

FLOOD INSURANCE STUDY



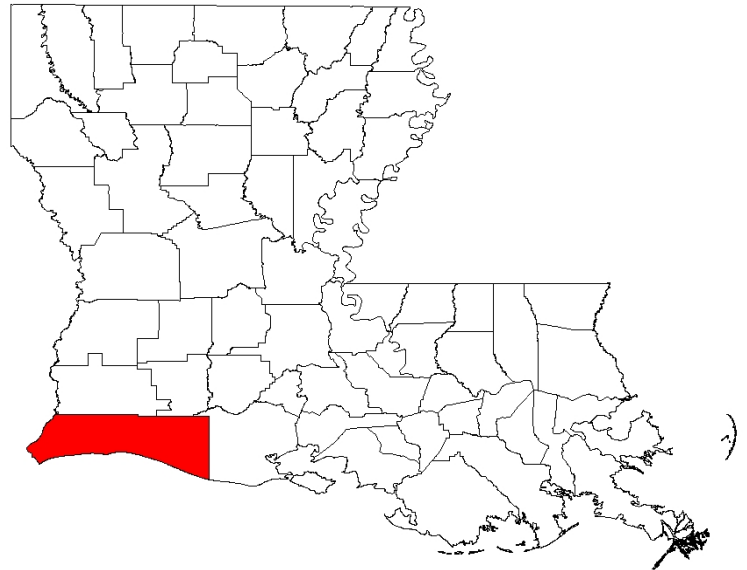
CAMERON PARISH, LOUISIANA AND INCORPORATED AREAS

Community
Name

CAMERON PARISH
(UNINCORPORATED AREAS)

Community
Number

225194



Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
22023CV001A

**NOTICE TO
FLOOD INSURANCE STUDY USERS**

Communities participating in the National Flood Insurance Program (NFIP) have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

Selected Flood Insurance Rate Map panels for this community contain information that was previously shown separately on the corresponding Flood Boundary and Floodway Map panels (e.g., floodways, cross sections). In addition, former flood hazard zone designations have been changed as follows:

<u>Old Zone(s)</u>	<u>New Zone</u>
A1 through A30	AE
V1 through V30	VE
B	X
C	X

Part or all of this FIS may be revised and republished at any time. In addition, part of this FIS may be revised by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current FIS components.

Initial Parishwide FIS Effective Date: September 4, 1970
First Revised Parishwide FIS Revision Date: July 1, 1974
Second Revised Parishwide FIS Revision Date: October 1, 1983
Third Revised Parishwide FIS Revision Date: April 3, 1984
Fourth Revised Parishwide FIS Revision Date: July 17, 1985
Fifth Revised Parishwide FIS Revision Date: April 16, 1991
Sixth Revised Parishwide FIS Revision Date: <To be Determined>

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**FLOOD INSURANCE STUDY
CAMERON PARISH, LOUISIANA, AND INCORPORATED AREAS**

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of Cameron Parish, including the unincorporated areas of Cameron Parish (referred to collectively herein as Cameron Parish), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this FIS are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The original Cameron Parish, Louisiana, Unincorporated Areas study was published September 4, 1970. The first revision to this study was dated July 1, 1974. Additional revisions have occurred and are dated October 1, 1983, April 3, 1984, July 17, 1985, and April 16, 1991. The last revision, completed on April 16, 1991, was performed by Tetra Tech, Inc., for the Federal Emergency Management Agency (FEMA), under Contract No. H-4789. No narratives were available for first through fourth revisions; therefore, information on the authority and acknowledgements for those studies are not available.

The fifth revision to the Cameron Parish, Louisiana, Unincorporated Areas, FIS was published on April 16, 1991. In this revision, FEMA prepared a new wave height analysis using an updated hydraulic model, and an updated hydrologic analysis prepared by the Parish (Reference 1); these updated analyses were completed in December 1989 and February 1990, respectively.

The new detailed coastal analyses for this study were performed by FTN/Taylor Joint Venture, for FEMA under Contract No. EMT-2002-CO-0050, Task Order No. J022. This study was completed in November 2007.

Base map information shown on the Flood Insurance Rate Map (FIRM) was derived from multiple sources. Base map files were provided and/or extracted in digital format from

Atlas: The Louisiana Statewide GIS, 2006, and the U.S. Census Bureau TIGER/Line files, 2006 Second Edition.

The digital Flood Insurance Rate Map (FIRM) was produced using the State Plane Coordinate System, Louisiana South, FIPZONE 1702. The horizontal datum was the North American Datum of 1983, GRS 80 spheroid. Distance units were measured in U.S. feet.

1.3 Coordination

The dates of the initial and final Consultation and Coordination Officer’s (CCO) meetings held for Cameron Parish are shown in the following tabulation.

