-1 Application Forms and Instructions for Conditional and Final Letters of Map Amendment and Letters of Map Revision Based on Fill". Visit the "Flood Map-Related Fees" section to determine the cost, if any, of applying for a LOMA.

FEMA offers a tutorial on how to apply for a LOMA. The LOMA Tutorial Series can be accessed at http://www.fema.gov/plan/prevent/fhm/ot_lmreq.shtm.

For more information about how to apply for a LOMA, call the FEMA Map Information eXchange; toll free, at 1-877-FEMA MAP (1-877-336-2627).

6.5.2 Letters of Map Revision Based on Fill

A LOMR-F is an official revision by letter to an effective NFIP map. A LOMR-F states FEMA's determination concerning whether a structure or parcel has been elevated on fill above the BFE and is, therefore, excluded from the SFHA.

Information about obtaining an application for a LOMR-F can be obtained in the same manner as that for a LOMA, by visiting http://www.fema.gov for the "MT-1 Application Forms and Instructions for Conditional and Final Letters of Map Amendment and Letters of Map Revision Based on Fill" or by calling the FEMA Map Information eXchange, toll free, at 1-877-FEMA MAP (1-877-336-2627). Fees for applying for a LOMR-F, if any, are listed in the "Flood Map-Related Fees" section.

A tutorial for LOMR-F is available at http://www.fema.gov/plan/prevent/fhm/ot_lmreq.shtm.

6.5.3 Letters of Map Revision

A LOMR is an official revision to the currently effective FEMA map. It is used to change flood zones, floodplain and floodway delineations, flood elevations and planimetric features. All requests for LOMRs should be made to FEMA through the chief executive officer of the community, since it is the community that must adopt any changes and revisions to the map. If the request for a LOMR is not submitted through the chief executive officer of the community, evidence must be submitted that the community has been notified of the request.

To obtain an application for a LOMR, visit http://www.fema.gov and download the form "MT-2 Application Forms and Instructions for Conditional Letters of Map Revision and Letters of Map Revision". Visit the "Flood Map-Related Fees" section to determine the cost of applying for a LOMR. For more information about how to apply for a LOMR, call the FEMA Map Information eXchange; toll free, at 1-877-FEMA MAP (1-877-336-2627) to speak to a Map Specialist.

Previously issued mappable LOMCs (including LOMRs) that have been incorporated into the Chambers County FIRM are listed in Table 27.

Please not that this table only includes LOMCs that have been issued on the FIRM panels updated by this map revision. For all other areas within this county, users should be aware that revision to the FIS Report made by prior LOMRs may not be reflected herein and users will need to continue to use the previously issued LOMRs to obtain the most current data.

Table 27: Incorporated Letters of Map Change

[Not Applicable to this FIS Project]

6.5.4 Physical Map Revisions

A PMR is an official republication of a community's NFIP map to effect changes to base flood elevations, floodplain boundary delineations, regulatory floodways and planimetric features. These changes typically occur as a result of structural works or improvements, annexations resulting in additional flood hazard areas or correction to base flood elevations or SFHAs.

The community's chief executive officer must submit scientific and technical data to FEMA to support the request for a PMR. The data will be analyzed and the map will be revised if warranted. The community is provided with copies of the revised information and is afforded a review period. When the base flood elevations are changed, a 90-day appeal period is provided. A 6-month adoption period for formal approval of the revised map(s) is also provided.

For more information about the PMR process, please visit http://www.fema.gov and visit the "Flood Map Revision Processes" section.

6.5.5 Contracted Restudies

The NFIP provides for a periodic review and restudy of flood hazards within a given community. FEMA accomplishes this through a national watershed-based mapping needs assessment strategy, known as the Coordinated Needs Management Strategy (CNMS). The CNMS is used by FEMA to assign priorities and allocate funding for new flood hazard analyses used to update the FIS Report and FIRM. The goal of CNMS is to define the validity of the engineering study data within a mapped inventory. The CNMS is used to track the assessment process, document engineering gaps and their resolution, and aid in prioritization for using flood risk as a key factor for areas identified for flood map updates. Visit www.fema.gov to learn more about the CNMS or contact the FEMA Regional Office listed in Section 8 of this FIS Report.

