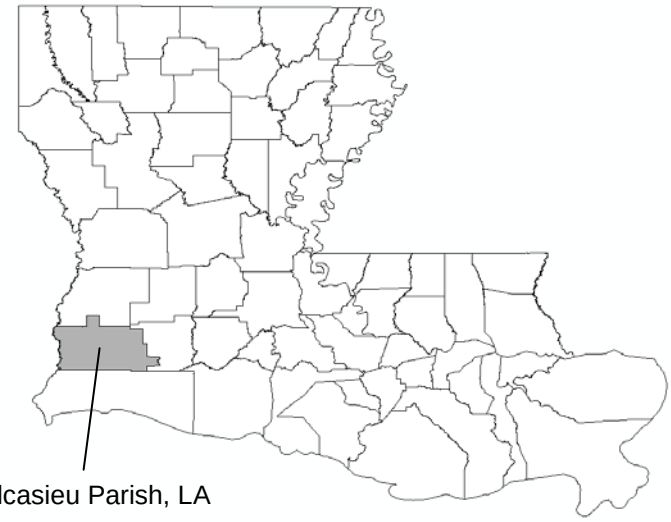
FLOOD INSURANCE STUDY

CALCASIEU PARISH, LOUISIANA

AND INCORPORATED AREAS
VOLUME 1 OF 2

Community Name	Community Number
CALCASIEU PARISH (UNINCORPORATED AREAS)	220037
DEQUINCY, CITY OF	220038
IOWA, TOWN OF	220039
LAKE CHARLES, CITY OF	220040
SULPHUR, CITY OF	220041
VINTON, TOWN OF	220042
WESTLAKE, CITY OF	220043



This Preliminary FIS report only includes revised Floodway Data and Flood Profiles.

The unrevised Floodway Data and Flood Profiles will appear in the final FIS report.

REVISED: **PRELIMINARY**
February 29, 2016

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
22019CV001B

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.

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: February 8, 2011

Revised Parishwide FIS Date: [TBD]

This Preliminary FIS report only includes revised Floodway Data and Flood Profiles. The unrevised Floodway Data and Flood Profiles will appear in the final FIS report.

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FLOOD INSURANCE STUDY
CALCASIEU 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 Calcasieu Parish, including the Cities of DeQuincy, Lake Charles, Sulphur and, Westlake; the Towns of Iowa, and Vinton; and the unincorporated areas of Calcasieu Parish (referred to collectively herein as Calcasieu 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 report are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The original hydrologic and hydraulic analyses for the riverine and coastal flooding sources in the parish were prepared by the U.S. Army Corps of Engineers (USACE) for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. IAA-H-15-72, Project Order No. 18. This work was completed in August 1973. The analyses were updated by Tetra Tech, Inc., for FEMA, under Contract No. H-4788; this work was completed in September 1982. The hydrologic and hydraulic analyses for the Sabine River were updated by Tetra Tech, Inc.; this work was completed in November 1985.

Revisions to the hydrologic and hydraulic analyses for the parish were performed by Owen and White, Inc., for FEMA, under Contract No. EMW-94-C-4516. Aerial photography and land surveys were carried out by Aero Data Corporation and Maptech, Inc., respectively. This work was completed in September 1995.

The original hydrologic and hydraulic analyses for the City of DeQuincy were performed by the New Orleans District, USACE, for the Federal Insurance Administration under Interagency Agreement No. IAA-H-16-75, Project Order No. 20. This work was completed in May 1977.

The original hydrologic and hydraulic analyses for the Town of Iowa were prepared by Professional Engineering Consultants Corporation for FEMA, under Contract No. EMW- 84¬R-1622. The work for that study was completed in September 1986. Revisions to the hydraulic analyses were prepared by D.W. Jessen & Associates for FEMA. This revision was completed in August 1989.

The original riverine and coastal analyses for the City of Lake Charles were prepared by the USACE for FEMA under Inter-Agency Agreement No. IAA-H-2-73, Project Order No. 8. That work was completed in August 1973. Updated coastal analyses were prepared by Tetra Tech, Inc., for FEMA, under Contract No. H-4788. That work was completed in September 1982. The revised hydraulic analyses for Kayouche Coulee were prepared by Dewberry & Davis under agreement with FEMA. The revised hydrologic analyses for Kayouche Coulee were prepared by the New Orleans District of the USACE.

Revised hydrologic and hydraulic analyses for the City of Lake Charles were performed by the USACE, New Orleans District, for FEMA, under Interagency Agreement No. EMW-95-E-4759. This work was completed in September 1996.

The original hydrologic and hydraulic analyses for the City of Sulphur were prepared by Professional Engineering Consultants Corporation for FEMA, under Contract No. EMW-84-R-1622. This work was completed in January 1986.

The original hydrologic and hydraulic analyses for the Town of Vinton were performed by Pyburn & Odom, Inc., for the Federal Insurance Administration, under Contract No. H-4813. This study was completed in April 1980.

The original hydrologic and hydraulic analyses for the City of Westlake were performed by Pyburn & Odom, Inc., for the City of Westlake were performed by Pyburn & Odom, Inc., for FEMA under Contract No. H-4813. This study was completed in May 1980.

The new detailed and enhanced approximate hydrologic and hydraulic analyses for this study were performed by Watershed Concepts, for FEMA, under Contract No. EMT-2001-CO-0029. This study was completed in February 2005.

The new detailed hydrologic and hydraulic analyses for the coastal analyses and the Bayou Choupique Restudy were performed by FTN/Taylor Joint Venture, for FEMA under Contract No. EMT-2002-CO-0050, Task Order No. J023. This study was completed in October 2006.

The DFIRM and FIS report for this study were revised by Watershed VI Alliance for FEMA under Contract No. EMT-2002-CO-0048, Task Order No. J032.

1.3 Coordination

The results of the study were reviewed at the final Consultation Coordination Officer (CCO) meeting held on June 18, 2008, and attended by representatives of FEMA, study contractor and community officials. All problems raised at that meeting have been addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS report covers the geographic area of Calcasieu Parish, Louisiana including the incorporated communities listed in Section 1.1.

The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction through March 2003.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon, by FEMA and community officials.

The flooding sources studied by detailed riverine methods along with the limits of study are shown in Table 1 "Streams Studied by Detailed Methods". "Streams Redelineated on updated topography" are presented in Table 2.

Table 1: Streams Studied by Detailed Methods

Stream Name	Downstream Limit	Upstream Limit	Length (mi)
Bayou Choupique	Dave Dugas Road	Approximately 0.8 mile upstream of Southern Pacific Railroad	6.3
Bayou Contraband	Confluence with Calcasieu River	Upstream of Gerstner Memorial Boulevard / Hwy LA 14	6.9
South Branch Bayou Contraband	Confluence with Bayou Contraband	0.2 miles upstream of Morningside Drive	1.2
East Branch Bayou Contraband	Confluence with Bayou Contraband	0.2 miles upstream of Hwy LA 3092	1.5

Table 2: Streams Redelineated on Updated Topography

Stream Name	Downstream Limit	Upstream Limit	Length (mi)
30 W. Main Lateral	Confluence with Houston River	Approximately 0.2 mile upstream of Section Line 13/24	1.9
Addison Lateral	Gauthier Road, Mile 3.0	Tom Herbert Road, Mile 4.1	1.1
Airport Lateral	Gauthier Road, Mile 3.0	Pool Area upstream of confluence with Greathouse Lateral, Mile 4.8	1.8
Amoco Lateral	Gauthier Road	Southern Pacific Railroad	3.7
Antoine Gully	Confluence with English Bayou, Mile 0	At private road approximately 0.7 mile upstream of McCown Road	3.4
Bayou Choupique	Confluence with Gulf Intracoastal Waterway, Mile 0	Dave Dugas Road	6.4
Bayou d'Inde	Confluence with Calcasieu River, Mile 0	Interstate Highway 10, Mile 7.1	7.1
Bayou d'Inde Lateral	Confluence with Bayou d'Inde	Houston River Canal	1.7
Bayou Lacassine	Boundary of Jefferson Davis Parish, Mile 17.8	Loraine Road, Mile 23.5	5.7
Bayou Marino	Confluence with Calcasieu River, Mile 0	Approximately 0.1 mile upstream of Sampson Street	1.3
Bayou Verdine	Confluence with Calcasieu River, Mile 0	Louisiana Highway 379	5.8
Bear Head Creek	Confluence with the Houston River, Mile 0	Mile 6.5	6.5
Belfield Lateral	Confluence with Little Indian Bayou, Mile 0.0	Upstream of Joe Miller Road	1.2
Bellvue Lateral	Confluence with West Fork English Bayou	Metzger Road	1.7
Black Bayou	Gauthier Road, Mile 11.7	LA Highway 14, Mile 13.1	1.4

Table 2: Streams Redelineated on Updated Topography (continued)

Buxton Creek	Approximately 2.5 miles downstream of Louisiana Highway 27	Upstream of Railroad, Mile 17.3	6.1
Calcasieu River	Boundary of Cameron Parish, Mile 19.7	Confluence of English Bayou	39.9
Calcasieu River Tributary	Confluence with Calcasieu River, Mile 0	Weaver Road, Mile 2.62	2.6
Diamond Gully	Confluence with Belfield Lateral	Approximately 1.3 mile upstream of U.S. Highway 171	1.8
Dick Arkel Lateral	Confluence with Gilbert Lateral	City of Sulphur Corporate Limits approximately 0.6 mile upstream of W. Burton Street	1.9
East Fork English Bayou	Confluence with English Bayou, Mile 0	U.S. Route 90, Mile 2.9	2.9
English Bayou	Confluence with Calcasieu River, Mile 0	Confluence of East Fork English Bayou, Mile 9.5	9.5
Fairground Lateral	Confluence with Bayou d'Inde Lateral	Approximately 0.3 mile upstream of confluence of Lateral 2B West	1.6
Gilbert Lateral	Confluence with Bayou d'Inde	City of Sulphur Corporate Limits approximately 0.4 mile upstream of the divergence of Bayou d'Inde	4.2
Gillis Lateral	Confluence with Little Indian Bayou	Parish Boundary	2.4
Greathouse Lateral	Gauthier Road, Mile 0.4	Pool Area upstream of confluence with Airport Lateral, Mile 1.0	0.6
Hampton Coulee	Courville Road	Town of Vinton Corporate Limits approximately 0.9 mile upstream of West Street	2.9
Herbert Lateral	Approximately 1.4 miles upstream of Houston River	Myrtle Springs Road	1.2
Higgins Lateral	Confluence with Black Bayou, Mile 0.0	Tom Herbert Road, Mile 1.7	1.7
Houston River	Confluence with West Fork Calcasieu River, Mile 0	Confluence of Bear Head Creek, Mile 30.5	30.5
Houston River Tributary	Confluence with Houston River, Mile 0	Parish Road, Mile 1.82	1.8
Indian Bayou	Confluence with West Fork Calcasieu River, Mile 0	Parish Boundary	9.9
Kayouche Coulee	Confluence with English Bayou, Mile 0	Prien Lake Road, Mile 5.8	5.8
Kinner Gully	Confluence with English Bayou, Mile 0	Mar LeBleu Road, Mile 5.8	5.8
Lateral 14	Approximately 2.5 miles upstream of the confluence with East Fork English Bayou	Approximately 0.3 mile upstream of US Highway 90	2.8
Lateral 14-1	Confluence with Lateral 14	Approximately 0.2 mile upstream of confluence with Lateral 14	0.2

Table 2: Streams Redelineated on Updated Topography (continued)

Lateral 14-2	Confluence with Lateral 14	Upstream of W. Miller Street	0.2
Lateral 14-3	Confluence with Lateral 14	Upstream of E. Miller Street	0.3
Lateral 14-4	Confluence with Lateral 14	Approximately 0.7 mile upstream confluence of Lateral 14	0.7
Lateral 14B	Downstream of Town of Iowa Corporate Limits	South Thompson Avenue	1.1
Lateral 14B-2	Confluence with Lateral 14B	Approximately 0.6 mile upstream of US Highway 90	0.7
Lateral 2B East	Confluence with Bayou d'Inde Lateral	Old Louisiana Highway 27	0.9
Lateral 2B West	Fairgrounds Lateral	Old Louisiana Highway 27	0.2
Lateral A of Maple Fork Bayou	Confluence with Maple Fork Bayou	Approximately 0.4 mile upstream of West Lee Ave.	0.8
Lateral B of Maple Fork Bayou	Confluence with Maple Fork Bayou	Approximately 0.2 mile upstream of Beauregard Ave.	0.5
Le Bleu Canal	Confluence with Bayou Arceneaux, Mile 0.0	Parish Barn Road, Mile 3.9	3.9
Little Bayou	Confluence with Bayou Contraband	West 18th Street	0.9
Little Bayou d' Inde	Confluence with Bayou d'Inde, Mile 0	Approximately 0.2 mile upstream of Patton Street	2.3
Little Bayou d' Inde Tributary	Confluence with Little Bayou d'Inde, Mile 0	Wright Road	0.7
Little Indian Bayou	Confluence with Indian Bayou, Mile 0.0	Approximately 0.9 mile upstream of Birdnest Road	6.8
Lower West Fork Buxton Creek	Confluence with Buxton Creek, Mile 0	Approximately 0.2 mile upstream of South Division Street	1.3
Manchester Lateral	Confluence with West Fork English Bayou	McCown Road	0.5
Maple Fork Bayou	Interstate Highway 10	Reeves Road	3.1
McFillen Lateral	Gauthier Road, Mile 0.5	Approximately 0.4 mile upstream of Marty Lane, Mile1.7	1.2
Pithon Coulee	Confluence with Calcasieu River (Lake Charles)	Approximately 0.3 mile upstream of W. 6th Street	5.6
Sabine River	Boundary of Cameron Parish, Mile 3.6	Boundary of Beauregard Parish, Mile 52.9	46.3
Sturrock Lateral	Confluence with Indian Bayou	Approximately 0.2 mile upstream of Hickory Branch Road	1.7
Sumpter Bayou	Confluence with Gilbert Lateral	City of Sulphur Corporate Limits approximately 0.1 mile upstream of Drost Street	1.3
Upper East Fork Buxton Creek	Confluence with Buxton Creek, Mile 0	Mile 1.9	1.9
Upper West Fork Buxton Creek	Confluence with Buxton Creek	Mile 2.5	2.5
Upper West Fork Tributary	Confluence with Upper West Fork Buxton Creek	Mile 0.4	0.4

"Streams Studied by Enhanced Approximate Methods" are presented in Table 3.