<u>Community Name</u>	<u>Initial CCO Date</u>	<u>Final CCO Date</u>
Unincorporated Areas of Cameron Parish	*	May 3, 1983
Cameron Parish and Incorporated Areas	February 14, 2006	<To be Determined>

*Data not available

The initial CCO meetings were held with representatives of FEMA, the Parish, and the study contractors to identify the streams to be studied. The results of the studies were reviewed at the final CCO meetings held on the dates listed above, and attended by representatives of FEMA, the Parish, and the study contractors. All problems raised at those meetings have been addressed.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Cameron Parish, Louisiana.

The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction. The scope and methods of study were proposed to, and agreed upon, by FEMA and Cameron Parish.

Tidal flooding from the Gulf of Mexico, including wave action, was studied by detailed methods. This revision was carried out to incorporate an updated coastal surge analysis, implement coastal erosion regulations for frontal dunes, and incorporate an analysis of the effects of marsh grass on wave dissipation.

This parishwide study also incorporates Letters of Map Change (LOMC) issued by FEMA since the date of the final issued FIRMs.

2.2 Community Description

Cameron Parish is located entirely in the coastal marsh area in the extreme southwestern corner of Louisiana (Reference 2). It is bordered by Sabine Lake, the Sabine River, the City of Port Arthur, Texas, and Jefferson County, Texas to the west; Orange County, Texas to the northwest; Calcasieu and Jefferson Davis Parishes to the north; Vermilion

Parish to the east; and the Gulf of Mexico to the south. Calcasieu Lake forms a natural division between the eastern and western parts of the Parish. The only crossing point is a ferry at the southern end of the lake.

Cameron Parish has no incorporated areas. The Parish seat is the community of Cameron, which is located in the south-central section of the Parish. Port Arthur, Texas, lies seven miles across Sabine Lake, and Beaumont, Texas is ten miles beyond. Louisiana and Texas are connected by a toll bridge located approximately seven miles south of Port Arthur. Lake Charles lies approximately eight miles north of the Cameron Parish boundary, and Lafayette is approximately 35 miles northeast of the Parish.

Encompassing an area of 1,313 square miles, Cameron is the largest parish in the state. Its population, however, is the smallest among Louisiana parishes. Cameron Parish had a population density of 7.6 people per square mile in 2000, which represented a total parish population of 9,991 (Reference 3). This was 7.9 percent increase over the 1990 population.

Although the Parish is not densely populated, there are several population centers. They are found near the unincorporated communities of Hackberry, Johnsons Bayou, Holly Beach, Cameron, Creole, Oak Grove, and Grand Chenier. Other areas of residential development are located along the ridges in the Parish, specifically, along Highway 82, Front Ridge Road, and the southern portion of State Highway 27, between Creole and Cameron. Additional residential development is located along State Highway 1143 and Little Chenier Road. Scattered rural-residential development is found in the Sweet Lake area (Reference 2).

Three wildlife preserves are located in the Parish. The largest, the Sabine Migratory Waterfowl Refuge, located to the west and southeast of Calcasieu Lake, is federally owned and operated, as is the Lacassine Migratory Waterfowl Refuge, which is located in the northeastern part of the Parish. The Rockefeller Wildlife Refuge and Game Park, which extends into Vermilion Parish, is owned and operated by the State of Louisiana.

Wetlands cover more than two-thirds of the Parish; this is one of the largest wetland areas in a single district in the United States. The Parish's economy is linked to this valuable resource through rice growing, cattle raising, commercial and sport fishing, fur trapping, oil and gas production, base facilities for offshore oil and gas drilling, tourism, and recreation.

The Parish has extensive mineral resources, ranking first in natural gas production and sixth in total mineral production in the United States (Reference 4). Oil development, an important activity in the Parish, is not concentrated in one area (Reference 2). Piping and processing plants, as well as oil support facilities are located throughout the Parish near major oil and gas fields. Pipelines traverse the Parish and link oil deposits with processing plants and users throughout the country. Petroleum pipelines are expected to influence the future development of the Parish; there is high potential for the construction of processing plants and refineries along pipeline routes.

Cameron Parish, located in a subtropical latitude, which reflects the general climate of the southern United States, with mild, pleasant winters and warm, humid summers. The average temperature in July is 81 degrees Fahrenheit (°F), and the average temperature in January is 51° F. Rainfall averages over 60 inches annually, and is evenly distributed

throughout the year, except for July, the wettest month. Temperatures in the Parish are usually comfortable, but often accompanied by high humidity. The Parish's location on the Gulf Coast makes it particularly susceptible to frequent hurricanes and severe storms (Reference 5).

The Parish has elevations ranging from sea level to 20 feet. A short distance inland and parallel to the coastline, there are numerous ridges, or cheniers, which are generally at elevations of 4 to 7 feet; in a few cases, they are at elevations of 10 feet or slightly higher (Reference 2). These cheniers are long, narrow beach ridges composed essentially of sand and shells thrown up by waves during storms. Originating as beachfront ridges, the cheniers have since been isolated within the marsh as accretion extended the coastline toward the south. These cheniers are important as wildlife habitats, storm barriers, and barriers to the intrusion of salt water into the marshes. They also support the Parish's major industries – fish processing and oil development and its support services (Reference 6).