6.5.6 Community Map History

The current FIRM presents flooding information for the entire geographic area of Chambers County. Previously, separate FIRMs, Flood Hazard Boundary Maps (FHBMs) and/or Flood Boundary and Floodway Maps (FBFMs) may have been prepared for the incorporated communities and the unincorporated areas in the county that had identified SFHAs. Current and historical data relating to the maps prepared for the project area are presented inTable 28, "Community Map History." A description of each of the column headings and the source of the date is also listed below.

- *Community Name* includes communities falling within the geographic area shown on the FIRM, including those that fall on the boundary line, nonparticipating communities, and communities with maps that have been rescinded. Communities with No Special Flood Hazards are indicated by a footnote. If all maps (FHBM, FBFM, and FIRM) were rescinded for a community, it is not listed in this table unless SFHAs have been identified in this community.

- *Initial Identification Date (First NFIP Map Published)* is the date of the first NFIP map that identified flood hazards in the community. If the FHBM has been converted to a FIRM, the initial FHBM date is shown. If the community has never been mapped, the

upcoming effective date or "pending" (for Preliminary FIS Reports) is shown. If the community is listed in Table 28 but not identified on the map, the community is treated as if it were unmapped.

- *Initial FHBM Effective Date* is the effective date of the first FHBM. This date may be the same date as the Initial NFIP Map Date.

- *FHBM Revision Date(s)* is the date(s) that the FHBM was revised, if applicable.

- *Initial FIRM Effective Date* is the date of the first effective FIRM for the community. This is the first effective date that is shown on the FIRM panel.

- *FIRM Revision Date(s)* is the date(s) the FIRM was revised, if applicable. This is the revised date that is shown on the FIRM panel, if applicable. As countywide studies are completed or revised, each community listed should have its FIRM dates updated accordingly to reflect the date of the countywide study. Once the FIRM exists in countywide format, as PMR of FIRM panels within the county are completed, the FIRM Revision Dates in the table for each community affected by the PMR are updated with the date of the PMR, even if the PMR did not revise all the panels within that community.

The initial effective date for the Chambers County FIRM in countywide format was May 4, 2015.

Table 28: Community Map History

Community Name	Initial Identification Date (First NFIP Map Published)	Initial FHBM Effective Date	FHBM Revision Date(s)	Initial FIRM Effective Date	FIRM Revision Date(s)
Anahuac, City of	6/28/1974	6/28/1974	11/8/1977 7/30/1976	7/16/1981	5/4/2015 1/6/1983
Baytown, City of	12/31/1974	N/A	N/A	12/31/1974	5/4/2015 3/4/1987 11/15/1985 9/28/1982 2/9/1979 11/14/1975
Beach City, City of	5/20/1977	5/20/1977	N/A	1/19/1983	5/4/2015
Chambers County, Unincorporated Areas	8/9/1974	8/9/1974	10/25/1977	6/15/1983	5/4/2015 5/18/1999 12/2/1992 5/4/1992 10/1/1983
Cove, City of	6/5/1979	6/5/1979	N/A	2/17/1993	5/4/2015
Mont Belvieu, City of	12/24/1976	12/24/1976	N/A	8/16/1982	5/4/2015

Community Name	Initial Identification Date (First NFIP Map Published)	Initial FHBM Effective Date	FHBM Revision Date(s)	Initial FIRM Effective Date	FIRM Revision Date(s)
Old River-Winfree, City of	8/9/1974	8/9/1974	10/25/1977	6/15/1983	5/4/2015 2/17/1993

SECTION 7.0 – CONTRACTED STUDIES AND COMMUNITY COORDINATION

7.1 Contracted Studies

Table 29 provides a summary of the contracted studies, by flooding source, that are included in this FIS Report.