Table 3: Streams Studied by Enhanced Approximate Methods

Stream Name	Downstream Limit	Upstream Limit	Length (mi)
Bayou Arceneaux	Confluence with Bayou Serpent	Calcasieu Parish/Jefferson Davis Parish Boundary	4.1
Bayou Contraband Tributary 1	Confluence with Bayou Contraband	Approximately 0.1 Miles upstream of Country Club Road	1.6
Bayou Guy	Confluence with Bayou Guy Tributary 1	Approximately 0.2 Miles downstream of Elliott Road	1.0
Bayou Guy Tributary1	Confluence with Bayou Guy	Approximately 0.5 Miles upstream of Gauthier Road	1.5
Bayou Serpent	Confluence with Calcasieu River	Calcasieu Parish/Jefferson Davis Parish Boundary	7.6
Bear Head Creek Tributary 1	Confluence with Bear Head Creek	Approximately 0.9 Miles upstream of LA Hwy 12	4.2
Beckwith Creek	Confluence with Hickory Branch	Calcasieu Parish/Beauregard Parish Boundary	7.5
Black Bayou	Upstream of LA Hwy 14	Downstream of LA Hwy 397	1.8
Blackman Bayou	Approximately 1.9 miles upstream of Calcasieu River	Approximately 3.4 miles upstream of Calcasieu River	1.5
Buxton Creek	Confluence with Houston River	Approximately 0.6 Miles upstream of Kansas City RR	9.9
Buxton Creek Tributary 1	Confluence with Buxton Creek	Approximately 0.5 Miles downstream of Bud Bennett Road	3.6
Buxton Creek Tributary 2	Confluence with Buxton Creek	Approximately 0.4 miles downstream of Marcantel Road	3.0
Calcasieu River Tributary 1	Downstream of Big Lake Road	Approximately 0.3 miles upstream of Nelson Road	3.6
Chennault Lateral	Confluence with Kayouchee Coulee	Downstream of Leger Road	7.5
Cowards Gully	Confluence with Buxton Creek	Calcasieu Parish/Beauregard Parish Boundary	5.1
Cypress Creek	Confluence with Little River	Calcasieu Parish/Beauregard Parish Boundary	1.5
Henderson Bayou	Confluence with Calcasieu River/Lake Charles	Upstream of Ihles Road	1.5
Hickory Branch	Confluence with West Fork Calcasieu River	Calcasieu Parish/BeauregardParish Boundary	5.6
Hudson Lateral	Confluence with Chenault Lateral	Approximately 0.2 miles downstream of LA Hwy 397	1.8
Kayouchee Coulee	Upstream of E Prien Lake Road	Approximately 0.8 miles downstream of LA Hwy 14	2.1
L1	Confluence with Coulee Hippolyte	Downstream of Tom Herbert Road	2.8
L4B	Confluence with Kayouchee Coulee	Approximately 0.4 miles upstream of Confluence with L4C	0.4
L4C	Confluence with Kayouchee Coulee	Approximately 1.1 miles upstream of Confluence with Kayouchee Coulee	1.1

Table 3: Streams Studied by Enhanced Approximate Methods (continued)

Little Bayou D'Inde	LA Hwy 27	Downstream of I-10 Service Road	3.0
Little River	Confluence with West Fork Calcasieu River	Approximately 0.5 miles upstream of Holbrook Park Road	13.5
Marsh Bayou	Calcasieu Parish/Jefferson Davis Parish Boundary	Calcasieu Parish/Beauregard Parish Boundary	3.0
McFillen Lateral	Confluence with L1	Downstream of Gauthier Road	0.5
Old River Tributary 1	Approximately 2.0 miles downstream of Green Moore Road	Approximately 0.3 miles upstream of Jim Drake Road	6.3
Persimmon Gully	Confluence with Houston River	Calcasieu Parish/Beauregard Parish Boundary	8.4
Persimmon Gully Tributary 1	Confluence with Persimmon Gully	Upstream of LA Hwy 12	4.1
Persimmon Gully Tributary 2	Confluence with Persimmon Gully	Approximately 0.4 miles upstream of Bud Bennett Road	1.4
Persimmon Gully Tributary 3	Confluence with Persimmon Gully	Upstream of LA Hwy 12	0.5
Spring Gully	Confluence with Bayou Choupique	Upstream of Fabacher Road	6.5

Coastal flooding from the Gulf of Mexico affecting Sabine Lake/Sabine River, Calcasieu Lake/Calcasieu River, and Bayou Lacassine was also studied by detailed methods.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon, by FEMA and Watershed Concepts.

All or portions of the following flooding sources were initially studied by approximate methods: Bayou Arceneaux, Bayou d'Inde, Bayou Verdine, Bayou Serpent, Beckwith Creek, Blackman Bayou, Calcasieu River, Cowards Gully, Cypress Creek, David Bayou, Dynamite Slough, Green Island Marsh Creek, Henderson Bayou, Hickory Branch, Kinner Gully, Lateral 14-4 Tributary, Little River, Long Marsh Creek, Pithon Coulee, Sabine River, Spring Gully, and West Branch Kayouche Coulee.

All stream reaches not subsequently studied by either detailed or enhanced approximate methods were redelineated for this parish-wide update.

Mapping for Calcasieu Parish, Louisiana and Incorporated Areas has been prepared using digital data. Previously published Flood Insurance Rate Map (FIRM) and Flood Boundary and Floodway Map data produced manually have been converted to vector digital data by a digitizing process.

Table 4, "Stream Name Changes" lists those streams whose name has changed or differs from that published in the previous FIS for Calcasieu Parish or any of the communities within.

Table 4: Stream Name Changes

Community	Old Name	New Name
City of DeQuincy	Lower West Fork	Lower West Fork Buxton Creek
City of DeQuincy	Upper East Fork	Upper East Fork Buxton Creek
City of DeQuincy	Upper West Fork	Upper West Fork Buxton Creek

2.2 Community Description

Calcasieu Parish is located near the southwestern corner of Louisiana. It is bordered by the unincorporated areas of Cameron Parish, Louisiana, to the south; the unincorporated areas of Beauregard Parish, Louisiana, to the north; the unincorporated areas of Jefferson Davis Parish, Louisiana, to the east; and the City of Orange, and the unincorporated areas of Orange County and Newton County, Texas to the west.

The parish contains six incorporated communities, with a combined population of 192,768 in the 2010 Census. (Reference 1) According to the 2000 Census, the populations of the incorporated communities were: City of DeQuincy, 3,235; Town of Iowa, 2,996; City of Lake Charles, 71,993; City of Sulphur, 20,410; Town of Vinton, 3,212; and City of Westlake, 4,588 (Reference 2).

The following roads and railroads serve the parish: Interstate 10; U.S. Routes 171 and 90; and the Southern Pacific, Missouri Pacific, and Kansas City Southern Railroads.

Calcasieu Parish is situated in the lower Mississippi alluvial plain. The topography is characterized by flat marshy lowlands, meandering rivers and streams, and a maximum relief of 9 feet.

The average annual precipitation within the study area is 56.6 inches per year. (Reference 3) The mean annual temperature for Calcasieu Parish is 67.9 degrees Fahrenheit, ranging from an average high of 82.6 degrees in July to an average low of 50.9 degrees in January (Reference 4).

2.3 Principal Flood Problems

Flooding in Calcasieu Parish occurs as a result of overflow from the streams that drain it. The flood problems are compounded by low-lying and marshy surface areas that inhibit rapid drainage. Flooding also results from hurricane surge in low areas (Reference 5).

In the City of DeQuincy, low-lying areas are subject to periodic flooding caused by overflow of Buxton Creek and its tributaries. Flooding may occur at any time during the year. Damaging floods are known to have occurred in 1940, 1943, 1952, 1953, 1955, 1958, 1959, 1964, 1966, 1970, and 1976 (Reference 6).

Flooding in the Town of Iowa is relatively frequent and is caused by channel overflow. The worst of these floods have occurred in 1927, 1940, 1953, 1955, 1964, 1972, and 1983. Flooding normally occurs in the late winter and spring and occasionally hurricanes will induce floods in late summer (Reference 7).

Channel overflow is the principal flood problem in the City of Lake Charles. Streams flowing through and around the City of Lake Charles have gradients of a few feet per mile. Flooding caused by hurricane surges affects the Calcasieu River and backwater areas of its tributaries (Reference 8).

Flooding in the City of Sulphur is relatively frequent and is caused by channel overflow from rainfall runoff. Floods will usually occur in the late winter and spring. Occasionally hurricanes in the late summer will induce floods. The watersheds are generally flat, which delays the runoff of water and inhibits drainage. (Reference 9)

Flooding from rainfall may occur during any season of the in the Town of Vinton. Heavy rainfalls during the winter and spring are usually the result of the passage of warm and cold fronts. Summer thunderstorms sometimes cause localized flooding. During the summer and fall, tropical storms and hurricanes occasionally affect this area. In addition to their intense rainfall, these storms produce wind driven tides which affect the area. (Reference 10)

Flooding from rainfall falling within the study area may occur during any season of the year in the City of Westlake. Heavy rainfalls during the winter and spring are usually the result of the passage of warm and cold fronts. Summer thunderstorms sometimes cause localized flooding. During the summer and fall, tropical storms and hurricanes sometimes hit this area.

These storms, in addition to the intense rainfall which accompany them, produce wind-driven tides which also affect the area. (Reference 11) Significant floods occurred in the City of Westlake in May 1953; August 1940; June 1957; and September 1961. (Reference 12)

<u>2005 Hurricane Katrina (August 23-30)</u>

Katrina developed over the central Bahamas on the evening of August 23. The storm strengthened and reached hurricane status on the evening of August 25, less than 2 hours before it made landfall as a Category 1 storm near the border of Miami-Dade County and Broward County, Florida. Katrina continued moving west-southwest and entered the Gulf of Mexico early on August 26. The storm intensified to a Category 3 hurricane by noon on August 27 over 275 mi southeast of the mouth of the Mississippi River. Over the next day, Katrina doubled in size and turned toward the northwest. Katrina strengthened to a Category 5 in less than 12 hours and reached 160 mph winds by noon on August 28. Although Katrina did not make landfall near Buras, Louisiana until around noon on August 29 as a strong Category 3 storm (according to best estimates), the storm was large enough that hurricane force winds were reaching the coast as early as August 28.

Since most of the tide gauges failed along the coast and buildings were completely destroyed, it was difficult to determine the storm surge from Katrina. Compared to the 1969 storm (Hurricane Camille) that traveled along nearly the same path, Katrina was a weaker storm, but caused as much or more damage due to its large size. The radius of maximum winds was 25-30 n. mi. and hurricane force winds extended at least 75 n. mi. to the east from the center of the storm. Also, Katrina generated substantial wave setup along the northern Gulf coast while it was still a Category 4 and 5 before it made landfall.

Katrina was a powerful and deadly hurricane that ranks as one of the costliest and one of the five deadliest hurricanes to ever strike the United States. A total of 1,833 fatalities from Louisiana, Mississippi, Florida, Georgia and Alabama are directly and indirectly related to Katrina. Early estimates of the total damages place the losses at over $81 billion.

2005 Hurricane Rita (September 18-24)

Tropical Storm Rita developed on September 18th from a tropical depression that formed early on the same day. The storm increased in intensity over the next 48 hours, becoming a Category 1 hurricane on the 20th and a Category 2 hurricane later that afternoon. Tracking through the Florida Straits, Hurricane Rita neared the Florida Keys on the 20th, causing sustained tropical storm force winds on Key West with gusts of up to 76 mph (66 knots).

Rapidly intensifying, Hurricane Rita tracked westward into the Gulf of Mexico and by the afternoon of the 21st, Rita had reached Category 5 strength on the Saffir-Simpson scale, with winds of 165 mph. Continuing to intensify to reach windspeeds of 175 mph, the minimum central pressure of the storm dropped to 897 mb, the third lowest on record for the Atlantic Basin, after Hurricane Gilbert in 1988 (888 mb), and the 1935 Labor Day Hurricane (892 mb). 2005 marks the first time in recorded history that two hurricanes (Katrina and Rita) have reached Category 5 strength in the Gulf of Mexico in a single season. Additionally, it was only the third time that two Category 5 storms formed in the Atlantic Basic in the same year.