The southern part of the Parish is developed along these cheniers (Reference 2). Except for the unincorporated community of Hackberry near the Cameron Parish-Calcasieu Parish boundary, practically all residents of the Parish live on the cheniers. North of these ridges there is a wide belt of marsh, relieved in scattered localities by small ridges. The northern extremity of the Parish joins the upland prairie and rises from elevations of 10 feet to 20 feet.

There are five basic soil associations present in Cameron Parish: the Harris-Salt Water Marsh Association; the Fresh Water Marsh-Harris Association; the Morey-Beaumont Association; the Harris, Chenier Variant-Palm Beach Association; and the Crowley-Morey-Mowata Association (Reference 7). The majority of these soils have low infiltration rates and high runoff potential. They are classified as United States Soil Conservation Service (SCS) Group D for hydrologic purposes.

The Harris-Salt Water Marsh Association, which covers more than 50 percent of the Parish, is mostly in the southern and western parts of the Parish, and is found at or near sea level. It consists of mineral and organic salt-water marshland. Land areas in which this soil predominates are mainly used for cattle ranging and wildlife habitat. Along the Intracoastal Waterway, in the eastern part of the Parish, is the Fresh Water Marsh-Harris Association. Covering more than 20 percent of Cameron's land area, this mineral and organic freshwater marshland is flooded within many places. The Morey-Beaumont Association is made up of nearly level clayey and silty soils. These soils are on the prairie in the northern part of the Parish, and are mainly used for rice growing. On the low, narrow ridges in the southern part of the Parish are the clayey and sandy soils of the Harris, Chenier Variant-Palm Beach Soils Association. These lands are devoted to range, pasture, and residential uses. The association covering the least area is the Crowley-Morey-Mowata group, which has nearly level, silty soils with clayey and silty subsoils. This association is in the northern part of the Parish. It is used principally for growing rice.

The majority of soils in Cameron Parish have moderate subsidence potentials. The organic or semi-fluid mineral layer soil has a potential of losing up to 4 feet of elevation if drained. The subsidence potential grows greater as the organic layers thicken.

Cameron Parish has established a drainage system to provide gravity drainage to certain areas that were poorly drained previously (Reference 2). The system has series of levees, canals, and gate structures. In 1971, a deepwater channel from the Mermentau River, at Grand Chenier, to the Gulf of Mexico was constructed to serve the offshore oil industry.

2.3 Principal Flood Problems

Flood hazards with the Parish result primarily from tidal surge and associated waves caused by tropical storms and hurricanes (Reference 2). Tides can intrude into the low-lying areas through the Calcasieu Ship Channel, and through the Creole Canal and Kings Bayou, which flow into the Mermentau River. Less severe than tidal flooding, stream overflow occurs infrequently from the Sabine, Calcasieu, and Mermentau River systems, all of which cross Cameron Parish and empty into the Gulf of Mexico within the Parish boundaries. Because of the flat terrain and inadequate drainage, many areas are also susceptible to shallow flooding or ponding during rainfalls.

Not all storms that pass closely to the study area produce extremely high tides. Similarly, storms that produce extreme conditions in one area may not produce critical conditions in other locations. The rainfall that usually accompanies hurricanes can aggravate the tidal flooding.

Brief descriptions of several significant tropical storms and hurricanes are presented below to provide historical information to which coastal and riverine flood hazards and flood depths can be compared.

August 5 - 24, 1915

This hurricane, which originated in the Cape Verde region of the African coast, advanced through the Yucatan Channel and proceeded north across the Gulf of Mexico (Reference 8). The storm caused high tides along the Gulf Coast, from a point approximately 100 miles west of Galveston to the vicinity of New Orleans, although the center never came within 100 miles from the Louisiana coast. There were tides in Louisiana of 10 feet at Grand Chenier, 10.3 feet at Cameron, 5 feet at Pecan Island, 9.5 feet at Marsh Island, 6 feet at Hackberry, and 11 feet at Calcasieu, near Cameron.

August 2 - 10, 1940

This tropical disturbance, originating in the Atlantic Ocean on August 2, 1940, followed an unusual path across Florida and the northern Gulf Coast, moving inland again near Port Arthur on August 7, 1940 (Reference 8). It was accompanied by high tides and torrential rains in Louisiana; it produced tides of 4.8 feet at Calcasieu Pass in the vicinity of Cameron, and 4.3 feet near Sabine. The rains produced extremely high stages in tidal streams several days after the passage of the storm. A stage of particular note was that of 6.7 feet, which occurred on the Calcasieu River at Lake Charles on August 10, 1940. Flooding was extensive in all coastal parishes, and in several inland parishes. Many people were marooned and thousands were evacuated to higher ground. The high winds and heavy rains caused extensive damage to crops, homes, and utilities. Muskrat losses were heavy, and estimates of livestock drowned or lost ran as high as 75,000 head. Six persons lost their lives, and damages from wind, tide, and rain were estimated at more than \$6 million.