Table 29: Summary of Contracted Studies Included in this FIS Report

Flooding Source	FIS Report Dated	Contractor	Number	Work Completed Date	Affected Communities
Coastal	5/4/2015	Mapping Alliance Partnership VI (MAPVI)	EMT-2002-CO-0052	August 2011	City of Beach City, City of Baytown, City of Anahuac, City of Cove, Chambers County Uninc. Areas
Cedar Bayou	5/4/2015	Harris County Flood Control District (HCFCD)	DR 1379	2004	City of Baytown
Smith Gully	6/15/1982	Tetra Tech, Inc.	IAA-H-4788	August 1981	City of Mont Belvieu

Flooding Source	FIS Report Dated	Contractor	Number	Work Completed Date	Affected Communities
Barrow Slough, Cedar Gully, Cotton Bayou, Double Bayou West Fork, Double Bayou East Fork, Hackberry Gully, Horsepen Bayou, Lee Gully, Sawpit Gully, Spindletop Bayou, Spring Branch, Whites Bayou Turtle Bayou, Oyster Bayou	6/15/1983	Tetra Tech, Inc.	IAA-H-4788	June 1981	Chambers County Uninc. Areas, City of Cove, City of Old River-Winfree
Trinity River	5/18/1999	Water Resources Division of the U.S. Geological Survey (USGS)	EMW-H-4788	June 1986	Chambers County Uninc. Areas
Cherry Point Gully, Cherry Point Gully Tributary 1, Cherry Point Tributary, Cotton Bayou, Crooked Bayou, Crooked Marsh, Hackberry Gully, Labbit Creek, Lee Gully, Little Caney Creek, Old Ditch, Old River, Old River Tributary 1, Old River Tributary 1A, Old River Tributary 2, Old River Tributary 3, Spring Branch, The Cutoff Tributary 1, The Cutoff Tributary 2, Turtle Bayou, Whites Bayou, Whites Bayou Tributary 1		RAMPP	HSFEHQ-09-D-0369	June 2014	Chambers County Uninc. Areas, City of Mont Belvieu, City of Old River-Winfree

7.2 Community Meetings

The dates of the community meetings held for this FIS project and any previous FIS projects are shown in Table 30. These meetings may have previously been referred to by a variety of names (Community Coordination Officer (CCO), Scoping, Discovery, etc.), but all meetings represent opportunities for FEMA, community officials, study contractors, and other invited guests to discuss the planning for and results of the project.

Table 30: Community Meetings

Community	FIS Report Dated	Date of Meeting	Meeting Type	Attended By
Chambers County and Incorporated Areas		4/2/2013	Discovery Close-Out	Chambers County, City of Anahuac, FEMA, Liberty County, Liberty County Fire Department, RAMPP, San Jacinto County
		4/2/2013	Project Discovery	Chambers County, City of Anahuac, FEMA, Liberty County, Liberty County Fire Department, RAMPP, San Jacinto County
		8/13/2014	Flood Risk Review	City of Baytown Office of Emergency Management, Chambers County, City of Ames, City of Baytown, City of Dayton, City of Liberty, Coastal Water Authority, Dannenbaum Engineering, Dayton News, FEMA, LAN, LCSO, Liberty County, Liberty County Engineering Department, Liberty County Fire Department, Liberty County Office of Emergency Management, RAMPP, State Rep District 18, Texas DOT, TFS, Trinity River Authority, Trinity River National Wildlife Refuge

SECTION 8.0 – ADDITIONAL INFORMATION

Information concerning the pertinent data used in the preparation of this FIS Report can be obtained by submitting an order with any required payment to the FEMA Engineering Library. For more information on this process, see http://www.fema.gov.

The additional data that was used for this project includes the FIS Report and FIRM that were previously prepared for Chambers County, Texas and Incorporated Areas (FEMA 2015).

Table 31 is a list of the locations where FIRM panels for Chambers County can be viewed. Please note that the maps at these locations are for reference only and are not for distribution. Also, please note that only the maps for the community listed in the table are available at that particular repository. A user may need to visit another repository to view maps from an adjacent community.