Weakening during the afternoon of the 22nd, due to an eyewall replacement cycle and perhaps some influence of slightly cooler sea-surface temperatures, Rita's intensity dipped to a surface windspeed of 145 mph (125 knots) and continued to weaken gradually over the next 36 hours prior to landfall. Rita tracked west-northwest during the 23rd and made landfall at the Texas/Louisiana border early on the 24th, at Category 3 strength with sustained winds of 120 mph. Rita brought hurricane strength winds more than 150 miles inland and caused significant damage along the coast. (Reference 13)

Flooding from the rain and storm surge in Calcasieu Parish was extensive, especially in the southern portion of the parish. Lake Charles experienced severe flooding, with reports of water rising six to eight feet in areas around the lake. Most of the parish population followed an evacuation order issued on Sept. 22 by parish officials. No casualties were reported in Calcasieu Parish. (Reference 14)

2.4 Flood Protection Measures

There has been extensive modification of the natural drainage of Calcasieu Parish through the construction of canals and levees and the straightening of river channels. Several ship channels have been dug across meanders of the Calcasieu River in order to promote access to the City of Lake Charles from the Gulf of Mexico. A portion of the Intracoastal Waterway has been constructed near the southern boundary of the parish. Innumerable drainage ditches and canals have been dug throughout the parish, some of which are navigable. The channels, canals, ditches, and the waterway help in conveying flows, thereby reducing flood problems. (Reference 5)

The effects of the Calcasieu River saltwater barrier control structure and closure dam were accounted for in this study. (Reference 5)

The Toledo Bend Dam, located on the Sabine River in Sabine Parish, has an effect on the flood-flow frequency of the Sabine River in Calcasieu Parish. The effects of the Toledo Bend Dam were accounted for in the hydrologic analysis of the Sabine River. (Reference 5)

In 1958, the State of Louisiana, Department of Public Works completed a channel improvement project in the City of DeQuincy beginning on the Upper West Fork Buxton Creek at North Division Street and extending downstream to the Louisiana Highway 27 crossing of Buxton Creek. In 1968, the Department of Public Works (currently referred to as the Office of Public Works) completed a second channel improvement project on Buxton Creek from Douglas Street to a point 2.6 miles southwest of Louisiana Highway 27. An additional Office of Public Works Project included channel improvements from the Kansas City Southern Railway crossing of Upper West Fork Buxton Creek downstream to a point 1.4 miles southwest of Louisiana Highway 27. These projects included the deepening, widening, and realignment of the channels. (Reference 6)

The stream channels in the Town of Iowa studied by detailed methods are maintained by the Town. (Reference 7)

Significant channel improvements have been accomplished on Kayouche Coulee and West Branch Kayouche Coulee within the City of Lake Charles. Pumping stations are located near the mouths of Kayouche Coulee and Pithon Coulee. Additionally, floodgates have been built adjacent to the Kayouche Coulee pumping station. A levee (located outside the City of Lake Charles corporate limits) protects against interbasin flow into the Kayouche Coulee basin from the Calcasieu River and English Bayou. A seawall along the eastern shore of Lake Charles also protects against flooding. (Reference 8)

The streams in the City of Sulphur are maintained locally, and some channel improvements have been undertaken in the past. Gilbert Lateral has been concrete lined from State Route 27 to U.S. Route 90. Channel improvements were constructed to the W-36 Drainage Canal, which is located in the western portion of the City of Sulphur. Flow is diverted from Dick Arkel Bayou into the W-36 Drainage Canal and on to the Calcasieu River, which relieves flooding in the upper reaches of Dick Arkel Bayou; this canal diverts the flow from Dick Arkel Bayou at a point approximately 1,260 feet upstream from its confluence with Gilbert Lateral. This also diverts some of the flow on Gilbert Lateral and relieves some of the flood problems where Gilbert Lateral converges with Bayou d'Inde. These effects have been incorporated into this study. (Reference 9)

Channel dredging projects within the Town of Vinton by the Louisiana Office of Public Works and local interests have been completed on the Vinton Drainage Canal and Hampton Coulee. These projects helped reduce flood stages in the area. (Reference 10)

In the City of Westlake, the channel of Bayou Marino has been enlarged by dredging which has greatly improved the local drainage. Improved navigation is the primary purpose of the channel improvements of the Calcasieu River and Pass. (Reference 11)

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 is 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 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 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 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community.

3.1.1 New Detailed Study Streams

The discharges for the new detailed and enhanced approximate studied streams were calculated using the region of influence regression model (RIRM) developed by the USGS for estimating discharges on unregulated streams in Louisiana. (Reference 15) The RIRM is a computer program designed to estimate discharges based on data from stations whose drainage area, main channel slope, and mean annual precipitation are most similar to the ungaged site. In order for the model to predict the peak discharges, the following variables must be known:

Drainage Area
Channel Slope
Mean Annual Precipitation

The drainage area and channel slope were calculated from topography data provided by the state of Louisiana statewide LiDAR project. (Reference 16) Precipitation for each stream was estimated using the map of mean annual precipitation for Louisiana presented in the USGS Technical Report No. 60, Floods in Louisiana, Magnitude and Frequency, Fifth Edition, 1998 (Reference 15).

There are no streamflow gages located on any of the detailed or enhanced approximate study streams in Calcasieu Parish. There are two gages in Beauregard Parish that are qualified for use for gage weighting in this study, 8016400 – Beckwith Creek near DeQuincy, LA, and 8016990 – Cowards Gully near DeQuincy, LA. (Reference 17) The gage weighting procedure is detailed on Page 24 in the USGS report.

In this study, discharges for the restudied reach of Bayou Choupique were based on new hydrologic analyses.

The hydrologic analyses of discharges for the restudied reach of Bayou Choupique were based on design storms computed using the USACE Hydrologic Engineering Center (HEC) - Hydrologic Modeling System (HMS) computer program. (Reference 18) The HEC-HMS computer program computes flood hydrographs using a unit hydrograph defined by the Soil Conservation Service (SCS) method parameters. In order to use this program, the estimated SCS Curve Number, the lag time (tL), the storm rainfall, and drainage areas had to be defined as input parameters. The SCS Curve Number method, the SCS Unit Hydrograph Method and the Modified Puls Method were used to determine the loss-rate, transform rainfall excess into surface runoff, and route the flow through the channel for steady-state simulations, respectively. Rainfall data were taken from the National Oceanic and Atmospheric Administration (NOAA) Hydro-35, for precipitation frequency for 5- to 60-minute

durations, and the U.S. Weather Bureau Technical Paper No. 40 (TP-40), for precipitation frequency for 30-minute to 24-hour durations. (References 19 and 20)

3.1.2 Redelineated Streams

The redelineated streams were initially studied by detailed methods. These flooding sources include all those listed in the redelineation section of Table 1 unless identified otherwise below.

Due to the topography of the area, hydrologic analyses need to emphasize the slopes in the overbanks and channel, flow diversion, storage, and ponding. Each of the studied areas was subdivided in selected subbasins, with concentration points determined for the computations of synthetic unit hydrographs.

Times of Concentration (Tc) were computed for overland flow using the Kerby Method and for channel flow using the Ramser Method. (Reference 21) Clark Storage Coefficients (R) were computed to be 5 x Tc based on theoretical and observed flooding effects. Clark Unit Hydrographs were computed for all streams and converted to runoff hydrographs using rainfall from isopluvial maps and initial and uniform loss rates. (References 19 & 22) These computations, and those for routing and combining the hydrograph ordinates utilizing the Modified Puls Routing Method, were performed through the use of the USACE HEC-1 computer program. (Reference 23)

The initial flood discharge-frequency estimates for the Sabine River were obtained from an analysis of 18 gages selected from the USGS WATSTORE computer system. (Reference 24) Three of the selected gages (No. 08030500, No. 08028500, and No. 08026000) are located on the downstream side of the Toledo Bend Dam on the Sabine River. The rest of the gages were spread over tributaries of the Sabine River, both upstream and downstream of the Toledo Bend Dam.

Peak flood discharges before and after construction of the Toledo Bend Dam were compared with flood discharges on uncontrolled tributaries for the same periods. Gage No. 08030500, which is located on the Sabine River downstream of the Toledo Bend Dam near Ruliff, was selected as the main gage to compare with other gages on its tributaries since it is closest to the study area. The peak flood discharge analysis showed that the flows at gage No. 08030500 have been affected by the dam since its construction in 1967. Therefore, two data sets, the first before 1967 (pre-1967) and the second after 1967 (post-1967), were developed to analyze the effects of the Toledo Bend Dam.

The annual peak discharges for the two data sets were used to calculate the ratio of gage No. 08030500 to each tributary gage as shown by the following equation:

$$r = (1/n) \sum (Q_P \text{ (gage No. 08030500)}/Q_P \text{ (tributary gages)})$$

Where r is the ratio, n is the number of gages, and QP is the peak discharge at the gage. An average of the pre-1967 and the post-1967 ratios of each gage was then developed using the equation:

$$R = (1/n) \sum (r_2/r_1)$$

Where r is the ratio, n is the number of tributary gages (15 in this case), r1 is the ratio for pre-1967 data at a tributary gage; and r2 is the ratio for post-1967 data at a tributary gage. The discharge can then be determined using the equation:

$$Q_{Post\text{-}1967} = RQ_{Pre\text{-}1967}$$

Where QPost-1967 is the peak discharge at the gage after 1967; QPre-1967 is the peak

discharge at the gage before 1967; and R is the ratio from the equation above.

Pre-1967 discharge estimates of various recurrence intervals can be obtained directly from WATSTORE. (Reference 24) The value of R developed for gage No. 08030500, 0.893, compared well with those developed for gage No. 08028500 and No. 0802600.

The floodplain for the Sabine River has been modified to incorporate data from a detailed restudy prepared for Newton County, Texas. (Reference 25) These modifications include the addition of detailed flooding to the Sabine River from profile station 116,320 to profile station 242,900 (boundary of Beauregard Parish). The discharge through this reach is 113,800, based on the log-Pearson Type III analysis of USGS Gage No. 08030500 at Ruliff, Texas.

To define discharge-frequency data for Buxton Creek and its tributaries in and around the City of DeQuincy, two basic methods of unit hydrograph analysis were used:

(1) Technical Report No. 2d, prepared by the USGS in cooperation with the Louisiana Department of Public Works; (Reference 26) and

(2) A method employed by the Texas Water Development Board to develop unit hydrographs for urban areas (Reference 27).

Adjustments for urbanization were made to the unit hydrographs developed by Method (1), above, according to a technique that has been used for other floodplain information and FISs performed by the New Orleans District, USACE. Two factors, degree of imperviousness and extent of drainage improvements, were selected as quantitative indicators of heightened runoff rates in urban areas. Their combined effect is expressed by an urbanization factor that can vary between 1.0 and 0.5 for runoff conditions ranging from completely rural to completely urban.

The unit hydrograph characteristics for drainage areas that have experienced development were adjusted through application of the urbanization factor:

$T_{LU} = T_L$ x (Urbanization Factor); and

$Q_{PU} = Q_P$ + (Urbanization Factor),

Where TL and QP are adjusted lag time and peak discharge computed by the method of Technical Report No. 2d.

These relationships are based on a study of streams in the Dallas-Fort Worth Metropolitan area (Reference 28) in which unit hydrograph lag times were correlated with drainage basin parameters and degrees of urbanization.

Storm rainfall depths were obtained from the isohyetal maps in U.S. Weather Bureau Technical Memorandum No. 40 (Reference 22) for frequencies of up to 100 years. The assumption was made that a 24-hour storm occurring over a basin would produce a flood having the same frequency for normal runoff conditions. Flood hydrographs were then obtained by application of the hypothetical storms to the previously developed unit hydrographs. Peak discharges for the 0.2 percent annual chance flood were determined by extrapolation of the peak discharge-frequency curves. As a check on the discharge- frequency extrapolation method, extrapolated 0.2 percent annual chance rainfall amounts were applied to the unit hydrographs for certain drainage areas. The resultant 0.2 percent annual chance peak discharges closely matched those previously determined. Most of the hydrologic analyses referred to above were originally performed during the DeQuincy, Louisiana Flood Plain Information Study (Reference 29), which was published in 1972.

For Lateral 14, Lateral 14-1, Lateral 14-2, Lateral 14-3, Lateral 14-4, Lateral 14B, and Lateral 14B-2 in and around the Town of Iowa; and Bayou Choupique, Bayou d'Inde, Bayou d'Inde Lateral, Dick Arkel Lateral, Fairground Lateral, Lateral A of Maple Fork Bayou, Lateral B of Maple Fork Bayou, Maple Fork Bayou, and Sumpter Bayou in the City of Sulphur area, the peak discharge-frequency relationships were determined using the regression equations as established in the USGS publication on small watersheds in Louisiana (Reference 30). Discharge values were calculated using drainage areas, average annual precipitation, stream slopes, and urbanization factors.

The only long-term stream gaging stations in the Lake Charles area are located on the Calcasieu River. These stations record stages only. Peak discharges were obtained by the application of generalized rainfall frequency depth-duration data to synthetic unit hydrographs, which were derived from regionalized storm and hydrograph studies, with allowance for storage, channel improvements, and urbanization. (References 22 & 26) The influence of hurricane surge flooding was also considered.

For Kayouche Coulee, peak discharges were obtained using the USACE HEC-1 Flood Hydrograph Package (Reference 31).

A hydrologic analysis of flooding by ponding was prepared for the Pinewood Lateral area which emphasized the slope of the ground, flow diversion, storage, and ponding. A Clark unit hydrograph was computed and converted to a runoff hydrograph using rainfall from isopluvial maps (References 19 & 22) and initial and uniform loss rates. These computations and those for routing were performed using the HEC-1 computer program (Reference 23).

For Hampton Coulee and the Vinton Drainage Canal in the Town of Vinton area; and Bayou Marino in the City of Westlake area, the 10 percent, 2 percent, and 1 percent annual chance peak discharges were developed using the USGS regionalized method. (References 28 & 32) The 0.2 percent annual chance peak discharges were extrapolated from log-probability plots of the discharge-frequency data. Peak discharges were adjusted for urbanization in accordance with the references cited. Peak discharge-drainage area relationships for streams studied by detailed methods are shown in Table 5, "Summary of Discharges."