September 27 - October 6, 1949

This storm developed off the west coast of Central America, crossed the Yucatan Peninsula, and moved into the western Gulf of Mexico (Reference 8). It attained hurricane force when it reached the Texas coast near Freeport. The lowest pressure was 28.88 inches at Freeport; winds reached speeds of 100 miles per hour (mph). This hurricane produced heavy rainfall in Texas and Louisiana. Several stations received over 10 inches.

June 25 - 28, 1957 (Hurricane Audrey)

This was one of the most devastating hurricanes to strike the west Louisiana coast (Reference 9). Cameron was at the extreme eastern edge of the calm center, where the maximum and most swiftly rising tides are generated. The maximum tide reported at Cameron was 10.6 feet. However, later investigations have shown that winds drove these tides to elevations of 12 and 12.5 feet, at points 1 to 4 miles inland. Over 80 percent of the Parish was flooded. More than 550 lives were lost, mainly because people failed to evacuate the coast in time to escape the rapidly rising waters. Offshore waves were reported as high as 45 to 50 feet, and waves striking Cameron were reported to be 18 to 20 feet above sea level. Winds were reported at speeds of up to 105 mph at Cameron.

In addition to the heavy loss of life, 40,000 cattle were destroyed and more than 2,200 buildings (including 1,500 homes) were seriously damaged. The total damages within the Parish were estimated at \$30,749,300. Tidal overflow was responsible for \$29,368,800 in damages; the remaining damage was caused by wind and/or rain.

September 4 - 14, 1961 (Hurricane Carla)

Hurricane Carla moved northwestward from the western Caribbean Sea on September 4, 1961, and through the Yucatan Channel on September 7, 1961 (Reference 10). The hurricane reached the Texas coast during the afternoon of September 11, 1961. However, by September 9, 1961, Hurricane Carla's circulation enveloped the entire Gulf of Mexico, with fringe effects felt by all the Gulf Coast States; reconnaissance aircraft estimated maximum winds near the center at 135 mph. On September 10, 1961, wind estimates rose to 150 mph.

In Louisiana, sustained winds were generally less than 50 mph. Minimum barometric pressures of 29.55 and 29.56 inches were recorded at Cameron and Lake Charles on September 11, 1961. Tides along the Louisiana coast ranged from about 3.5 to 7.5 feet above mean sea level. Grand Chenier had a high tide of 7.5 feet, while Cameron experienced a tide of 6.6 feet.

Total damages in the Parish were estimated a \$3,987,000, consisting of tidal overflow damage of \$3,965,000 and wind damage of \$22,000.

Substantial shoaling occurred in the Calcasieu River and Calcasieu Pass Ship Channel. To the west of the Calcasieu River, the areas along the coast were buffeted by waves that either severely damage or destroyed 60 camps and residences, and washed out sections of the highway. To the east of the Calcasieu River, 61 public and commercial buildings and a few homes were flooded.

State Highway 27, from Hackberry to Holly Beach, was under 1 to 3 feet of water from September 10 – 14, 1961. State Highway 82, from the Sabine River to the Calcasieu River, and at several locations between Cameron and Pecan Island, was covered by 2 to 3 feet of water from September 9 - 14, 1961. The State Highway 27 pontoon swing bridge over the Gulf Intracoastal Waterway, east of the Calcasieu River, was closed to marine traffic from 8:15 p.m. September 9, 1961, until 4:50 p.m. September 12, 1961.

September 5 - 17, 1971 (Hurricane Edith)

Hurricane Edith began as a tropical storm and made landfall three times (Reference 8). Nicaragua and Honduras were hit first, British Honduras and the Yucatan Peninsula were hit second, and the Louisiana coast between Grand Chenier and the Rockefeller Wildlife Refuge suffered Hurricane Edith's final landfall at 8:00 a.m. on September 16, 1971.

As the hurricane track neared the Louisiana coast on September 15, 1971, winds and tides increased. The highest wind speed measured on shore was 69 mph, with gusts of up to 96 mph at Cameron. Because of the fast forward movement of Edith, only moderate buildup of tides was experienced along the Louisiana coast. Tides generally ranged from 5.0 feet to slightly more than 8.0 feet.

Hurricane Edith produced the following maximum stages at the corresponding locations: Cameron, 4.3 feet; Grand Chenier, 5.9 feet; Freshwater Bayou Lock, 7.4 feet; and Schooner Bayou Lock, 4.6 feet.

September 18 - 26, 2005 Hurricane Rita:

Hurricane Rita was an intense hurricane that reached Category 5 strength over the central Gulf of Mexico, where it had the fourth-lowest central pressure on record in the Atlantic basin (895mb) (Reference 11). Although it weakened prior to making landfall as a Category 3 hurricane near the Texas/Louisiana border, Hurricane Rita produced significant storm surge that devastated coastal communities in southwestern Louisiana, and its winds, rain, and tornadoes caused fatalities and a wide swath of damage from eastern Texas to Alabama.