Table 31: Map Repositories

Community	Address	City	State	Zip Code
Chambers County, Unincorporated Areas	Chambers County Road and Bridge Department 201 Airport Road	Anahuac	TX	77514
City of Anahuac	City Hall, Foreman's Office 501 Miller Street	Anahuac	TX	77514
City of Baytown	City Hall 2401 Market Street	Baytown	TX	77522
City of Beach City	Community Building 12723 Farm to Market 2354	Beach City	TX	77523
City of Cove	Chambers County Road and Bridge Department 201 Airport Road	Anahuac	TX	77514
City of Mont Belvieu	City Hall 11607 Eagle Drive	Mont Belvieu	TX	77523
City of Old River-Winfree	City Hall 4818 North Farm to Market 565 Road	Old River-Winfree	TX	77523

The National Flood Hazard Layer (NFHL) dataset is a compilation of effective FIRM databases and LOMCs. Together they create a GIS data layer for a State or Territory. The NFHL is updated as studies become effective and extracts are made available to the public monthly. NFHL data can be viewed or ordered from the website shown in Table 32.

Table 32 contains useful contact information regarding the FIS Report, the FIRM, and other relevant flood hazard and GIS data. In addition, information about the state NFIP Coordinator and GIS Coordinator is shown in this table. At the request of FEMA, each Governor has designated an agency of State or territorial government to coordinate that State's or territory's NFIP activities. These agencies often assist communities in developing and adopting necessary floodplain management measures. State GIS Coordinators are knowledgeable about the availability and location of state and local GIS data in their state.

Table 32: Additional Information

FEMA and the NFIP	
FEMA and FEMA Engineering Library website	http://www.fema.gov
NFIP website	http://www.fema.gov/national-flood-insurance-program
NFHL Dataset	http://msc.fema.gov
FEMA Region 6	Federal Emergency Management Agency, FRC 800 North Loop 288, Denton, TX 76209-3698 940-898-5399
Other Federal Agencies	
USGS website	http://www.usgs.gov
Hydraulic Engineering Center website	http://www.hec.usace.army.mil
State Agencies and Organizations	
State NFIP Coordinator	Mike Segner Texas Water Development Board (TWDB) 1700 North Congress Ave Austin, TX 78701 512-463-3509 Michael.Segner@twdb.state.tx.us
State GIS Coordinator	Mike Segner Texas Water Development Board (TWDB) 1700 North Congress Ave Austin, TX 78701 512-463-3509 Michael.Segner@twdb.state.tx.us

SECTION 9.0 – BIBLIOGRAPHY AND REFERENCES

Table 33 includes sources used in the preparation of and cited in this FIS Report as well as additional studies that have been conducted in the study area.

Table 33: Bibliography and References

Citation in this FIS	Publisher/ Issuer	*Publication Title,* "Article," Volume, Number, etc.	Author/Editor	Place of Publication	Publication Date/ Date of Issuance	Link
Amer Soc of Civil Eng	American Society of Civil Engineers and Harris County Flood Control District	*Hydrology for Harris County*			March 3, 1988	https://www.hcfcd.org/
Census Bureau 2011	U.S. Census Bureau	*2010 Census: Chambers County, Texas*			September 12, 2011	http://www.factfinder2census.gov
Corps of Engineers 1973	U.S. Army Corps of Engineers, Hydrologic Engineering Center	*HEC-1 Flood Hydrograph Package. Users Manual*		Davis, California	January 1973	
Corps of Engineers 2011	U.S. Army Corps of Engineers	*Flood Insurance Study: Coastal Counties, Texas Intermediate Submission 2-Scoping and Data Review*			November 2011	
Dept of Agriculture Soil	U.S. Department of Agriculture, Soil Conservation Service	*Soil Survey of Chambers County, Texas*			May 1976	