Table 5: Summary of Discharges

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
New Detailed Study Streams					
BAYOU CHOUPIQUE					
At Dave Dugas Road	65.4	14,448	24,125	30,261	35,558
Approximately 1.5 miles upstream of Dave Dugas Road	62.4	14,382	23,973	27,693	35,184
Approximately 1.3 miles downstream of Interstate 10	39.3	9,030	15,029 *	16,796	21,343
Approximately 0.7 mile downstream of Interstate 10	34.4	8,653	15,029	16,284	20,773
At the Southern Pacific Railroad	30.1	8,258	12,341	14,132	18,279
Approximately 0.8 mile upstream of the Southern Pacific Railroad	5.0	3,473	4,960	5,577	7,013
BAYOU CONTRABAND					
At Mouth	15.13	2,356	3,039	3,412	4,094
Upstream confluence w/ Little Bayou	14.18	2,122	2,730	3,062	3,668
Upstream confluence w/ Bayou Contraband Tributary 1	8.32	1,664	2,155	2,414	2,884
Upstream confluence w/ South Branch Bayou Contraband	6.36	1,345	1,725	1,922	2,274
Upstream confluence w/ East Branch Bayou Contraband	4.92	1,120	1,420	1,572	1,839
At Kirkman Street	3.77	894	1,119	1,230	1,421
At Fifth Avenue	1.71	605	776	857	998
At Hwy LA 14	0.50	240	292	314	348
EAST BRANCH BAYOU CONTRABAND					
At Mouth	1.15	432	563	625	749
At Common Street	0.86	378	492	544	642

* Computed discharge decreased downstream and therefore the upstream value was used.

Table 5: Summary of Discharges (cont.)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
EAST BRANCH BAYOU CONTRABAND (cont.)					
At Petro Point Drive	0.58	337	447	496	590
At Link Road	0.52	255	318	344	394
At Hwy 3092	0.37	215	269	289	327
SOUTH BRANCH BAYOU CONTRABAND					
At Mouth	0.94	490	665	746	906
At Jefferson Drive	0.74	453	614	688	833
At University Drive	0.56	367	498	558	672
At Morningside Drive	0.40	247	328	363	428
Redelineation Streams					
30 W. MAIN LATERAL					
At Highways 27 and 3065	3.91	--[n]	--[n]	430	--[n]
ADDISON LATERAL					
At Gauthier Road	1.3	--[n]	--[n]	449	--[n]
AIRPORT LATERAL					
At Gauthier Road	2.6	--[n]	--[n]	799	--[n]
At Gulf Highway	1.3	--[n]	--[n]	370	--[n]
AMOCO LATERAL					
At Gauthier Road	4.00	--[n]	--[n]	1,040	--[n]
At Ward Line Road (Louisiana Highway 397)	2.12	--[n]	--[n]	570	--[n]

[n] Not Computed

Table 5: Summary of Discharges (cont.)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
AMOCO LATERAL (cont.)					
At Highway 14	1.67	--[n]	--[n]	430	--[n]
At Southern Pacific Railroad	0.50	--[n]	--[n]	150	--[n]
ANTOINE GULLY					
At Interstate 10	3.48	--[n]	--[n]	860	--[n]
At Louisiana Highway 397	2.57	--[n]	--[n]	740	--[n]
At McCown Road	1.12	--[n]	--[n]	400	--[n]
BAYOU CHOUPIQUE	n/a	n/a	n/a	n/a	n/a
BAYOU D'INDE					
At downstream City of Sulphur Corporate Limits	8.1	2,517	3,605	3,889	4,391
Upstream side of confluence of Gilbert Lateral	2.4	1,020	1,453	1,605	1,850
At Post Oak Road	2.2	982	1,398	1,543	1,700
At Maplewood Drive	1.8	863	1,226	1,351	1,475
At East Napoleon Street	1.3	482	702	766	880
At East Burton Street	0.8	353	511	554	750
At Arizona Street	0.3	168	239	256	310
At Lewis Street	0.1	28	39	39	50
BAYOU D'INDE LATERAL					
At City of Sulphur corporate limits	2.62	--[n]	--[n]	700	--[n]
At Barney Hoffpauir Road	1.08	--[n]	--[n]	300	--[n]

[n] Not Computed
n/a Not Available

Table 5: Summary of Discharges (cont.)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
BAYOU LACASSINE	n/a	n/a	n/a	n/a	n/a
BAYOU MARINO					
At downstream City of Westlake Corporate Limits	2.49	859	1,294	1,428	1,700
Just east of intersection of Carlin Drive and Gardin Drive	2.13	816	1,241	1,368	1,580
At Sampson Street	1.21	612	924	1,010	1,150
BAYOU VERDINE					
At Old Spanish Trail	2.40	--[n]	--[n]	480	--[n]
At Houston River Canal	0.73	--[n]	--[n]	150	--[n]
BEAR HEAD CREEK	n/a	n/a	n/a	n/a	n/a
BELFIELD LATERAL					
At confluence with Little Indian Bayou	5.08	--[n]	--[n]	576	--[n]
Upstream confluence with Diamond Gully	3.40	--[n]	--[n]	860	--[n]
BELLEVUE LATERAL					
At confluence with West Fork English Bayou	1.42	--[n]	--[n]	180	--[n]
BLACK BAYOU					
At Gauthier Road	2.6	--[n]	--[n]	827	--[n]
At Louisiana Highway 14	0.9	--[n]	--[n]	231	--[n]

[n] Not Computed
n/a Not Available

Table 5: Summary of Discharges (cont.)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
BUXTON CREEK					
At Louisiana Highway 27	14.6	4,430	6,020	6,880	9,330
Just upstream of the confluence of Upper East Fork Buxton Creek	10.1	3,610	4,900	5,590	7,590
Just upstream of the confluence of Upper West Fork Buxton Creek	3.4	2,240	3,050	3,480	4,400
CALCASIEU RIVER	n/a	n/a	n/a	n/a	n/a
CALCASIEU RIVER TRIBUTARY	n/a	n/a	n/a	n/a	n/a
DAVID BAYOU					
At mouth	0.9	779	1,100	1,210	1,500
DIAMOND GULLY					
At confluence with Belfield Lateral	1.89	--[n]	--[n]	350	--[n]
DICK ARKEL LATERAL					
At confluence with Gilbert Lateral	1.2	294	456	451	491
At Golf Course Footbridge No. 2	1.1	449	653	712	820
At U.S. Route 90	1.0	416	604	657	750
Downstream side of Franklin Street at upstream face of 102-inch RCP	0.8	372	539	585	650
At upstream face of 102-inch RCP	0.4	147	216	227	250
EAST FORK ENGLISH BAYOU	n/a	n/a	n/a	n/a	n/a

[n] Not Computed
n/a Not Available

Table 5: Summary of Discharges (cont.)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
ENGLISH BAYOU	n/a	n/a	n/a	n/a	n/a
FAIRGROUND LATERAL					
At Bayou d'Inde Lateral	1.18	--[n]	--[n]	320	--[n]
At New Louisiana Highway 27	0.93	--[n]	--[n]	310	--[n]
GILBERT LATERAL					
At its confluence with Bayou d'Inde	5.7	1,497	2,152	2,384	2,541
At Arizona Street	5.3	1,493	2,073	2,292	2,441
Upstream side of confluence of Sumpter Bayou	4.7	1,351	1,949	2,150	2,241
Upstream side of confluence of David Bayou	3.7	1,186	1,709	1,881	1,991
Upstream side of confluence of Dick Arkel Bayou	2.5	783	1,146	1,252	1,391
At Bryan Street	1.2	633	901	989	1,100
At Southern Pacific Transportation	0.9	548	778	852	950
Just downstream of divergence of Bayou d'Inde at upstream face of 108-inch reinforced concrete pipe culvert	0.4	169	251	265	290
GILLIS LATERAL					
At confluence with Little Indian Bayou	7.15	--[n]	--[n]	1,160	--[n]
GOLDSMITH CANAL					
At Goos Road	1.83	--[n]	--[n]	220	--[n]
GREATHOUSE LATERAL					
At Gauthier Road	0.3	--[n]	--[n]	91	--[n]

[n] Not Computed
n/a Not Available

Table 5: Summary of Discharges (cont.)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
HAMPTON COULEE					
At Courville Road	15.19	1,094	1,529	1,731	2,200
Below tributary near Stevenson Street	12.84	1,024	1,438	1,630	2,060
At West Street	9.39	796	1,122	1,266	1,620
At Sabine Canal	8.75	652	911	1,016	1,320
HERBERT LATERAL					
At "Plant" Road	1.33	--[n]	--[n]	400	--[n]
At Myrtle Springs Road	0.60	--[n]	--[n]	170	--[n]
HIGGINS LATERAL					
At mouth	1.0	--[n]	--[n]	392	--[n]
HOUSTON RIVER	n/a	n/a	n/a	n/a	n/a
HOUSTON RIVER TRIBUTARY	n/a	n/a	n/a	n/a	n/a
INDIAN BAYOU					
At confluence with Little Indian Bayou	44.18	--[n]	--[n]	6,940	--[n]
At confluence with Sturrock Lateral	18.05	--[n]	--[n]	2,550	--[n]
KAYOUCHE COULEE					
At pump station	26.00	--[n]	--[n]	5,369	--[n]
At a point approximately 0.2 mile upstream of Broad Street	23.61	--[n]	--[n]	5,601	--[n]
At a point approximately 0.2 mile upstream of Legion Street	15.32	--[n]	--[n]	3,156	--[n]

[n] Not Computed
n/a Not Available

Table 5: Summary of Discharges (cont.)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
KAYOUCHE COULEE (cont.)					
At a point just downstream of access road	14.01	--[n]	--[n]	3,329	--[n]
At a point just downstream of East Prien Lake Road	1.94	--[n]	--[n]	1,658	--[n]
KINNER GULLY					
At mouth	6.0	--[n]	--[n]	1,524	--[n]
At Louisiana Highway 3059	1.1	--[n]	--[n]	306	--[n]
LATERAL 14					
At downstream Town of Iowa Corporate Limits	2.66	487	730	819	910
At confluence of Lateral 14-4	0.87	318	475	512	570
At Southern Pacific Transportation	0.72	281	419	450	520
At U.S. Route 90	0.33	150	222	234	260
LATERAL 14-1					
At confluence with Lateral 14	0.05	59	85	86	100
LATERAL 14-2					
At confluence with Lateral 14	0.05	40	56	57	80
LATERAL 14-3					
At confluence with Lateral 14	0.06	46	66	67	85
At Miller Street	0.03	24	34	34	50

[n] Not Computed

Table 5: Summary of Discharges (cont.)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
LATERAL 14-4					
At confluence with Lateral 14	0.93	348	529	571	635
Approximately 0.5 mile above confluence with Lateral 14	0.40	231	347	369	500
Approximately 0.7 mile above confluence with Lateral 14	0.37	184	279	300	402
LATERAL 14B					
At downstream Town of Iowa Corporate Limits	0.70	373	555	600	690
Approximately 0.4 mile above confluence with Lateral 14	0.55	318	472	508	560
Approximately 0.6 mile above confluence with Lateral 14	0.20	155	226	239	270
Approximately 1.0 mile above confluence with Lateral 14	0.07	67	95	98	130
LATERAL 14B-2					
At confluence with Lateral 14B	0.20	104	152	158	182
Approximately 0.2 mile above confluence with Lateral 14B	0.12	69	100	103	128
Approximately 0.6 mile above confluence with Lateral 14B	0.06	39	55	55	75
LATERAL 2B EAST					
At New Louisiana 27	0.21	--[n]	--[n]	70	--[n]
LATERAL 2B WEST					
At Fairground Lateral	0.06	--[n]	--[n]	30	--[n]
LATERAL A OF MAPLE FORK BAYOU					
At confluence with Maple Fork Bayou	0.3	344	490	531	600
At upstream face of 78-inch RCP	0.2	252	357	385	450

[n] Not Computed

Table 5: Summary of Discharges (cont.)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
LATERAL B OF MAPLE FORK BAYOU					
At confluence with Maple Fork Bayou	0.3	331	479	517	630
At downstream face of 72-inch RCP	0.3	317	458	494	610
At upstream face of 72-inch RCP	0.2	239	343	368	430
LE BLEU CANAL					
At mouth	4.7	--[n]	--[n]	1,433	--[n]
At Louisiana Highway 3059	0.9	--[n]	--[n]	295	--[n]
LITTLE BAYOU	n/a	n/a	n/a	n/a	n/a
LITTLE BAYOU D'INDE	n/a	n/a	n/a	n/a	n/a
LITTLE BAYOU D'INDE TRIBUTARY	n/a	n/a	n/a	n/a	n/a
LITTLE INDIAN BAYOU					
At confluence with Indian Bayou	23.66	--[n]	--[n]	4,020	--[n]
At confluence with Belfield Lateral	16.61	--[n]	--[n]	2,750	--[n]
LOWER WEST FORK BUXTON CREEK					
At the Kansas City Southern Railroad	0.74	1,020	1,390	1,530	1840
At cross section A	0.53	870	1,180	1,290	1,520
At upstream limit of detailed study	0.26	560	750	830	1,000

[n] Not Computed
n/a Not Available

Table 5: Summary of Discharges (cont.)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
MANCHESTER LATERAL					
At confluence with West Fork English Bayou	1.03	--[n]	--[n]	280	--[n]
MAPLE FORK BAYOU					
At downstream City of Sulphur Corporate Limits	3.7	1,065	1,545	1,709	1,950
Approximately 0.1 mile downstream of confluence with Lateral B of Maple Fork Bayou	2.9	858	1,252	1,380	1,500
At confluence of Lateral A of Maple Fork Bayou	2.50	630	939	1,031	1,100
Approximately 1.7 miles above confluence with Bayou d'Inde	2.30	526	796	871	950
At Old Spanish Trail	2.01	--[n]	--[n]	210	--[n]
At Reeves Road	0.70	--[n]	--[n]	120	--[n]
MCFILLEN LATERAL					
At Gauthier Road	0.7	--[n]	--[n]	268	--[n]
PITHON COULEE	n/a	n/a	n/a	n/a	n/a
SABINE RIVER					
Entire reach	n/a	n/a	n/a	113,800	n/a
STURROCK LATERAL					
At confluence with Indian Bayou	3.13	--[n]	--[n]	880	--[n]
SUMPTER BAYOU					
At Lightning Street	0.55	300	440	500	590