Despite having weakened, Hurricane Rita was still a large Category 3 hurricane at landfall and produced a very significant storm surge in southwestern Louisiana, an area very vulnerable to surge. Since so many structures were completely destroyed, and because many gages failed several hours before the center of the hurricane crossed the coast, only a few high water marks have been collected and analyzed under the direction of FEMA. These data along with unofficial, visual estimates suggest that the storm surge in portions of Cameron Parish, Louisiana was as high as about 15 feet. Water was also pushed into Calcasieu Lake, flooding portions of communities along its shoreline with a storm surge of at least 8 feet. The surge then propagated up the Calcasieu River and flooded portions of the Lake Charles area, where in several locations the surge reached Interstate 10. Floodwaters in downtown Lake Charles were as deep as 6 feet in some places. Farther east, most or all of Vermilion, Iberia, and St. Mary Parishes south of State Highway 14 and U.S. Highway 90 were inundated by the storm surge, visually estimated at 8-12 feet in some of these areas; a high water mark of nearly 12 feet was also observed in western St. Mary Parish near the Town of Louisa. The water crossed these highways in numerous locations and was 3 to 6 feet deep in many homes. The storm surge of Rita devastated entire communities in coastal areas of southwestern Louisiana, including

Holly Beach, Cameron, Creole, and Grand Chenier in Cameron Parish. Almost every structure in these areas was destroyed, and some were completely swept away. Severe beach erosion occurred at Holly Beach. Several miles inland from the Gulf along Calcasieu Lake, numerous homes in the town of Grand Lake were damaged or destroyed. Many portions of the Lake Charles area suffered substantial flood damage, including downtown and some surrounding residential communities. Storm surge damage to homes and businesses in low-lying areas extended eastward along the entire coast of Louisiana.

The approach of Hurricane Rita provoked one of the largest evacuations in U. S. history. Hurricane Rita caused wide swaths of downed trees and power lines, leaving well over one million customers in these areas without electrical service. Oil and gas production and refining in the northwestern Gulf of Mexico region was disrupted by Hurricane Rita (largely due to evacuations), but the impacts were not as severe as that farther east due to Hurricane Katrina. The most recent available estimate by the American Insurance Services Group of the insured property damage in the U.S. caused by Hurricane Rita is \$5.05 billion. Doubling this figure to account for uninsured losses yields a rough estimate for total damage of about \$10 billion.

2.4 Flood Protection Measures

Nonstructural flood protection measures in the Parish consist of the Cameron Parish Police Ordinance entitled "An Ordinance Providing for Flood Insurance Requirements", dated August 2, 1977, and amended September 5, 1977 (Reference 12). This ordinance places controls on the types of development and activities that are permissible in the floodplain.

Major hurricane disasters have occurred in Cameron Parish because of its location on the coast and low ground elevations. The Parish government has now minimized the potential for loss of life during hurricanes by organizing prompt evacuations. Local officials receive weather information from the National Weather Service (NWS) in Lake Charles, LA. Because of the Parish's geographical location and topography, however, the only method of protection available to the public during hurricanes is evacuation; there is a lack of adequate emergency shelters.

3.0 **ENGINEERING METHODS**

For the flooding sources studied by detailed methods 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 once on the average during any 10-, 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-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent-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 1-percent-annual-chance (100-year) flood in any 50-year period is approximately 40 percent (4 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.

3.1 Coastal Analyses

The hydraulic characteristics of flooding from the sources studied were analyzed to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown in the coastal data tables and flood profiles in the FIS report.

3.1.1 Storm Surge Analysis and Modeling

For areas subject to tidal inundation, the 10-, 2-, 1-, and 0.2-percent-annual-chance stillwater elevations and delineations were taken directly from a detailed storm surge study documented in the Technical Study Data Notebook (TSDN) for this new Louisiana coastal flood hazard study.

The Advanced Circulation model for Coastal Ocean Hydrodynamics (ADCIRC) developed by the USACE, was selected to develop the stillwater elevations or storm surge levels for coastal Louisiana. ADCIRC uses an unstructured grid and is a finite-element long wave model. ADCIRC has the capability to simulate tidal circulation and storm surge propagation over large areas and is able to provide highly detailed resolution along the shorelines and areas of interest along the open coast and inland bays. It solves three dimensional equations of motion, including tidal potential, Coriolis, and nonlinear terms of the governing equations. The model is formulated from the depth averaged shallow water equations for conservation of mass and momentum which results in the generalized wave continuity equation.

Nearshore waves are required to calculate wave runup and overtopping on structures, and the wave momentum (radiation stress) contribution to elevated water levels (wave setup). The numerical model STWAVE was used to generate and transform waves to the shore. STWAVE is a finite-difference model that calculates wave spectra on a rectangular grid. The model outputs zero-moment wave height, peak wave period (T_p), and mean wave direction (α_m) at all grid points and two-dimensional spectra at selected grid points. STWAVE includes an option to input spatially variable wind and surge fields. The surge significantly alters the wave transformation and generation for the hurricane simulations in shallow areas and where low-lying areas are flooded.