Citation in this FIS	Publisher/ Issuer	*Publication Title,* "Article," Volume, Number, etc.	Author/Editor	Place of Publication	Publication Date/ Date of Issuance	Link
Dept of Commerce 1957	U.S. Department of Commerce, Weather Bureau	*Survey of meteorological factors pertinent to reduction of loss of life and property in hurricane situations: a progress report of work accomplished under P.L. 71, 84th Congress, 1st Session. National Hurricane Research Project Report No. 5*		Washington, DC	1957	
Dept of Commerce 1963	U.S. Department of Commerce, Weather Bureau	*Technical Paper No. 40, Rainfall Frequency Atlas of the United States*		Washington, D.C.	Revised 1963	
Dept of Commerce 1970	U.S. Department of Commerce, Environmental Sciences Services Administration (ESSA)	*Weather Bureau Technical Memorandum Hydro 11. Joint Probability Method of Tide Frequency Analysis*		Meyers, VA	April 1970	
Dept of Commerce 1975_1	U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center	*Deck 488, Hourly Precipitation*			1948-1975	

Citation in this FIS	Publisher/ Issuer	*Publication Title,* "Article," Volume, Number, etc.	Author/Editor	Place of Publication	Publication Date/ Date of Issuance	Link
Dept of Commerce 1975_2	U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service	*Technical Report NWS-15, Some Climatological Characteristics of Hurricanes and Tropical Storms, Gulf and East Coasts of the United States*	P. Ho, R.W. Schwert and H.V. Goodyear		May 1975	
Dept of Commerce 1977	U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service	*Tape of Digitized Storm Information from 1886 through 1977*			1977	
Dept of Commerce 1978	U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service	*Tropical Cyclones of the North Atlantic Ocean 1871-1977*			June 1978	
Dept of Interior 1961_1	U.S. Department of Interior, Geological Survey	*7.5-Minute Series Topographic Maps, Contour Interval 5 Feet. Sheeks, Texas*			1943	

Citation in this FIS	Publisher/ Issuer	*Publication Title,* "Article," Volume, Number, etc.	Author/Editor	Place of Publication	Publication Date/ Date of Issuance	Link
Dept of Interior 1961_2	U.S. Department of Interior, Geological Survey	*7.5-Minute Series Topographic Maps, Contour Interval 5 Feet. Sheeks; Moss Bluff; Shiloh: Whites Bayou; Mont Belvieu; Photorevised 1969; Cove; Monroe City: Umbrella; Oak Island: Oyster Bayou; Stanolind Reservoir; Lake Stephenson; Mud Lake, TX*			1961	
Dept of Interior 1961_3	U.S. Department of Interior, Geological Survey	*Water Supply Papers, Surface Water Supply of the United States*		Washington, D.C.	1931-1961	
Dept of Interior 1962	U.S. Department of Interior, Geological Survey	*7.5-Minute Series Topographic Maps, Contour Interval 5 Feet. Fannett West, TX; Stowell, TX; Hamshire, TX; Frozen Point, TX; High Island, TX*			1962	
Dept of Interior 1969_1	U.S. Department of Interior, Geological Survey	*7.5-Minute Series Topographic Maps, Contour Interval 5 Feet. Texas City, Texas. Photorevised 1961*			1943 and 1954	

Citation in this FIS	Publisher/ Issuer	*Publication Title,* "Article," Volume, Number, etc.	Author/Editor	Place of Publication	Publication Date/ Date of Issuance	Link
Dept of Interior 1969_2	U.S. Department of Interior, Geological Survey	*7.5-Minute Series Topographic Maps, Contour Interval 5 Feet. Morgan Point, Texas. Photorevised 1969*			1956	
Dept of Interior 1974	U.S. Department of Interior, Geological Survey	*7.5-Minute Series Topographic Maps, Contour Interval 5 Feet. Winnie NW, TX; White Bayou, TX*			1974	
Dept of Interior 1976	U.S. Department of Interior, Geological Survey	*7.5-Minute Series Topographic Maps, Contour Interval 5 Feet. Fostoria, TX*			1976	
Dept of Interior 1979	U.S. Department of Interior, Geological Survey	*7.5-Minute Series Topographic Maps, Contour Interval 5 Feet. Plum Grove, TX; Splendora, TX*			1979	
Dept of Interior 1980	U.S. Department of Interior, Geological Survey	*7.5-Minute Series Topographic Maps, Contour Interval 5 Feet. Huffman, TX*			1980	