[n] Not Computed
n/a Not Available

Table 5: Summary of Discharges (cont.)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
SUMPTER BAYOU (cont.)					
At culvert approximately 0.2 mile upstream of Ruth Street	0.3	150	220	230	240
At Drost Street	0.2	100	150	155	165
UPPER EAST FORK BUXTON CREEK					
At the confluence with Buxton Creek	2.7	1,670	2,280	2,530	3,170
UPPER WEST FORK BUXTON CREEK					
At the confluence with Buxton Creek	3.6	2,380	3,280	3,640	4,410
Just upstream of the confluence of Upper West Fork Tributary	2.1	1,640	2,230	2,560	3,680
UPPER WEST FORK TRIBUTARY					
At the confluence with Upper West Fork Buxton Creek	0.99	1,220	1,650	1,820	2,190
Approximately 0.1 mile upstream of the confluence with Upper West Fork Buxton Creek	0.46	750	1,020	1,120	1,350
VINTON DRAINAGE CANAL					
At channel enlargement	1.18	376	560	606	720
At Stevenson Street	1.03	279	412	443	490
At West Street	0.97	211	309	330	370
W-36 DRAINAGE CANAL					
At mouth	n/a	176	229	266	359
WEST BRANCH KAYOUCHE COULEE	n/a	n/a	n/a	n/a	n/a

n/a Not Available

Table 5: Summary of Discharges (cont.)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	4-percent	2-percent	1-percent	0.2-percent
WEST FORK CALCASIEU RIVER	n/a	n/a	n/a	n/a	n/a	n/a
WEST FORK ENGLISH BAYOU						
At US Highway 90	6.76	--[n]	--[n]	--[n]	1,310	--[n]
At McCown Road	4.16	--[n]	--[n]	--[n]	940	--[n]
At Boys Village Road	3.64	--[n]	--[n]	--[n]	790	--[n]
New Approximate Study Streams						
BESS BRANCH						
680 meters downstream of Smith Cutoff Road	3.4	1,018	1,391	1,696	2,026	2,877
BESS BRANCH TRIB 1						
900 meters downstream of State Road 109	2.9	333	444	533	628	862

n/a Not Available
[n] Not Computed

3.2 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. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data tables in the FIS report. 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 in conjunction with the data shown on the FIRM.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross-section locations are also shown on the FIRM. The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the Flood Profiles (Exhibit 1) are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

3.2.1 New Detailed Study Streams

For streams studied under new detailed analysis, water surface elevations for the

10-percent, 2-percent-, 1-percent, and 0.2-percent annual chance floods were computed using the USACE HEC-RAS version 3.1 step-backwater computer program. (Reference 33) These streams were identified in Section 2.1.

Detailed field survey information was collected for these streams; each hydraulic crossing was surveyed and that survey information was incorporated into the HEC-RAS modeling. Additionally, 3 natural cross sections on Bayou Contraband and 1 natural cross section on South Branch Bayou Contraband were surveyed and incorporated into the HEC-RAS models.

The floodplain cross sections were placed at representative locations, approximately 1,000 feet apart along the stream centerline. Cross section geometries were obtained from a combination of field survey and cross section takeoffs based on topographic data provided by the State of Louisiana. Surveyed channel sections were propagated upstream and downstream to non-surveyed cross sections and blended with the underlying topographic source.

The starting water surface elevation for Bayou Contraband for all water surface profiles was fixed at Mean Higher High Water (MHHW) as reported by the NOAA observation site at Lake Charles, Calcasieu River (#8767816). A value of 1.7’ was used. (Reference 34) The other two streams used the normal depth method.

Roughness coefficients were estimated based on field inspection of stream channels and floodplain areas for Bayou Contraband and its tributaries. A GIS coverage of floodplain and channel n-values was developed. This GIS coverage consists of “bands” of Manning’s n-values. These bands were developed using the field reconnaissance and orthophotos. The purpose of the n-value “band” coverage is to allow the consistent application of Manning’s n-value estimates. Additional cross sections can be added to the models based on the same n-value assessments. The n- value bands also allow for the global increase or decrease of n-values for a stream reach or entire stream for historical calibration and verification. Ineffective flow areas (e.g., extremely dense trees and underbrush, dense residential areas, large buildings, fenced areas) were modeled in HEC-RAS by using a high Manning’s n- value to account for the ineffective area.

For the reach of Bayou Choupique restudied with detailed analyses, water surface elevations for the 10-, 2-, 1-, and 0.2 percent-annual-chance floods were computed using the USACE HEC-RAS Version 3.1.2 step backwater computer program (Reference 35). The study limits for this stream were identified in Section 2.1.

For this stream, the channel and near overbank (50 to 100 feet from channel) elevation and structure data for the hydraulic models were generally obtained from detailed field survey information. For each survey cross section, the field elevations were blended with overbank topographic data obtained from the terrain model for Calcasieu Parish, Louisiana (Reference 16).

The channel and overbank "n" values are shown in Table 6, "Summary of Roughness Coefficients."

Table 6: Summary of Roughness Coefficients

Stream Name	Channel "n" Value	Overbank "n" Value
New Detailed Streams		
Bayou Choupique	0.035-0.060	0.060-0.140
Bayou Contraband	0.035-0.055	0.060-0.200
East Branch Bayou Contraband	0.040-0.045	0.060-0.200
South Branch Bayou Contraband	0.05	0.070-0.200
Redelineated Streams		
30 W. Main Lateral	n/a	n/a
Addison Lateral	n/a	n/a
Airport Lateral	n/a	n/a
Amoco Lateral	n/a	n/a
Antoine Gully	n/a	n/a
Bayou Choupique	n/a	n/a
Bayou d'Inde	0.012-0.030	0.022-0.050
Bayou d'Inde Lateral	0.012-0.030	0.022-0.050
Bayou Lacassine	n/a	n/a
Bayou Marino	0.040-0.050	0.080-0.100
Bayou Verdine	n/a	n/a
Bear Head Creek	n/a	n/a
Belfield Lateral	n/a	n/a
Bellvue Lateral	n/a	n/a
Black Bayou	n/a	n/a
Buxton Creek	0.040-0.060	0.090
Calcasieu River	n/a	n/a
Calcasieu River Tributary	n/a	n/a
Diamond Gully	n/a	n/a
Dick Arkel Lateral	0.025	0.012-0.030
East Fork English Bayou	n/a	n/a
English Bayou	n/a	n/a
Fairground Lateral	n/a	n/a
Gilbert Lateral	0.012-0.030	0.025-0.060

Table 6: Summary of Roughness Coefficients (continued)

Stream Name	Channel "n" Value	Overbank "n" Value
Gillis Lateral	n/a	n/a
Greathouse Lateral	n/a	n/a
Hampton Coulee	0.040-0.060	0.050-0.090
Herbert Lateral	n/a	n/a
Higgins Lateral	n/a	n/a
Houston River	n/a	n/a
Houston River Tributary	n/a	n/a
Indian Bayou	n/a	n/a
Kayouche Coulee	n/a	n/a
Kinner Gully	n/a	n/a
Lateral 14	0.012-0.040	0.025-0.045
Lateral 14-1	0.023	0.025
Lateral 14-2	0.012-0.023	0.025
Lateral 14-3	0.012-0.023	0.025
Lateral 14-4	0.023	0.025
Lateral 14B	0.012-0.025	0.035
Lateral 14B-2	0.012-0.023	0.025
Lateral 2B East	n/a	n/a
Lateral 2B West	n/a	n/a
Lateral A of Maple Fork Bayou	0.012-0.030	0.035
Lateral B of Maple Fork Bayou	0.012-0.030	0.025
Le Bleu Canal	n/a	n/a
Little Bayou	n/a	n/a
Little Bayou d'Inde	n/a	n/a
Little Bayou d Inde Tributary	n/a	n/a
Little Indian Bayou	n/a	n/a
Lower West Fork Buxton Creek	0.040-0.060	0.090
Manchester Lateral	n/a	n/a
Maple Fork Bayou	0.030	0.025-0.055
McFillen Lateral	n/a	n/a
Pithon Coulee	n/a	n/a
Sabine River	n/a	n/a
Sturrock Lateral	n/a	n/a
Sumpter Bayou	0.012-0.030	0.025
Upper East Fork Buxton Creek	0.040-0.060	0.090
Upper West Fork Buxton Creek	0.040-0.060	0.090
Upper West Fork Tributary	0.040-0.060	0.090
Vinton Drainage Canal	0.035-0.060	0.060
West Branch Kayouche Coulee	n/a	n/a
West Fork Calcasieu River	n/a	n/a
West Fork English Bayou	n/a	n/a

3.2.2 Redelineation Detailed Study Streams

Water-surface elevations were initially computed through the use of USACE computer programs. Table 7, "Hydraulic Methods" includes a listing of the specific version of the program used.

For the prior analyses, cross-section data for channels and bridges were taken from field surveys. Elevation data for overbank areas were obtained from aerial photography maps with 2-foot contour intervals and spot elevations. All bridges and culverts were field surveyed to obtain elevation data and structural geometry.

Roughness coefficients (Manning's "n") values used in the hydraulic computations were estimated on the basis of field inspection, aerial photography, and photographs. The channel and overbank "n" values are shown in Table 6, "Summary of Roughness Coefficients".

Starting water-surface elevations used in the profile computations were estimated as shown in Table 7, "Hydraulic Methods".

The analyses for the redelineated study stream were taken from the prior FISs for Calcasieu Parish. The BFEs from the profiles were plotted on the State of Louisiana topographic data resulting in a better definition of the special flood hazard areas. (Reference 16) The redelineated streams are identified in Section 2.1.

Table 7: Hydraulic Methods

Stream Name	Elevations	Hydraulic Program
New Detailed Streams		
Bayou Choupique	n/a	HEC-RAS v3.1.2 (Reference 35)
Bayou Contraband	Fixed at Mean Higher Water	HEC-RAS v3.1 (Reference 33)
East Branch Bayou Contraband	Slope-Area Method	HEC-RAS v3.1 (Reference 33)
South Branch Bayou Contraband	Slope-Area Method	HEC-RAS v3.1 (Reference 33)
Redelineation Detailed Streams		
30 W. Main Lateral	Slope-Area Method	HEC-2 (Reference 23)
Addison Lateral	n/a	HEC-2 (Reference 36)
Airport Lateral	n/a	HEC-2 (Reference 36)
Amoco Lateral	Slope-Area Method	HEC-2 (Reference 23)
Antoine Gully	Coincidental flooding with English Bayou	HEC-2 (Reference 23)
Bayou Choupique	n/a	HEC-2 (Reference 36)
Bayou d'Inde	n/a	HEC-2 (Reference 36)
Bayou d'Inde Lateral	Slope-Area Method	HEC-2 (Reference 23)
Bayou Lacassine	n/a	HEC-2 (Reference 36)
Bayou Marino	Slope-Area Method	HEC-2 (Reference 37)
Bayou Verdine	n/a	HEC-2 (Reference 23)
Bear Head Creek	n/a	HEC-2 (Reference 36)
Belfield Lateral	Coincidental flooding with Little Indian Bayou	HEC-2 (Reference 23)
Bellvue Lateral	Coincidental flooding with West Fork of English Bayou	HEC-2 (Reference 23)

Table 7: Hydraulic Methods (continued)

Stream Name	Elevations	Hydraulic Program
Redelineation Detailed Streams (continued)		
Black Bayou	n/a	HEC-2 (Reference 36)
Buxton Creek	n/a	HEC-2 (Reference 36)
Calcasieu River	n/a	HEC-2 (Reference 36)
Calcasieu River Tributary	n/a	HEC-2 (Reference 36)
Diamond Gully	Coincidental flooding with Belfield Lateral	HEC-2 (Reference 36)
Dick Arkel Lateral	Slope-Area Method	HEC-2 (Reference 33)
East Fork English Bayou	n/a	HEC-2 (Reference 36)
English Bayou	n/a	HEC-2 (Reference 36)
Fairground Lateral	Coincidental flooding with Little Indian Bayou	HEC-2 (Reference 23)
Gilbert Lateral	n/a	HEC-2 (Reference 33)
Gillis Lateral	Coincidental flooding with Little Indian Bayou	HEC-2 (Reference 23)
Greathouse Lateral	n/a	HEC-2 (Reference 36)
Hampton Coulee	n/a	HEC-2 (Reference 37)
Herbert Lateral	Slope-Area Method	HEC-2 (Reference 23)
Higgins Lateral	n/a	HEC-2 (Reference 36)
Houston River	n/a	HEC-2 (Reference 36)
Houston River Tributary	n/a	HEC-2 (Reference 36)
Indian Bayou	n/a	HEC-2 (Reference 23)
Kayouche Coulee	n/a	HEC-2 (Reference 36)
Kinner Gully	n/a	HEC-2 (Reference 36)
Lateral 14	Slope-Area Method	HEC-2 (Reference 38)
Lateral 14-1	Slope-Area Method	HEC-2 (Reference 38)
Lateral 14-2	Slope-Area Method	HEC-2 (Reference 38)
Lateral 14-3	Slope-Area Method	HEC-2 (Reference 38)
Lateral 14-4	Slope-Area Method	HEC-2 (Reference 38)
Lateral 14B	Slope-Area Method	HEC-2 (Reference 38)
Lateral 14B-2	Slope-Area Method	HEC-2 (Reference 38)
Lateral 2B East	Coincidental flooding with Bayou d'Inde Lateral	HEC-2 (Reference 23)
Lateral 2B West	Coincidental flooding with Fairground Lateral	HEC-2 (Reference 23)
Lateral A of Maple Fork Bayou	Slope-Area Method	HEC-2 (Reference 38)
Lateral A of Maple Fork Bayou	Slope-Area Method	HEC-2 (Reference 38)
Lateral B of Maple Fork Bayou	Slope-Area Method	HEC-2 (Reference 38)
Le Bleu Canal	n/a	HEC-2 (Reference 36)
Little Bayou	n/a	HEC-2 (Reference 38)
Little Bayou d’Inde	n/a	HEC-2 (Reference 36)
Little Bayou d’Inde Tributary	n/a	HEC-2 (Reference 36)
Little Indian Bayou	Coincidental flooding with Indian Bayou	HEC-2 (Reference 23)
Lower West Fork Buxton Creek	From USACE study (Reference 25)	HEC-2 (Reference 36)
Manchester Lateral	Coincidental flooding with West Fork of English Bayou	HEC-2 (Reference 23)

Table 7: Hydraulic Methods (continued)

Stream Name	Elevations	Hydraulic Program
Redelineation Detailed Streams (continued)		
Maple Fork Bayou	Redevelopment of 1986 City of Sulphur FIS using calculated water-surface elevation at Interstate Highway 10 from the 1978 Calcasieu Parish (Unincorporated Areas) FIS	HEC-2 (Reference 23)
McFillen Lateral	n/a	HEC-2 (Reference 36)
Pithon Coulee	n/a	HEC-2 (Reference 38)
Sabine River	n/a	HEC-2 (Reference 36)
Sturrock Lateral	Coincidental flooding with Indian Bayou	HEC-2 (Reference 23)
Sumpter Bayou	Peak flood stages of Gilbert Lateral	HEC-RAS v1.0 (Reference 39)
Upper East Fork Buxton Creek	n/a	HEC-2 (Reference 36)
Upper West Fork Buxton Creek	From Buxton Creek profiles	HEC-2 (Reference 36)
Upper West Fork Tributary	From Upper West Fork Buxton Creek profiles	HEC-2 (Reference 36)
Vinton Drainage Canal	Slope-Area Method	HEC-2 (Reference 37)
West Branch Kayouche Coulee	n/a	HEC-2 (Reference 38)
West Fork Calcasieu River	n/a	HEC-2 (Reference 36)
West Fork English Bayou	Coincidental flooding with English Bayou	HEC-2 (Reference 23)

Enhanced Approximate Study Streams

The enhanced approximate study streams are listed in Table 1, "Scope of Study". These flooding sources were modeled by automated methods and HEC-RAS (Reference 33).