STWAVE was applied on several grids for the Southern Louisiana area. The input for each grid includes the bathymetry (interpolated from the ADCIRC domain), surge fields (interpolated from ADCIRC surge fields), and wind (interpolated from the ADCIRC wind fields, which apply land effects to the OWI wind fields). The wind applied in STWAVE is spatially and temporally variable for all domains. STWAVE was run at 30-minute intervals.

An existing ADCIRC grid mesh developed by the USACE was refined along the shoreline of Mississippi and surrounding areas using bathymetric and

topographic data from various sources. Bathymetric data consisted of ETOPO5 and Digital Nautical Charts databases in the offshore regions. In the nearshore areas, bathymetric data came from regional bathymetric surveys conducted by the USACE. The topographic portion of the ADCIRC mesh was populated with topographic light detection and ranging (LIDAR) from several sources. In addition, subgrid sized features such as roads and levees were captured in the grid and modeled as weirs. Further details about the terrain data and how it was processed can be found in the TSDN.

The completed ADCIRC grid mesh resulted in a finite element model coded with over 2,200,000 grid nodes. The NOAA high definition vector shoreline was used to define the change between water and land elements. The grid includes other features, such as islands, roads, bridges, open waters, bays, and rivers. Field reconnaissance detailed the significant drainage and road features, and documentation of coastal structures in the form of seawalls, bulkheads, and harbors. The National Land Cover Dataset was used to define Manning's n values for bottom roughness coefficients input at each node in the mesh. A directional surface wind roughness value was also applied. Further details about the ADCIRC mesh creation and grid development process can be found in the TSDN.

Predicted tidal cycles were used to calibrate the ADCIRC model and refine the grid. Tidal boundary conditions were obtained from a total of 40 NOAA tide gauges. Seven tidal constituents were used (K1, O1, Q1, M2, S2, N2, and K2). The simulated water-surface elevation time series was compared to measured tides from tide gauge stations for over a 30-day period. Model validation, which tests the model hydraulics and ability to reproduce events, was performed against Hurricanes Katrina (2005), Rita (2005), and Andrew (1993). Simulated water levels for each event were compared to observed water levels from NOAA tidal gauges, as well as available high water marks. Further details about the model calibration and validation can be found in the TSDN.

Production runs were carried out with STWAVE and ADCIRC on a set of hypothetical storm tracks and storm parameters in order to obtain the maximum water levels for input to the statistical analysis. The hypothetical (synthetic) population of storms was divided into two groups, one for hurricanes of Saffir-Simpson scale Category 3 and 4 strength or "greater storms" and another set for hurricanes of Category 2 strength or "lesser storms." A total of 304 individual storms with different tracks and various combinations of the storm parameters were chosen for the production run set of synthetic hurricane simulations. Each storm was run for at least 3 days of simulation and did not include tidal forcing. Wind and pressure fields obtained from the PBL model and wave radiation stress from the STWAVE model were input to the ADCIRC model for each production storm. All stillwater results for this study include the effects of wave setup. Maximum water-surface was output at every ADCIRC grid point that was wetted by a model storm. This resulted in more than 1,000,000 locations where statistical methods were applied to obtain return periods of the stillwater elevation. A Triangular Irregular Network (TIN) was created to represent the stillwater surface based on the density of the output points from ADCIRC. Further details about the production run process can be found in the TSDN.

3.1.2 Statistical Analysis

The Joint Probability Method (JPM) was used to develop the stillwater frequency curves for the 10-, 2-, 1-, and 0.2-percent-annual-chance stillwater elevations. The JPM approach is a simulation methodology that relies on the development of statistical distributions of key hurricane input variables such as central pressure, radius to maximum wind speed, maximum wind speed, translation speed, track heading, etc., and sampling from these distributions to develop model hurricanes. The resulting simulation results in a family of modeled storms that preserve the relationships between the various input model components, but provides a means to model the effects and probabilities of storms that historically have not occurred. The JPM approach was modified for this coastal study based on updated statistical methods developed by FEMA and the USACE for Mississippi and Louisiana.

Due to the excessive number of simulations required for the traditional JPM method, the Joint Probability Method-Optimum Sampling (JPM-OS) was utilized to determine the stillwater elevations associated with tropical events. JPM-OS is a modification of the JPM method developed cooperatively by FEMA and the USACE for Mississippi and Louisiana coastal flood studies that were being performed simultaneously, and is intended to minimize the number of synthetic storms that are needed as input to the ADCIRC model. The methodology entails sampling from a distribution of model storm parameters (e.g., central pressure, radius to maximum wind speed, maximum wind speed, translation speed, and track heading) whose statistical properties are consistent with historical storms impacting the region, but whose detailed tracks differ. The methodology inherently assumes that the hurricane climatology over the past 60 to 65 years (back to 1940) is representative of the past and future hurricanes likely to occur along the Louisiana coast.

3.1.3 Stillwater Elevations

The results of the ADCIRC model, as described above, provided stillwater elevations, including wave setup effects that are statistically analyzed to produce probability curves. The JPM-OS is applied to obtain the return periods associated with tropical storm events. The approach involves assigning statistical weights to each of the simulated storms and generating the flood hazard curves using these statistical weights. The statistical weights are chosen so that the effective probability distributions associated with the selected greater and lesser storm populations reproduce the modeled statistical distributions derived from all historical storms.