Citation in this FIS	Publisher/ Issuer	*Publication Title,* "Article," Volume, Number, etc.	Author/Editor	Place of Publication	Publication Date/ Date of Issuance	Link
Dept of Interior 1981	U.S. Department of Interior, Geological Survey, Office of Water and Data Collection, Interagency Advisory Committee on Water Data	*Guidelines for Determining Flood Flow Frequency, Bulletin 17B*		Reston, Virginia	Revised September 1981	
Dept of Interior Drafts	U.S. Department of Interior, Geological Survey	*7.5-Minute Series Topographic Maps, Contour Interval 5 Feet. Liberty NW, TX; Cleveland, TX; Lumm, TX; Westcott, TX; Rayburn, TX; Romayer, TX; Vowtaw, TX; Davis Hill, TX; Capers Ridge, TX; Dayton, TX; Daisetta, TX; Devers, TX; Nome, TX*			Draft	
Dewberry 2007	Dewberry and Davis, LLC	*Coastal Hazard Analysis Modeling Program (CHAMP), version 2.0*			April 2007	
FEMA 1982	Federal Emergency Management Agency	*Flood Insurance Study. City of Anahuac, Chambers County, Texas*		Washington D.C.	July 6, 1982	FEMA Map Service Center https://msc.fema.gov
FEMA 1992	Federal Emergency Management Agency	*Flood Insurance Study, Harris County, Texas and Incorporated Areas*		Washington, D.C.	September 30, 1992	FEMA Map Service Center https://msc.fema.gov

Citation in this FIS	Publisher/ Issuer	*Publication Title,* "Article," Volume, Number, etc.	Author/Editor	Place of Publication	Publication Date/ Date of Issuance	Link
FEMA 1999_1	Federal Emergency Management Agency	*Flood Insurance Rate Maps, Chambers County, Texas, Unincorporated Areas*		Washington, D.C.	May 18, 1999	FEMA Map Service Center https://msc.fema.gov
FEMA 1999_2	Federal Emergency Management Agency	*Flood Insurance Study, Chambers County, Texas, Unincorporated Areas*		Washington, D.C.	May 18, 1999	FEMA Map Service Center https://msc.fema.gov
FEMA 2007_1	Federal Emergency Management Agency	*Guidelines and Specifications for Flood Hazard Mapping Partners. Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update*			February 2007	http://www.fema.gov/media-library/assets/documents/34953
FEMA 2007_2	Federal Emergency Management Agency	*Harris County, TX DFIRM Database*		Washington, D.C.	June 18, 2007	FEMA Map Service Center https://msc.fema.gov
FEMA 2010	Federal Emergency Management Agency	*Hurricane Ike Debris Cleanup Operations*		Washington D.C.	December 3, 2010	
FEMA Beach City	Federal Emergency Management Agency	*Flood Insurance Study. City of Beach City, Chambers County, Texas*		Washington D.C.	July 19, 1982	FEMA Map Service Center https://msc.fema.gov
FEMA City of Mont Belvieu	Federal Emergency Management Agency	*Flood Insurance Study. City of Mont Belvieu, Chambers County, Texas*		Washington D.C.	June 15, 1982	FEMA Map Service Center https://msc.fema.gov