For streams studied using enhanced approximate methods, only the 1 percent annual chance flood was computed. No flood profiles are provided. Field visits were made to all hydraulic crossings. Measurements of bridges and structures were taken and incorporated into the model. In the event that a structure was inaccessible to the field crew, an interpolated cross-section was used in the model in place of the structure. Cross-section geometries for the stream were determined by blending overbank topography takeoffs with channel dimensions. Channel top widths were determined from a database that relates drainage area to top width while channel depth was estimated based on field measurements at structures.

The Manning's n-values were based on orthophotos. The normal depth method was used to calculate starting water surfaces.

3.3 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.

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) (References 40 & 41), 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 (Tp), and mean wave direction (am) 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 Louisiana and 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 at 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.

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.

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.

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. 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 VE/AE 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.

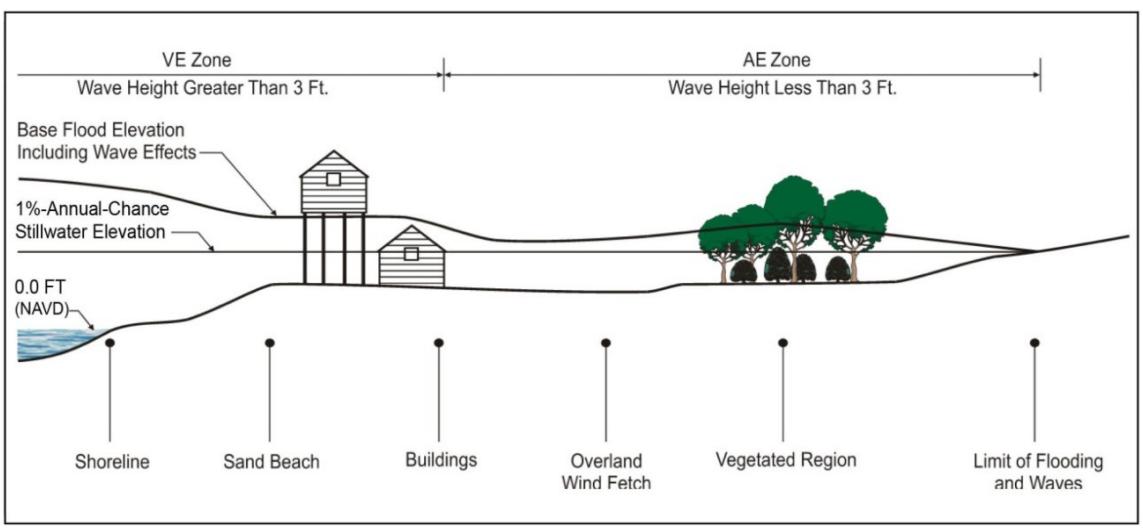

Figure 1: Transect Schematic

Since Cameron Parish lies between Calcasieu Parish and the flooding source, the Gulf of Mexico, the wave height analysis included a transect layout that extends some of Cameron Parish's transects into Calcasieu Parish. Starting wave conditions include those conditions applied for Cameron Parish's wave height analysis. Offshore wave characteristics were determined by performing a peaks-over-threshold (Reference 42) analysis of the hindcast data obtained from the Wave Information Studies (Reference 43). Wave conditions were determined at each WIS station directly in front of Cameron Parish, and the wave height values at the Cameron Parish shoreline 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 44), dampening of wave action due to muddy bottoms is negligible west of the Vermilion Parish-Cameron Parish line.

Additional transect layouts were analyzed along Sabine Lake and Calcasieu Lake's shores to identify wave heights that may have higher values than transects originating at the Gulf of Mexico. For transects starting along the lake's shorelines, starting wave conditions representing 1-percent-annual-chance flood events were calculated applying FEMA's wave model WHAFIS 4.0 (Reference 45). The fetch was determined as the distance across the lake, based on the location and orientation of each transect. However, none of the additional transect layouts for Sabine Lake or Calcasieu Lake 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 originating along the Cameron Parish shoreline and into Calcasieu Parish. In areas having more uniform characteristics, the transects were spaced at larger intervals. Transects were 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 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 46), 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 47). 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. The 0.2-percent wave height results are not included on the FIRMs but are provided as wave transect profiles in the study's TSDN.

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.

3.4 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), 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 NAVD88. 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 NAVD88. The datum conversion factor from NGVD29 to NAVD88 in Calcasieu Parish is 0.1 feet.

For information regarding conversion between the NGVD and NAVD, 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 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 Web site at www.ngs.noaa.gov.

3.5 Effects of Land Subsidence

The prevalence of land subsidence in the study area complicates the determination of the expected depth of flooding at a property. This information should always be obtained by direct comparison of the current property elevation with the official base flood elevation at that property as shown on the FIRM and accompanying Flood Profiles (Exhibits 2 and 1 respectively).

The hydraulic analysis of the Sabine River included a 0.7 foot adjustment to account for land subsidence.

Local officials should be aware of the subsidence problem and should require the use of the most up-to-date and accurate property elevation data in compensating for land subsidence; however, BFEs should not be adjusted, but obtained directly from the FIRM and accompanying profiles.

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, including Flood Profiles, Floodway Data tables, and Summary of Stillwater Elevation tables. Users should Reference the data presented in the FIS report as well as additional information that may be available at the local community 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.

For the streams studied by approximate methods, only the 1-percent-annual-chance floodplain boundary is shown on the FIRM.

4.2 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 this aspect of floodplain management. Under this concept, the area of the 1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the base flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study 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. The results of the floodway computations are tabulated for selected cross sections (see Table 8, “Floodway Data Table” of this FIS report). In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

The area between the floodway and 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation (WSEL) of the base 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 2.

Floodways were not computed for areas drained by larger streams such as the Calcasieu River, the West Fork Calcasieu River, English Bayou, and Bayou Choupique which have wide flat floodplains and are frequently flooded. It is improbable that sufficient encroachments could ever take place along these streams to raise flood elevations significantly.

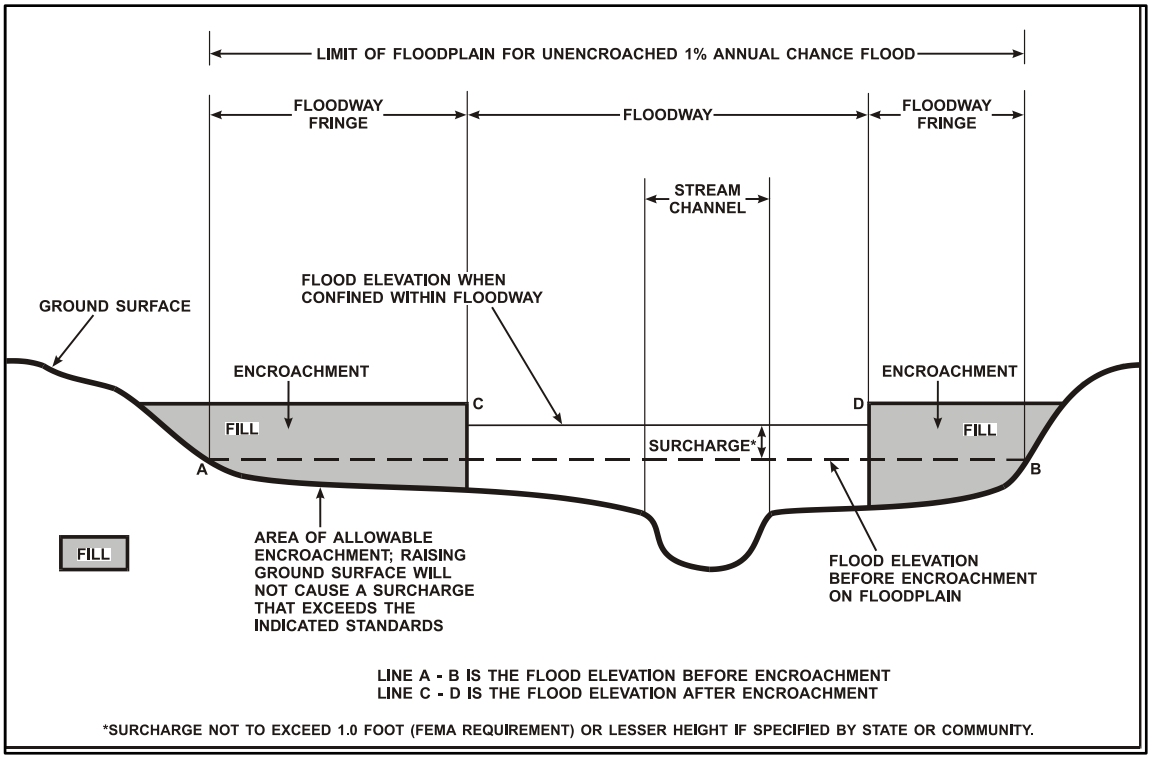

Figure 2: Floodway Schematic

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH[2] (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE
Sabine River								
A	7,000	10,600	52,479	2.2	11.5	4.9[3]	5.9[3]	1.0
B	10,000	12,600	61,742	1.8	11.2	5.1[3]	6.0[3]	0.9
C	13,500	11,200	57,226	2.0	11.0	5.2[3]	6.2[3]	1.0
D	14,500	11,200	59,035	1.9	10.9	5.3[3]	6.2[3]	0.9
E	18,700	9,500	63,874	1.8	10.5	5.8[3]	6.7[3]	0.9
F	21,200	8,400	67,931	1.7	10.3	6.0[3]	7.0[3]	1.0
G	22,900	11,470	72,543	1.6	10.2	6.1[3]	7.1[3]	1.0
H	29,700	15,500	90,566	1.3	9.7	7.1[3]	7.9[3]	0.8
I	34,000	17,200	38,273	3.0	9.5	7.6[3]	8.4[3]	0.8
J	34,900	18,300	131,352	0.9	9.4	8.4[3]	9.1[3]	0.7
K	46,250	21,000	150,742	0.8	9.9	9.2[3]	9.9[3]	0.7
L	59,950	12,300	48,644	2.3	10.2	9.9[3]	10.6[3]	0.7
M	62,120	22,100	190,919	0.6	11.2	11.2	11.9	0.7
N	73,620	16,400	142,009	0.8	12.2	12.2	12.9	0.7
O	80,620	12,800	122,581	0.9	13.1	13.1	14.0	0.9
P	91,820	15,200	154,278	0.7	14.1	14.1	15.1	1.0
Q	98,320	17,400	171,972	0.7	14.6	14.6	15.6	1.0
R	104,420	18,200	157,277	0.7	15.1	15.1	16.1	1.0
S	116,320	17,300	132,075	0.9	15.9	15.9	16.9	1.0
T	135,730	16,400	124,040	0.9	18.2	18.2	19.0	0.8
U	165,310	11,688	89,011	1.3	22.8	22.8	23.7	0.9

[1] Feet above parish boundary
[2] This width extends beyond the parish boundary
[3] Elevation computed without consideration of combined surge and riverine effects

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CALCASIEU PARISH, LA

AND INCORPORATED AREAS

FLOODWAY DATA

SABINE RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH[2] (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE
Sabine River								
V	180,358	16,133	127,750	0.9	24.0	24.0	24.9	0.9
W	191,608	12,843	124,052	0.9	24.8	24.8	25.8	1.0
X	214,158	10,029	81,172	1.0	26.8	26.8	27.7	0.9
Y	236,958	12,400	108,133	1.1	32.3	32.3	33.2	0.9

[1] Feet above parish boundary
[2] This width extends beyond the parish boundary

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CALCASIEU PARISH, LA

AND INCORPORATED AREAS

FLOODWAY DATA

SABINE RIVER

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 A

Zone A is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS report by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base (1-percent-annual-chance) flood elevations (BFEs) or depths are shown within this zone.