Stillwater elevations for each Louisiana coastal parish, obtained using the ADCIRC and JPM-OS models, are provided for JPM and ADCIRC grid node locations for the 10-, 2-, 1-, or 0.2-percent-annual-chance return period stillwater elevations in the TSDN

3.1.4 Wave Height Analysis

Areas of coastline subject to significant wave attack are referred to as coastal high hazard zones. The USACE has established the 3-foot breaking wave as the criterion for identifying the limit of coastal high hazard zones (Reference 13). The 3-foot wave has been established as the minimum size wave capable of causing major damage to conventional wood frame and brick veneer structures.

Figure 1 shows a profile for a typical transect illustrating the effects of energy dissipation and regeneration on a wave as it moves inland. This figure shows the wave crest elevations being decreased by obstructions, such as buildings, vegetation, and rising ground elevations, and being increased by open, unobstructed wind fetches. Figure 1 also illustrates the relationship between the local stillwater elevation, the ground profile, and the location of the V/A boundary. This inland limit of the coastal high hazard area is delineated to ensure that adequate insurance rates apply and appropriate construction standards are imposed, should local agencies permit building in this coastal high hazard area.

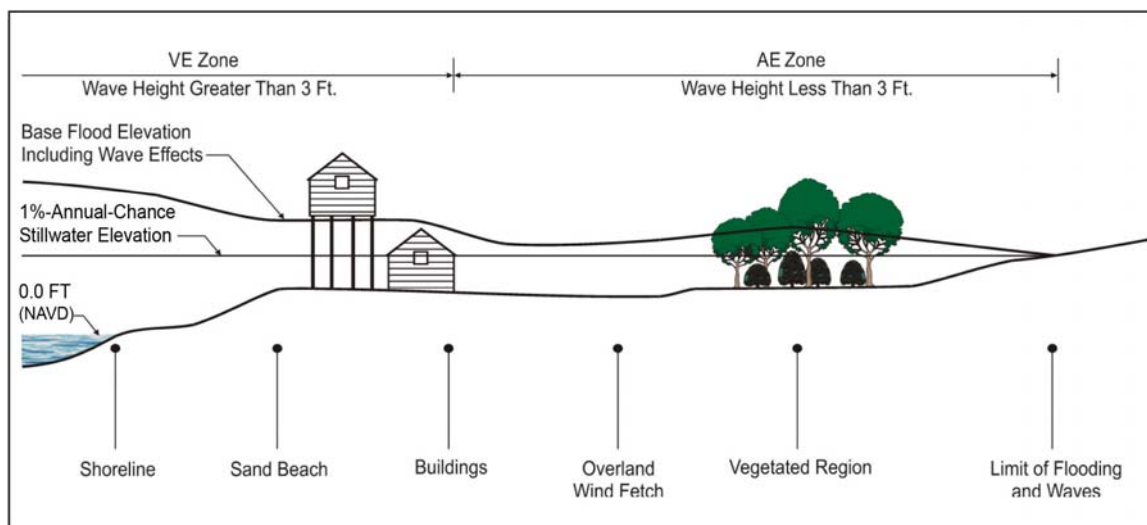


Figure 1. Transect Schematic

Offshore wave characteristics were determined by performing a peaks-over-threshold analysis of the hindcast data obtained from the Wave Information Studies (Reference 14). Wave conditions were determined at each WIS station and shoreline values were calculated through a wave shoaling analysis. The recommended wave-height-over-water-depth coefficient for sandy bottoms typical of those found along the Cameron Parish's nearshore is 0.78. According to Suhayda, 1984 (Reference 15), dampening of wave action due to muddy bottoms is negligible west of the Vermilion Parish-Cameron Parish line. In order to apply a gradual change in wave breaking conditions across the Vermilion Parish-Cameron Parish line, the wave-height-over-water-depth coefficients applied along the eastern end of Cameron Parish range from 0.74 to 0.78.

FTN/Taylor analyzed alternate transects along White Lake's West shores and along Grand Lake, Calcasieu Lake and Sabine Lake's shores to identify wave heights that may have higher values than transects originating at the Gulf of Mexico. For transects starting

along any of the lakes' shorelines, starting wave conditions representing 1-percent-annual-chance flood events were calculated applying FEMA's wave model WHAFIS 4.0 (Reference 13). The fetch was determined as the distance across each lake, based on the location and orientation of each transect. However, none of the alternate transect analyses for any of the lakes justified adding transects to the FIRM panels.

The transects for this study were located considering the physical and cultural characteristics of the land so that they would closely represent conditions in their locality. Transects were spaced closely together along Cameron Bay. In areas having more uniform characteristics, the transects were spaced at larger intervals. Transects are also located in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects. Transects are shown on the respective FIRM panels for the parish.