Citation in this FIS	Publisher/ Issuer	*Publication Title,* "Article," Volume, Number, etc.	Author/Editor	Place of Publication	Publication Date/ Date of Issuance	Link
FEMA Old River-Winfree	Federal Emergency Management Agency	*Flood Insurance Study. Town of Old River-Winfree, Chambers County, Texas*		Washington D.C.	February 17, 1993	FEMA Map Service Center https://msc.fema.gov
FEMA Town of Cove	Federal Emergency Management Agency	*Flood Insurance Study. Town of Cove, Chambers County, Texas*		Washington D.C.	February 17, 1993	FEMA Map Service Center https://msc.fema.gov
Geological Survey	U.S. Department of Interior, Geological Survey	*National Land Cover Database. Multi-Resolution Land Characteristic Consortium*				http://www.mrlc.gov./
Hydraulics Division 1979	Journal of the Hydraulics Division, ASCE, HY6	*Urbanization Impact of Streamflow*	L.R. Beard and S. Chang		June 1979	
Klotz 2009	Klotz Associates, Inc.	*City of Mont Belvieu Master Drainage Plan*			March 23, 2009	
Natl Academy of Sciences	National Academy of Sciences	*Methodology for Calculating Wave Action Effects Associated with Storm Surges, prepared by a panel of the Science and Engineering Program on the Prevention and Mitigation of Flood Losses*	Building Research Advisory Board Commission on Sociotechnical Systems, National Research Center		1977	

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NOAA 1978	U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data and Information Service, National Climatic Center	*North Atlantic Tropical Cyclones, 1978. AC945.N6*	Miles B. Lawrence	Miami, Florida	1978	
RAMPP 2014	Federal Emergency Management Agency	*Lower Trinity Watershed, Texas Technical Support Data Notebooks*		Denton, TX	June 20, 2014	https://hazards.fema.gov
State of Texas	State of Texas	*High Water Marks*			2008	
Tetra Tech 1979	Tetra Tech, Inc.	*Coastal Flooding Handbook, Parts 1 and 2, prepared for the Federal Insurance Adminisration.*			August 1979	
Tetra Tech 1979 Aerials	Tetra Tech, Inc.	*Aerial Photographs*			January 1979	
The Weather Channel 2011	The Weather Channel	*Monthly Averages for Chambers County, Texas*			September 12, 2011	http://www.weather.com
TNRIS 2002	Texas Natural Resources Information System	*Texas Natural Resources Information Systems StartMap*		Austin, TX	2002	http://tnris.org

Citation in this FIS	Publisher/ Issuer	*Publication Title,* "Article," Volume, Number, etc.	Author/Editor	Place of Publication	Publication Date/ Date of Issuance	Link
TWDB 2006	Texas Water Development Board	*Chambers County LiDAR, FEMA Case Number 05-06-A074S*		Albuquerque, NM	July 29, 2011	
University of Texas 1978	University of Texas, Department of Civil Engineering	*An Urban Runoff Model of Tulsa Oklahoma, Technical Report CRWR-160*	L.R. Beard and S. Chang	Austin, Texas	August 1978	
URS 2011	URS Albuquerque, MAPVI	*Chambers Coastal Model*			November 4, 2011	
URS 2011_2	URS Albuquerque, MAPVI	*Chambers Coastal Transects*			November 4, 2011	
USCB 2014	U.S. Department of Commerce, U.S. Census Bureau, Geography Division	*TIGER/Line shapefile, 2014, county, Chambers County, TX, All Roads County-based shapefile*		Washington, D.C.	2005	www2.census.gov/geo/tiger/TIGER2014/ROADS/tl_2014_48071_roads.zip
USDA 2010	U.S. Department of Agriculture	*Chambers County Digital Orthophotography (NAIP)*		Salt Lake City, UT	2010	USDA Geospatial Data Gateway http://datagateway.nrcs.usda.gov
USFWS 1990	U.S. Fish and Wildlife Service	*John H. Chafee Coastal Barrier Resources System Maps*		Washington, D.C.	1990	http://www.fws.gov/ecological-services/habitat-conservation/Coastal.html
USGS 1989	U.S. Geological Survey	*7.5-Minute Series Topographic Maps*		Reston, VA	1989	
USGS 2004	U.S. Geological Survey	*Chambers_TX_NHD_High*		Denver, CO	March 16, 2004	http://nhd.usgs.gov
USGS 2012	U.S. Geological Survey	*HUC 8 Boundaries*		Washington, D.C.	2012	