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 report by detailed methods. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance rate zone that corresponds to areas of 1-percent-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 detailed hydraulic analyses 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 (sq. mi.), and areas protected from the base flood by levees. No BFEs or depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

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 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- and 0.2-percent-annual-chance floodplains, floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

The parishwide FIRM presents flooding information for the entire geographic area of Calcasieu Parish. Previously, FIRMs were prepared for each incorporated community and the unincorporated areas of the Parish identified as flood-prone. This parishwide FIRM also includes flood-hazard information that was presented separately on Flood Boundary and Floodway Maps (FBFMs), where applicable. Historical data relating to the maps prepared for each community are presented in Table 9, “Community Map History.”

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FLOOD INSURANCE RATE MAP EFFECTIVE DATE	FLOOD INSURANCE RATE MAP REVISIONS DATE
Calcasieu Parish, Unincorporated Areas	September 13, 1974	None	September 29, 1978	January 15, 1988 February 2, 1996 June 8, 1998
DeQuincy, City of	January 16, 1974	November 14, 1975	April 2, 1979	None
Iowa, Town of	May 24, 1974	October 10, 1975	February 4, 1988	December 15, 1990
Lake Charles, City of	November 1, 1974	February 18, 1977	October 16, 1979	July 5, 1984 September 5, 1990 July 3, 1997
Sulphur, City of	May 24, 1974	September 3, 1976	August 16, 1988	September 21, 1998
Vinton, Town of	May 24, 1974	May 21, 1976	July 16, 1981	None
Westlake, City of	May 17, 1974	June 25, 1976	February 3, 1982	None

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

CALCASIEU PARISH, LA

AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

7.0 OTHER STUDIES

Revised flood insurance studies have been prepared for Cameron Parish and Vermilion Parish in Louisiana. This study is compatible with these studies. There are on-going studies in Beauregard Parish and Jefferson Davis Parish in Louisiana and in Orange County, Texas.

This FIS 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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10.0 REVISIONS DESCRIPTIONS

This section has been added to provide information regarding significant revisions made since the original FIS report and FIRM were printed. Future revisions may be made that do not result in the republishing of the FIS report. All users are advised to contact the Community Map Repository to obtain the most up-to-date flood hazard data.

10.1 First Revision (Revised <insert effective date>)

a. Acknowledgements

For the [TBD], FIS revision, Bess Branch and Bess Branch Tributary 1 were studied by approximate methods. In addition floodplains for the Sabine River were redelineated based on LiDAR (Reference 16) and brought into agreement with floodplains for the Sabine River in Newton County, Texas and Beauregard Parish, Louisiana. This work was performed by Risk Assessment, Mapping, and Planning Partners (RAMPP), for FEMA under Contract No. HSFHQ-09-D-0369, Homeland Security Task Order No. HSFE06-11-J-0001. This study was completed in November 2015.

This FIS revision is part of the larger Lower Sabine Watershed HUC-8 (12010002) study covering flooding sources in Calcasieu, Cameron, Sabine, and Vernon Parishes, Louisiana; and Jasper, Newton, and Orange Counties, Texas. Additional materials related to the entire Lower Sabine Watershed study may be obtained by accessing the appropriate Technical Support Data Notebook (TSDN). Interested individuals may contact FEMA to access these data.

For the [TBD], FIS revision, base map information shown on the FIRM was provided in digital format by FEMA, dated 2011; and from Calcasieu Parish dated 2011.

b. Coordination

The initial CCO meeting (study kick-off meeting) was held on April 23, 2013, and attended by representatives from the Natural Resource Conservation Service, the Louisiana NFIP

coordinator, the Sabine River Authority (SRA), FEMA, and the study contractor RAMPP. Additionally a Flood Risk Review meeting was held on June 15, 2015, and attended by representatives from Beauregard Parish, Sabine River Authority, the Louisiana State National Flood Insurance Program Coordinator, FEMA and the study contractor RAMPP.

The results of the [TBD], FIS revision, were reviewed at the final CCO meeting held [TBD], and attended by representatives of FEMA, the Study Contractor and Calcasieu Parish.

c. Scope

Streams previously studied by approximate analyses were restudied using approximate methods if they were located in the LiDAR data extent within the scope of this revision. This included Bess Branch and Bess Branch Tributary 1 in Calcasieu Parish.

In addition the floodplains for the Sabine River were redelineated using the detailed hydraulic analysis for the Sabine River taken from the Newton County, Texas and Incorporated Areas FIS (Reference 50) and updated LiDAR data.

d. Hydrology and Hydraulics

For all new studies, the 10-, 4-, 2-, 1-, and 0.2 percent chance discharges were calculated and have been added to Table 5.

USGS Regression equations for Louisiana and Texas were used to calculate the hydrology of the flood sources in the watershed. The 2009 Regression Equation for Estimation of Annual Peak-Stream flow Frequency for Undeveloped Watershed in Texas Using an L-Moment-Base, Press-Minimized, Residual-Adjusted Approach was the source for all flood sources in Texas. The Louisiana regression equations were obtained from The National Flood-Frequency Program Methods for Estimating Flood Magnitude and Frequency in Rural Areas in Louisiana, 2001. The Louisiana and Texas regression equations were applied to the applicable portions of the watersheds spanning the state boundary, and then the final peak flows were computed using the area-to-flow weighting technique as described in "The National Streamflow Statistics Program: A Computer Program for Estimating Streamflow Statistics for Ungaged Sites".

Regression for Louisiana and Texas utilize precipitation data rasters to determine the average annual rainfall in a drainage area. The precipitation raster dataset for Louisiana was created from the mean annual precipitation map from The National Flood-Frequency Program Methods for Estimating Flood Magnitude and Frequency in Rural Areas in Louisiana. The basin mean annual precipitation was determined by clipping the precipitation raster to the sub-basin extents and determining the raster mean value using ArcGIS tools. The 2009 Regression Equation for Estimation of Annual Peak-Stream flow Frequency for Undeveloped Watershed in Texas Using an L-Moment-Base, Press-Minimized, Residual-Adjusted Approach report states that any general and authoritative source of mean annual precipitation for any long period is sufficient for substitution in the equation. The precipitation raster dataset was obtained from Oregon State University's Parameter-Elevation Regressions on Independent Slopes Model (PRISM) website, http://www.prism.oregonstate.edu/. The mean annual precipitation data is for the climatological period from 1981 to 2010. The precipitation units of original raster data are in millimeters, so the units were converted to inches. The mean annual precipitation was assigned at the center of the watersheds. ArcMap tools were used to determine the center location of each drainage area and a point was placed at the center of the basin. The mean annual precipitation was determined at the center location of the drainage area.

Hydraulics for all approximate analyses were studied and refined by automated approximate methods. For WSELs determined using approximate methods, HEC-RAS version 4.1.0 and the HEC-GeoRAS ArcGIS extension version 10.1 were used to assist in the hydraulic computations. Cross sections were cut from the topographic data using GeoRAS within an Esri ArcMap version 10.1 GIS platform. Large rivers were modeled first in order to determine backwater extents in tributaries.

Hydraulic cross sections were placed approximately 500 feet apart. Additional cross sections were placed to account for significant profile inflection points (profile breaks). Cross sections at profile breaks are critical for accuracy in the development of flood elevations. Cross sections were extended to contain all flood frequencies.

Manning's n values for both the channel and overbanks were entered into the hydraulic model to represent the values that were estimated from the available aerial photography. Based on the vegetation and terrain observed in the aerial photography and from data collected in the field reconnaissance, a Manning's n value of 0.045 was selected as the default for main channels, which represents clean, winding, natural streams with some pools, shoals, weeds, and stones. For the floodplains, a Manning's n of 0.1 was used, which represents heavy strands of timber, with a few down trees, little undergrowth, and flood stages below branches. Areas that had cleared forests or were developed used different Manning's n values. A range of 0.03 to 0.045 was used for channel n values and a range of 0.045 to 0.1 was used for overbanks areas.

Expansion and contraction loss coefficients were applied to all crossing structures within the HEC-RAS model to account for the additional energy losses. Expansion and contraction loss coefficients were applied between cross sections to account for losses to the changing width of the channel.

In addition floodplains for the Sabine River were redelineated using the detailed hydraulic analysis for the Sabine River was taken from the Newtown County, Texas and Incorporated Areas FIS (Reference 50) and updated LiDAR data.

Floodplain boundaries for approximate studies, and redelineation were interpolated using LiDAR data that were provided by the communities in Louisiana and Texas. Floodway for the Sabine River redelineation was taken from the effective FIRMs.

e. Other Studies

As noted previously, this revision is part of a larger Lower Sabine Watershed HUC-8 (12010002) study covering flooding sources in Calcasieu, Cameron, Sabine, and Vernon Parishes, Louisiana; and Jasper, Newton, and Orange Counties, Texas. As such floodplain boundaries within the Watershed were adjusted to match across county and parish boundaries.

In addition Calcasieu Parish has conducted drainage studies on Laterals 13, 13A, 13B, 13C and 13E as part of the Sabine-Lacassine Basins Stormwater Master Plan (Reference 54). While the results of this study were considered, it was determined that except for portions of Laterals 13A and 13E, backwater effects from the Sabine River would control the floodplains in this area. Floodplains for Laterals 13A and 13E above the Sabine River floodplain were taken from this study.

g. Additional Considerations

This revision to the Calcasieu Parishwide FIS incorporates new analysis and mapping information for FIRM panels 22019C0020H, 22019C0040H, 22019C0045H, 22019C0185H, 22019C0205H, 22019C0210H, 22019C0215H, 22019C0220H, 22019C0380H, and

22019C0385H. This section presents important considerations for using the information contained in this FIS Report and in the FIRM panels updated by this revision. These considerations include changes in format and content. Figures 3 and 4 present information that applies to using the updated FIRM panels with the FIS Report.

Each FIRM panel may contain specific notes to the user that provide additional information regarding the flood hazard data shown on that map. However, the FIRM panel does not contain enough space to show all the notes that may be relevant in helping to better understand the information on the panel. Figure 3 contains the full list of these notes.

Figure 3: 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 Flood Map Service Center website at 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 Flood 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 Flood Map Service Center at the number listed above.

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 Non-Coastal 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.

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.

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.

Figure 3: FIRM Notes to Users (continued)

PROJECTION INFORMATION: The projection used in the preparation of the map was State Plane Louisiana South Zone (FIPS 1702). The horizontal datum was NAD83, GRS1980 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. 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, 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

Local vertical monuments may have been used to create the map.

BASE MAP INFORMATION: Base map information shown on the FIRM was provided in digital format by FEMA, dated 2011 and from Calcasieu Parish dated 2011.

The map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables may reflect stream channel distances that differ from what is shown on the map.

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.

NOTES FOR FIRM INDEX

REVISIONS TO INDEX: Future revisions to this FIRM index will only be issued to communities that are located on FIRM panels being revised. This FIRM Index remains valid for FIRM panels dated _____ or earlier. Please refer to the "MOST RECENT FIRM PANEL DATE" Column in the Listing of Communities table to determine the most recent FIRM index date for each community.

SPECIAL NOTES FOR SPECIFIC FIRM PANELS

This Note to Users section was created specifically for Calcasieu Parish, Louisiana, effective <insert effective date of revision>.

Each FIRM panel contains an abbreviated legend for the features shown on the maps. However, the FIRM panel does not contain enough space to show the legend for all map features. Figure 4 shows the full legend of all map features. Note that not all of these features may appear on the FIRM panels in Calcasieu Parish.

Figure 4: 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 4: Map Legend for FIRM (continued)

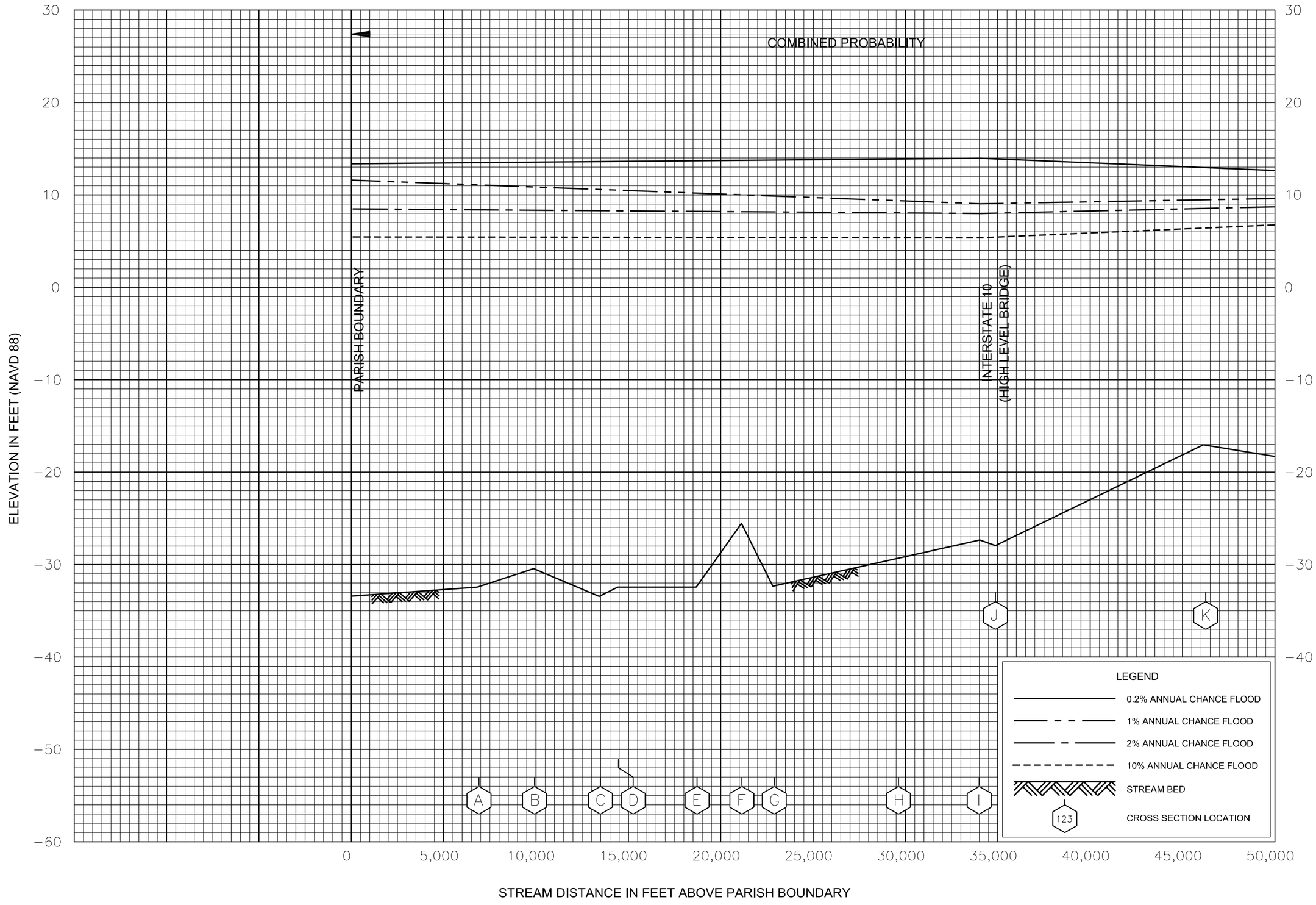
OTHER AREAS OF FLOOD HAZARD	
	Shaded Zone X: Areas of 0.2% annual chance flood hazards and areas of 1% annual chance flood hazards with average depths of less than 1 foot or with drainage areas less than 1 square mile.
	Future Conditions 1% Annual Chance Flood Hazard – Zone X: The flood insurance rate 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
	Levee, Dike or Floodwall
Bridge	Bridge