The topographic information applied in transect profiles was obtained from LiDAR data collected by the State of Louisiana and FEMA between 2003 and 2005 (Reference 16). The bathymetric data for White Lake, Grand Lake, Calcasieu Lake, and Sabine Lake was obtained from the STWAVE grid elevations applied by the USACE in the wave setup computation. The topographic data is referenced to NAVD88.

The Louisiana GAP Analysis (Reference 17), developed by the USGS, served as the primary source for the spatial distribution of vegetative cover. Aerial imagery and field reconnaissance were applied to verify the Louisiana GAP Analysis data. The imagery, collected from late October 2005 through November 2005, was applied to verify features such as buildings, forested vegetation, and marsh grass for input to the wave height models. Detailed information about the features, such as building types and density and vegetation types was gathered during a ground field reconnaissance.

No storm-induced erosion analysis was performed for this study. Primary frontal dune mapping was not applied.

Wave height calculation used in this study follows the methodology described in the Appendix D of the 2003 FEMA Guidelines and Specifications for Flood Hazard Mapping Partners (Reference 18). WHAFIS 4.0 was applied to calculate overland wave height propagation and establish base flood elevations. In addition to the 1-percent-annual-chance event, the 0.2-percent-annual-chance event was also modeled with WHAFIS 4.0.

Stillwater elevations were applied to each ground station along a transect and input to WHAFIS. The stillwater elevations were obtained from the storm surge study, using the stillwater TIN. Wave setup was not calculated separately because wave setup was included in the base stillwater elevations from the storm surge analysis.

Wave runup analysis was not performed for this study. Wave runup mapping was not applied.

Along each transect, wave envelopes were computed considering the combined effects of changes in ground elevation, stillwater surface elevation (including wave setup), vegetation, and physical features. Between transects, elevations were interpolated using topographic maps, land-use and land-cover data, and engineering judgment to determine the aerial extent of flooding. The results of the calculations are accurate until local topography, vegetation, or cultural developments within the community undergo major

changes. The transect data for each transect in the parish, including the flood hazard zone, base flood elevations, transect location description, 1-, and 0.2-percent-annual-chance stillwater elevations at the start of the transect and the range found along the length of the transect is provided in the TSDN.

3.2 Vertical Datum

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 (NGVD). With the completion of the North American Vertical Datum of 1988 (NAVD 88), many FIS reports and FIRMs are now prepared using NAVD as the referenced vertical datum.

Flood elevations shown in this FIS report and on the FIRM are referenced to the NAVD. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. Some of the data used in this revision were taken from the prior effective FIS reports and FIRMs and adjusted to NAVD 88. The datum conversion factor from NGVD 29 to NAVD 88 in Cameron Parish is +0.06 feet. The maximum offset is +0.14 feet, therefore the conversion is passive.

For additional information regarding conversion between NGVD and NAVD, visit the National Geodetic Survey (NGS) website at www.ngs.noaa.gov, or contact the NGS at the following address:

Vertical Network Branch, N/CG13
National Geodetic Survey, NOAA
Silver Spring Metro Center 3
1315 East-West Highway
Silver Spring, Maryland 20910
(301) 713-3191

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 Technical Support Data Notebook associated with the FIS report and FIRM for this community. Interested individuals may contact FEMA to access these data.

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

4.0 **FLOODPLAIN MANAGEMENT APPLICATIONS**

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS report provides 1-percent-annual-chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent-annual-chance flood elevations; delineations of the 1- and 0.2-percent-annual-chance

floodplains; and a 1-percent-annual-chance floodway. This information is presented on the FIRM and in many components of the FIS report. Users should review the data presented in the FIS report as well as additional information that may be available at the local map repository before making flood elevation and/or floodplain boundary determinations

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1 inch = 1,000 feet, with a contour interval of 2 feet (Reference 16).

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM. On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, AO, and VE), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-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.

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by detailed methods. Whole-foot Base Flood Elevations (BFEs) derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone V

Zone V is the flood insurance rate zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no BFEs are shown within this zone.

Zone VE

Zone VE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent-annual-chance floodplain, areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent-annual-chance flood by levees. No BFEs or depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP (FIRM)

The FIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 1-percent-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use the zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1-percent and 0.2-percent-annual-chance floodplains, floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

Historical data relating to the maps prepared for each community are presented in Table 1. "Community Map History."

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE (S)	FIRM EFFECTIVE DATE	FIRM REVISION DATE (S)
Cameron Parish (Unincorporated Areas)	September 4, 1970		September 4, 1970	April 16, 1991

FEDERAL EMERGENCY MANAGEMENT AGENCY

CAMERON PARISH, LA
AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

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7.0 OTHER STUDIES

FIS studies are ongoing for Vermilion Parish, LA, which borders Cameron Parish to the east, Calcasieu Parish, LA, which borders Cameron Parish to the north, Jefferson County, TX, which borders Cameron Parish to the west, and Orange County, TX, which borders Cameron Parish to the northwest.

This report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the NFIP.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting FEMA Region VI, Federal Insurance and Mitigation Division, 800 North Loop 288, Denton, Texas 76209.

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