Figure 4: Map Legend for FIRM (continued)

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.*	
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)
ZONE AO (DEPTH 2)	Zone designation with Depth
ZONE AO (DEPTH 2) (VEL 15 FPS)	Zone designation with Depth and Velocity

Figure 4: Map Legend for FIRM (continued)

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)



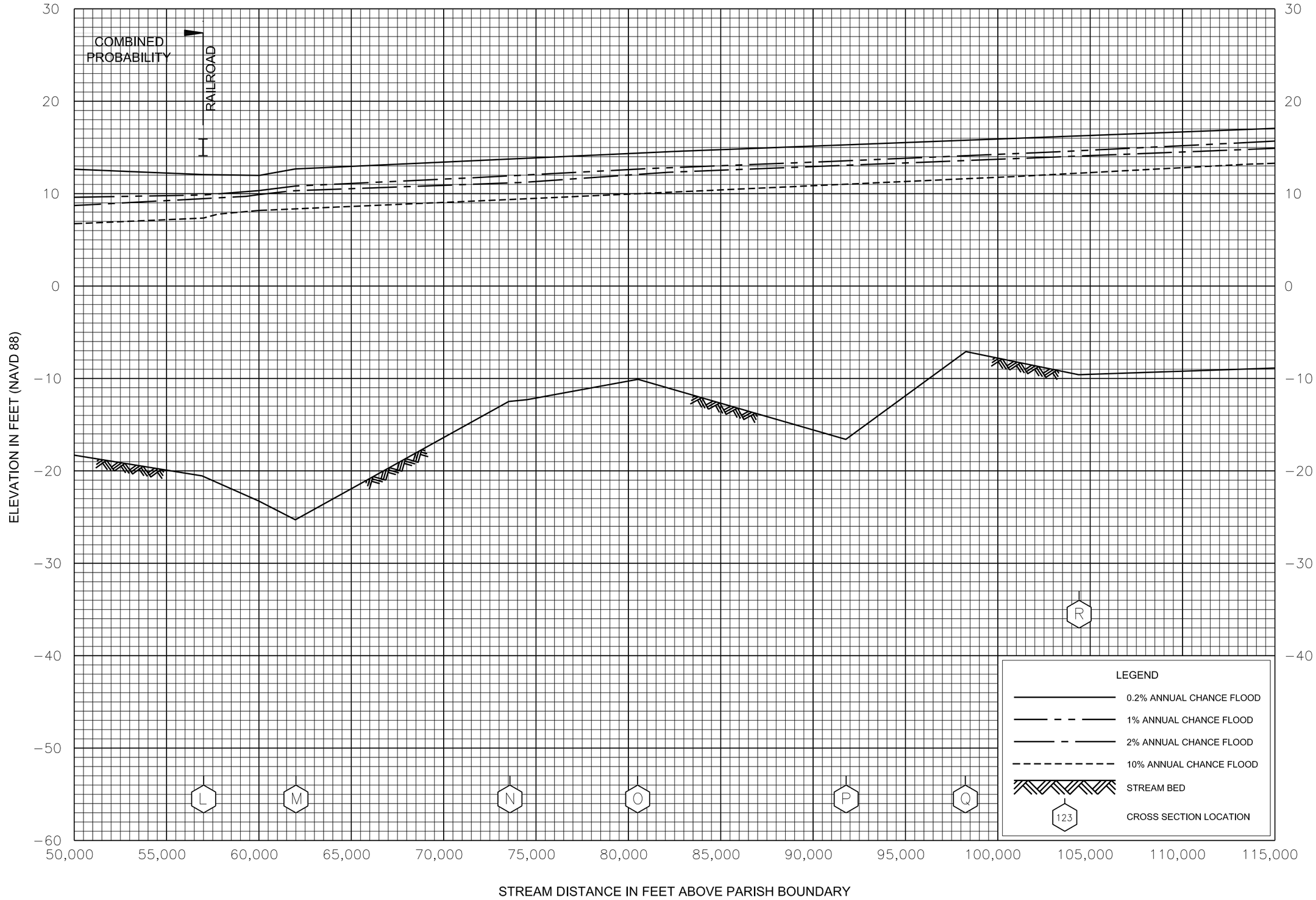
FLOOD PROFILES

SABINE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CALCASIEU PARISH, LA
AND INCORPORATED AREAS

105P



FLOOD PROFILES

SABINE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CALCASIEU PARISH, LA
AND INCORPORATED AREAS

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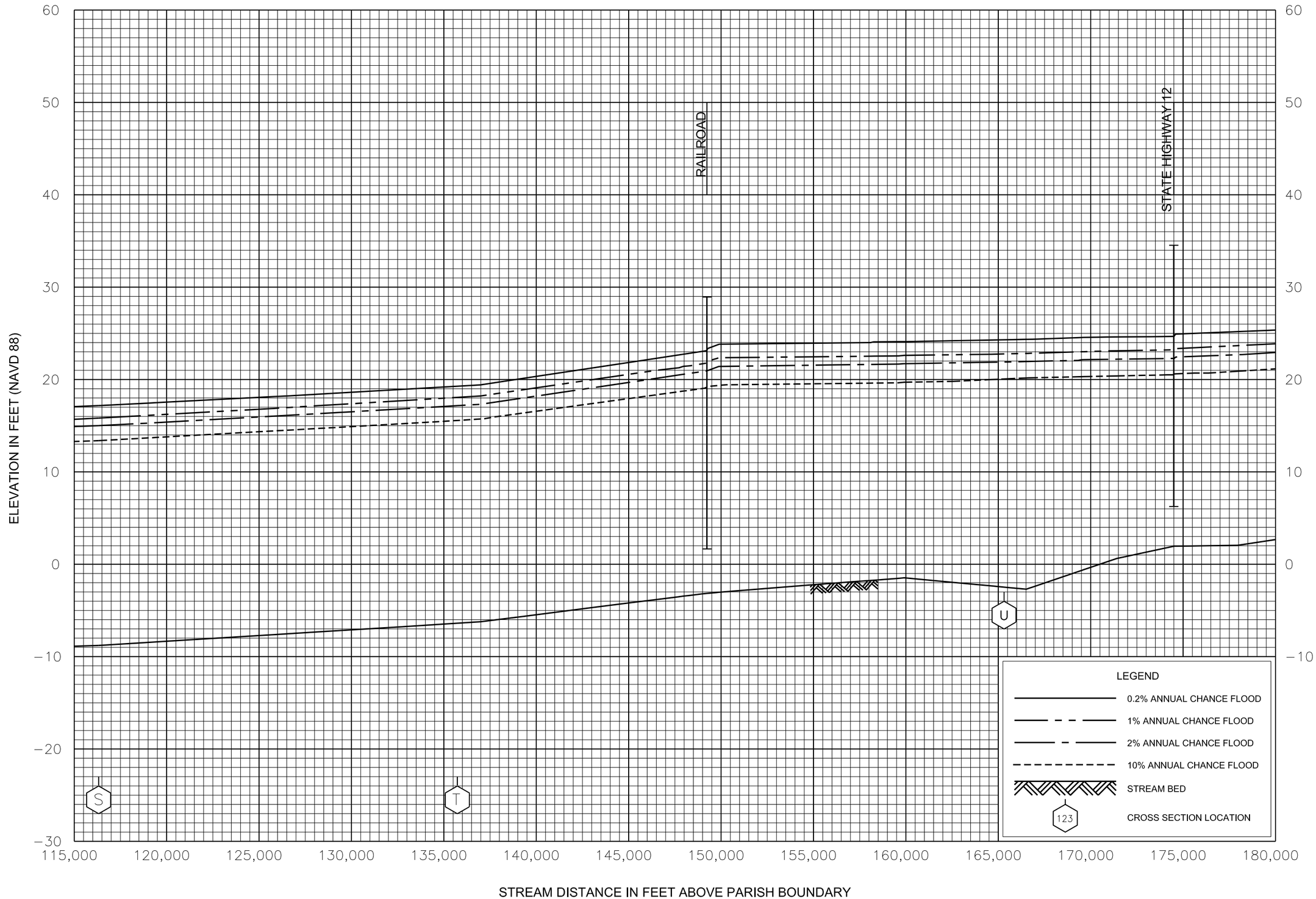
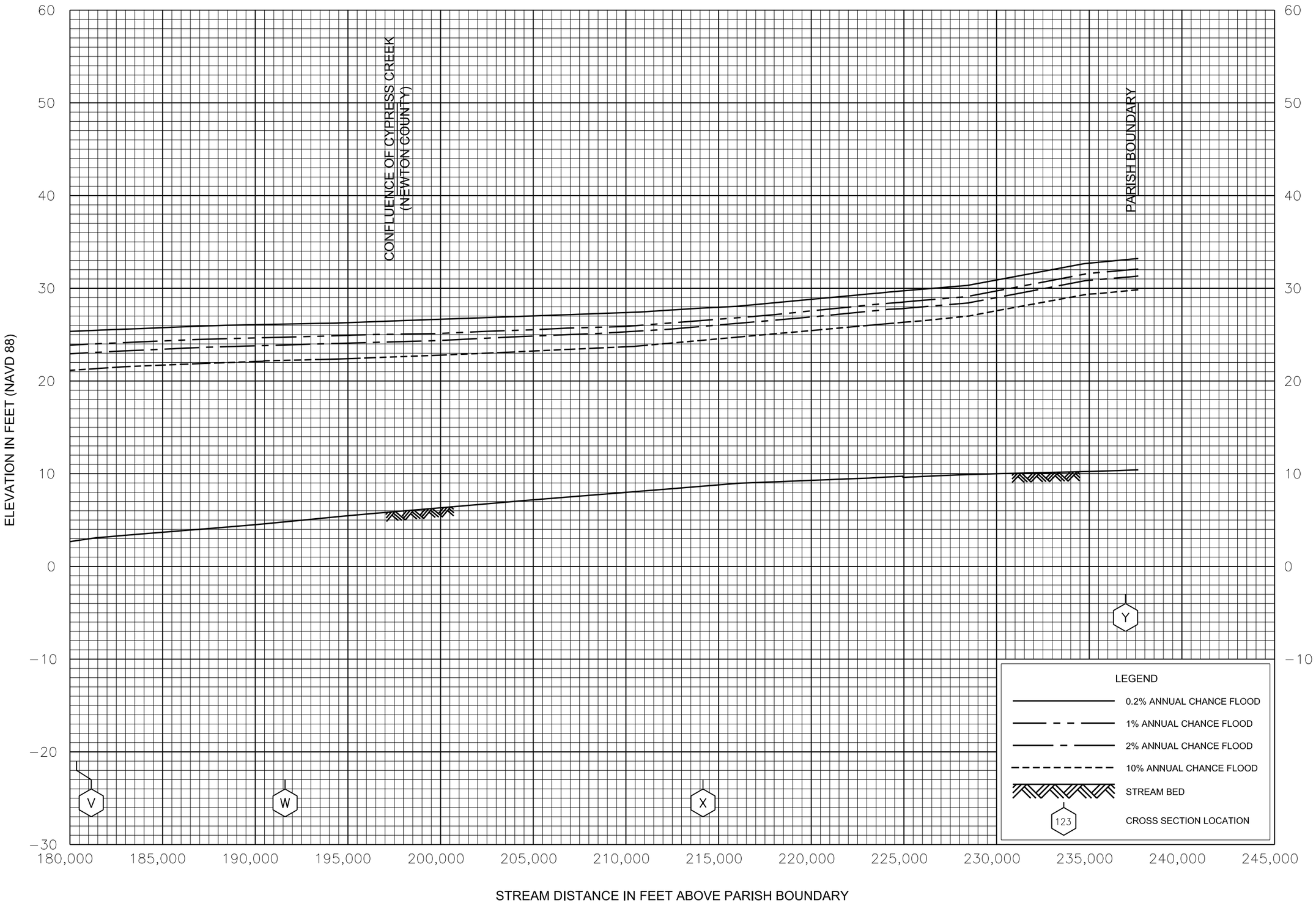


FLOOD PROFILES

SABINE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CALCASIEU PARISH, LA
AND INCORPORATED AREAS



FLOOD PROFILES

SABINE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CALCASIEU PARISH, LA
AND INCORPORATED AREAS